

## Crystal Oscillator / Clock Generator with optional SSC

### FEATURES

- Part of a Family of Easy to use Clock Generator Devices With Optional SSC
- Crystal Oscillator With Integrated Crystal Capacitors, Selectable Output Frequency and Selectable SSC
- SSC Controllable via 2 External Pins
  - $\pm 0\%$ ,  $\pm 0.5\%$ ,  $\pm 1\%$ ,  $\pm 2\%$  Center Spread
- Frequency Multiplication Selectable Between x1 or x4 With one External Control Pin
- Single 3.3V Device Power Supply
- Wide Temperature Range  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$
- Low space Consumption by 8 pin TSSOP Package

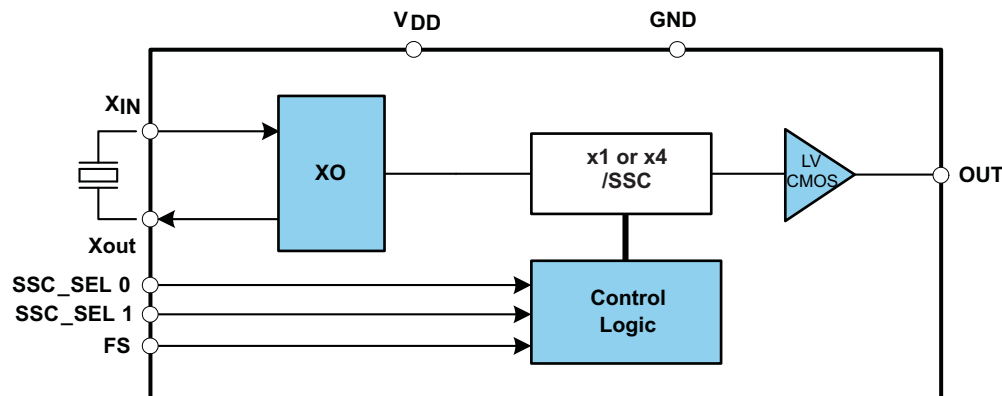
### APPLICATIONS

- Consumer and Industrial Applications requiring Crystal Oscillator with the possibility of EMI reduction through Spread Spectrum Clocking

### PACKAGE

XIN	1		8	XOUT
SSC_SEL 0	2		7	VDD
SSC_SEL 1	3	CDCS502	6	OUT
GND	4		5	FS

### BLOCK DIAGRAM



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.



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.

## DESCRIPTION

The CDCS502 is a spread spectrum capable, fundamental mode crystal oscillator with selectable frequency multiplication.

It features an advanced gain controlled fundamental mode crystal oscillator stage with a built-in load capacitance of 10pF. This oscillator stage accepts crystals from 8MHz to 32MHz with an ESR of up to 180Ω. The stage can be used with crystals with power dissipation of 50μW and up.

The input signal is processed by a PLL, whose output frequency is either equal to the input frequency or multiplied by the factor of 4.

The PLL is also able to spread the clock signal by ±0%, ±0.5%, ±1% or ±2% centered around the output clock frequency with an triangular modulation.

By this, the device can generate output frequencies between 8MHz and 108MHz with or without SSC from a fundamental mode crystal.

In x1 Mode with an SSC amount of 0%, the device works as a standard crystal oscillator and does not make use of the built in PLL.

The CDCS502 operates in 3.3V environment.

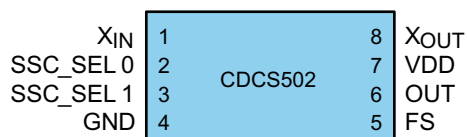
It is characterized for operation from –40°C to 85°C. It is offered in an 8 Pin TSSOP package.

