

CDx4HC4002 高速 CMOS 逻辑双路 4 输入或非门

1 特性

- $V_{CC} = 5V$ 、 $C_L = 15pF$ 且 $T_A = 25^\circ C$ 时的传播延迟典型值为 8ns
- 扇出 (超出温度范围)
 - 标准输出: 10 个 LSTTL 负载
 - 总线驱动器输出: 15 个 LSTTL 负载
- 宽工作温度范围: $-55^\circ C$ 至 $125^\circ C$
- 平衡的传播延迟及转换时间
- 与 LSTTL 逻辑 IC 相比, 功耗显著降低
- HC 类型
 - 2 V 至 6 V 范围内运行
 - 高抗噪性: 当 $V_{CC} = 5 V$ 时, $N_{IL} = 30\%$, $N_{IH} = V_{CC}$ 的 30%

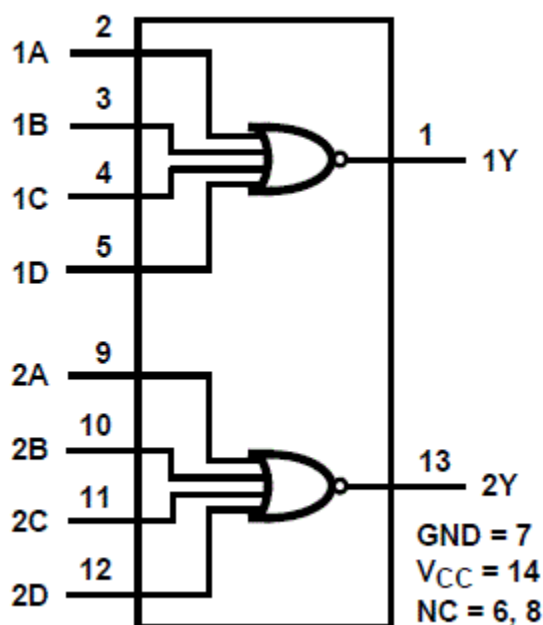
2 说明

HC4002 逻辑门利用硅栅 CMOS 技术, 在标准 CMOS 集成电路的低功耗下实现与 LSTTL 电路各门接近的运行速度。所有器件都能够驱动 10 LSTTL 负载。HC4002 系列逻辑器件功能齐全, 并与标准 LS 系列逻辑器件引脚兼容。

器件信息

| 零件编号 | 封装 ⁽¹⁾ | 封装尺寸 (标称值) |
|---------------|-------------------|--------------------|
| CD74HC4002M | SOIC (14) | 8.65 mm × 3.9 mm |
| CD54HC4002F3A | CDIP (14) | 19.55 mm × 6.71 mm |
| CD74HC4002E | PDIP (14) | 19.31mm × 6.35mm |
| CD74HC4002PW | TSSOP (14) | 5.0mm × 4.4mm |

(1) 如需了解所有可用封装, 请参阅数据表末尾的可订购产品附录。



功能方框图



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3 Revision History

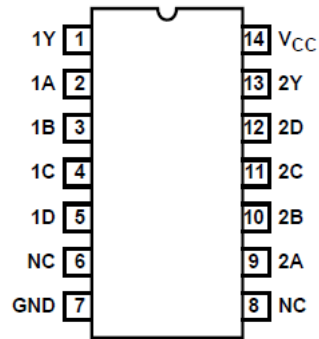
注：以前版本的页码可能与当前版本的页码不同

Changes from Revision E (October 2003) to Revision F (February 2022)

Page

- 更新了整个文档中的编号、格式、表格、图和交叉参考，以反映现代数据表标准..... 1

4 Pin Configuration and Functions



J, N, D, or PW package
14-Pin CDIP, PDIP, SOIC, or TSSOP
Top View

5 Specifications

5.1 Absolute Maximum Ratings

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

| | | MIN | MAX | UNIT |
|------------------|--|---|------|------------|
| V _{CC} | Supply voltage | - 0.5 | 7 | V |
| I _{IK} | Input diode current | For V _I < -0.5 V or V _I > V _{CC} + 0.5 V | | ± 20 mA |
| I _{OK} | Output diode current | For V _O < -0.5 V or V _O > V _{CC} + 0.5 V | | ± 20 mA |
| I _O | Output source or sink current per output pin | For V _O > -0.5 V or V _O < V _{CC} + 0.5 V | | ± 25 mA |
| | Continuous current V _{CC} or ground current | | ± 50 | mA |
| T _J | Junction temperature | | 150 | |
| T _{stg} | Storage temperature range | - 65 | 150 | |
| | Lead temperature (Soldering 10s) (SOIC - lead tips only) | | 300 | |

- (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.