## FUNCTION TABLE

FS	SSC_SEL 0	SSC_SEL 1	SSC Amount	$f_{OUT}/f_{IN}$	$f_{OUT}$ at $f_{in} = 27 \text{ MHz}$
0	0	0	±0.00%	1	27 MHz <sup>(1)</sup>
0	0	1	±0.50%	1	27 MHz
0	1	0	±1.00%	1	27 MHz
0	1	1	±2.00%	1	27 MHz
1	0	0	±0.00%	4	108 MHz
1	0	1	±0.50%	4	108 MHz
1	1	0	±1.00%	4	108 MHz
1	1	1	±2.00%	4	108 MHz

(1) In this mode the signal from the crystal bypasses the internal PLL for maximum performance.

## PACKAGE



## PIN FUNCTIONS

SIGNAL	PIN	TYPE	DESCRIPTION
X <sub>IN</sub>	1	I	Crystal Input
X <sub>OUT</sub>	8	O	Crystal Output
OUT	6	O	LVC MOS Clock Output
SSC_SEL 0, 1	2, 3	I	Spread Selection Pins, internal pull-up
FS	5	I	Frequency Multiplication Selection, internal pull-up
V <sub>DD</sub>	7	Power	3.3V Power Supply
GND	4	Ground	Ground

**PACKAGE THERMAL RESISTANCE FOR TSSOP (PW) PACKAGE<sup>(1)</sup>**

CDCV304PW 8-PIN TSSOP				THERMAL AIR FLOW (CFM)				UNIT
				0	150	250	500	
R <sub>θJA</sub>	High K			149	142	138	132	°C/W
R <sub>θJA</sub>	Low K			230	185	170	150	°C/W
R <sub>θJC</sub>	High K	65						°C/W
R <sub>θJC</sub>	High K	69						°C/W

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

**ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>**

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

		VALUE	UNIT
V <sub>DD</sub>	Supply voltage range	–0.5 to 4.6	V
V <sub>IN</sub>	Input voltage range	–0.5 to 4.6	V
V <sub>out</sub>	Output voltage range	–0.5 to 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>ST</sub>	Storage temperature range	–65 to 150	°C
T <sub>J</sub>	Maximum junction temperature	125	°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.

**RECOMMENDED OPERATING CONDITIONS**

		MIN	NOM	MAX	UNIT
V <sub>DD</sub>	Supply voltage	3.0		3.6	V
f <sub>IN</sub>	Input Frequency	8		32	MHz
V <sub>IL</sub>	Low level input voltage LVCMOS			0.3 VDD	V
V <sub>IH</sub>	High level input voltage LVCMOS	0.7 VDD			V
V <sub>I</sub>	Input Voltage threshold LVCMOS		0.5 VDD		V
C <sub>L</sub>	Output Test Load LVCMOS			10	pF
I <sub>OH</sub> /I <sub>OL</sub>	Output Current			12	mA
T <sub>A</sub>	Operating free-air temperature	–40		85	°C

**RECOMMENDED CRYSTAL SPECIFICATIONS<sup>(1)</sup>**

PARAMETER	CONDITIONS	MIN	NOM	MAX	UNIT
f <sub>X-tal</sub>	Crystal input frequency range	8		32	MHz
	FS = 1	8		27	
ESR	Effective series resistance <sup>(2)</sup>			180	Ω
C <sub>L</sub>	On-chip load capacitance at Xin and Xout		10		pF
T <sub>X-tal</sub>	Crystal power dissipation	50			μW

(1) For further details on the crystal, see the crystal part in the Applications section

(2) With 5 pF crystal package parallel capacitance

## DEVICE CHARACTERISTICS

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

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
IDD      Device supply current	$f_{out} = 20 \text{ MHz}$ ; FS = 0, no SSC		8		mA
	$f_{out} = 20 \text{ MHz}$ ; FS = 0, SSC = 2%		18		
	$f_{out} = 70 \text{ MHz}$ ; FS = 1, SSC = 2%		22		
$f_{OUT}$ Output frequency	FS = 0	8		32	MHz
	FS = 1	32		108	MHz
$I_{IH}$ LVCMOS input current	$V_I = V_{DD}$ ; $V_{DD} = 3.6 \text{ V}$			10	$\mu\text{A}$
$I_{IL}$ LVCMOS input current	$V_I = 0 \text{ V}$ ; $V_{DD} = 3.6 \text{ V}$			-10	$\mu\text{A}$
$V_{OH}$ LVCMOS high-level output voltage	$I_{OH} = -0.1 \text{ mA}$	2.9			V
	$I_{OH} = -8 \text{ mA}$	2.4			
	$I_{OH} = -12 \text{ mA}$	2.2			
$V_{OL}$ 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	
$t_{jit(CC)}$ Cycle to cycle jitter	$f_{out} = 108 \text{ MHz}$ ; FS = 1, SSC = 1%, 10000 Cycles		100		ps
$t_r/t_f$ Rise and fall time	20%–80%		0.75		ns
$O_{dc}$ Output duty cycle	PLL active	45%		55%	
$f_{MOD}$ Modulation frequency			30		kHz

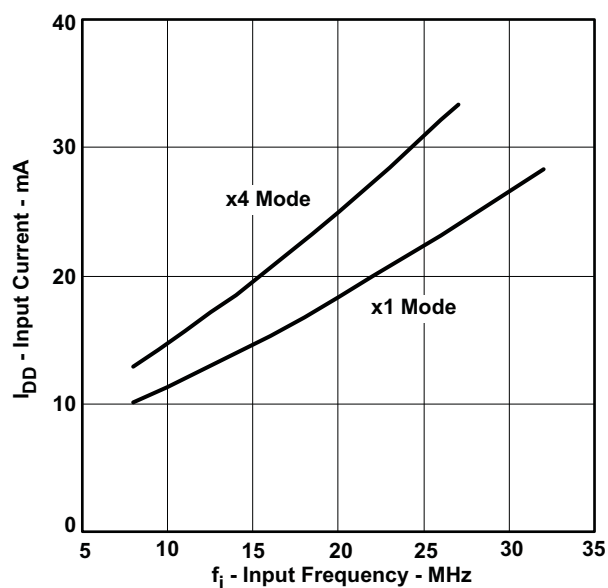


Figure 1. IDD vs Input Frequency, VCC = 3.3V, SSC = 2%

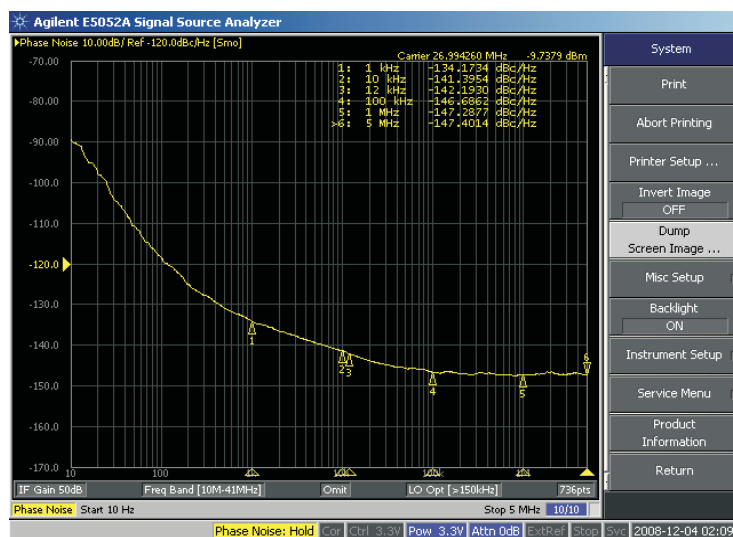


Figure 2. Phase Noise Plot, x1 Mode, 0% SSC, 27 MHz Crystal

## APPLICATION INFORMATION

### SELECTION OF A CRYSTAL

The CDCS502 requires a crystal with a frequency between 8 and 32 MHz (27MHz in x4 Mode). The crystal stage is designed with an internal load capacitance of 10pF for crystals with this shunt load capacitance. If a slightly bigger capacity than 10pF is needed, small external capacitors can be used to get to this value. This solution however might influence the power-up behavior of the crystal stage, so using a 10pF load capacitance crystal is highly recommended.

For further details on capacitive load calculation, see application report ([SCAA085](#)).

#### NOTE:

Even though the CDCS502 is characterized down to  $-40^{\circ}\text{C}$ , a standard crystal is usually not rated for operation at this low temperature.

### SSC MODULATION

The exact implementation of the SSC modulation plays a vital role for the EMI reduction. The CDCS502 uses a triangular modulation scheme implemented in a way that the modulation frequency depends on the VCO frequency of the internal PLL and the spread amount is independent from the VCO frequency.

The modulation frequency can be calculated by using one of the below formulas chosen by frequency multiplication mode.

$$\text{FS}=0: f_{\text{mod}} = f_{\text{IN}} / 708$$

$$\text{FS}=1: f_{\text{mod}} = f_{\text{IN}} / 620$$

### PARAMETER MEASUREMENT INFORMATION

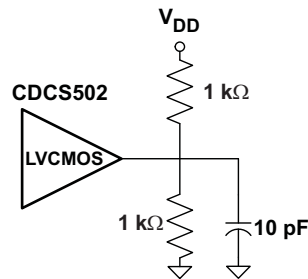


Figure 3. Test Load

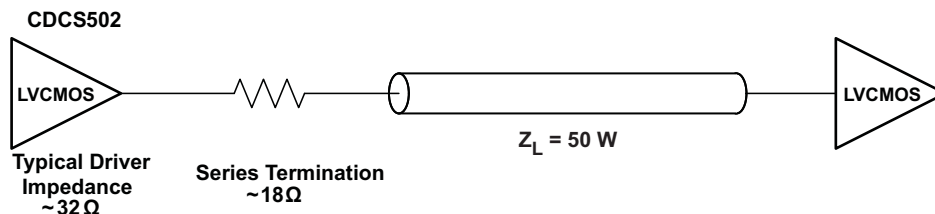


Figure 4. Test Load for 50-Ω Board Environment

## PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package   Pins	Package qty   Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
<a href="#">CDCS502PW</a>	Active	Production	TSSOP (PW)   8	150   TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	CS502
CDCS502PW.B	Active	Production	TSSOP (PW)   8	150   TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	CS502
<a href="#">CDCS502PWR</a>	Active	Production	TSSOP (PW)   8	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	CS502
CDCS502PWR.B	Active	Production	TSSOP (PW)   8	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	CS502
CDCS502PWRG4.B	Active	Production	TSSOP (PW)   8	2000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	CS502

<sup>(1)</sup> **Status:** For more details on status, see our [product life cycle](#).

<sup>(2)</sup> **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

<sup>(3)</sup> **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

<sup>(4)</sup> **Lead finish/Ball material:** Parts 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.

<sup>(5)</sup> **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

<sup>(6)</sup> **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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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
CDCS502PWR	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)
CDCS502PWR	TSSOP	PW	8	2000	356.0	356.0	35.0

## TUBE



\*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μm)	B (mm)
CDCS502PW	PW	TSSOP	8	150	530	10.2	3600	3.5
CDCS502PW.B	PW	TSSOP	8	150	530	10.2	3600	3.5

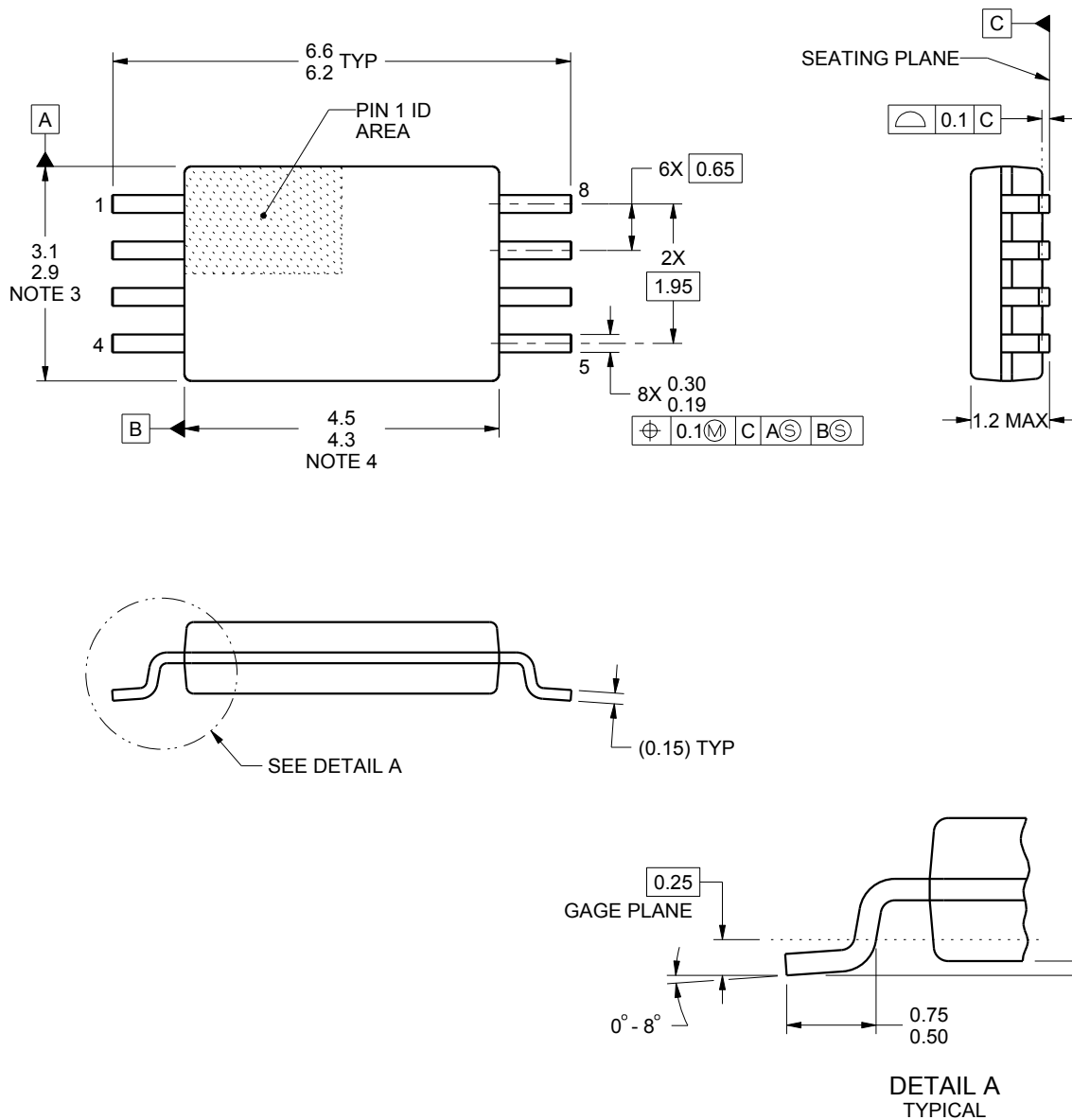
PW0008A



# PACKAGE OUTLINE

## TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



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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. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-153, variation AA.

# EXAMPLE BOARD LAYOUT

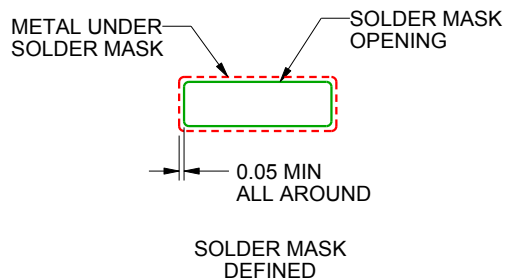
PW0008A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
SCALE:10X



SOLDER MASK DETAILS  
NOT TO SCALE

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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.

## EXAMPLE STENCIL DESIGN

PW0008A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



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

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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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