5.2 Recommended Operating Conditions

| | | MIN | MAX | UNIT | |
|---------------------------------|--------------------------|-----------|-----------------|------|---|
| V _{CC} | Supply voltage range | HC Types | 2 | 6 | V |
| | | HCT Types | 4.5 | 5.5 | V |
| V _I , V _O | Input or output voltage | 0 | V _{CC} | V | |
| t _t | Input rise and fall time | 2 V | 1000 | ns | |
| | | 4.5 V | 500 | ns | |
| | | 6 V | 400 | ns | |
| T _A | Temperature range | - 55 | 125 | °C | |

5.3 Thermal Information

| THERMAL METRIC | | D (SOIC) | N (PDIP) | NS (SO) | PW (TSSOP) | UNIT |
|------------------|---|----------|----------|---------|------------|------|
| | | 14 PINS | 14 PINS | 14 PINS | 14 PINS | |
| R _{θJA} | Junction-to-ambient thermal resistance ⁽¹⁾ | 86 | 80 | 76 | 113 | °C/W |

- (1) For more information about traditional and new thermal metrics, see the [Semiconductor and IC package thermal metrics](#) application report.

5.4 Electrical Characteristics

| PARAMETER | TEST CONDITIONS ⁽¹⁾ | V _{CC} (V) | 25 °C | | | -40°C to 85°C | | -55°C to 125°C | | UNIT |
|-----------------|--------------------------------|---|-------|------|------|---------------|------|----------------|------|------|
| | | | MIN | TYP | MAX | MIN | MAX | MIN | MAX | |
| V _{IH} | High level input voltage | 2 | 1.5 | | | 1.5 | | 1.5 | | V |
| | | 4.5 | 3.15 | | | 3.15 | | 3.15 | | V |
| | | 6 | 4.2 | | | 4.2 | | 4.2 | | V |
| V _{IL} | Low level input voltage | 2 | | | 0.5 | | 0.5 | | 0.5 | V |
| | | 4.5 | | | 1.35 | | 1.35 | | 1.35 | V |
| | | 6 | | | 1.8 | | 1.8 | | 1.8 | V |
| V _{OH} | High level output voltage | I _{OH} = - 20 μA | 2 | 1.9 | | 1.9 | | 1.9 | | V |
| | | I _{OH} = - 20 μA | 4.5 | 4.4 | | 4.4 | | 4.4 | | V |
| | | I _{OH} = - 20 μA | 6 | 5.9 | | 5.9 | | 5.9 | | V |
| | High level output voltage | I _{OH} = - 4 mA | 4.5 | 3.98 | | 3.84 | | 3.7 | | V |
| | | I _{OH} = - 5.2 mA | 6 | 5.48 | | 5.34 | | 5.2 | | V |
| V _{OL} | Low level output voltage | I _{OL} = 20 μA | 2 | | 0.1 | | 0.1 | | 0.1 | V |
| | | I _{OL} = 20 μA | 4.5 | | 0.1 | | 0.1 | | 0.1 | V |
| | | I _{OL} = 20 μA | 6 | | 0.1 | | 0.1 | | 0.1 | V |
| | Low level output voltage | I _{OL} = 4 mA | 4.5 | | 0.26 | | 0.33 | | 0.4 | V |
| | | I _{OL} = 5.2 mA | 6 | | 0.26 | | 0.33 | | 0.4 | V |
| I _I | Input leakage current | V _I = V _{CC} or GND | 6 | | ±0.1 | | ±1 | | ±1 | μA |
| I _{CC} | Supply current | V _I = V _{CC} or GND | 6 | | 2 | | 20 | | 40 | μA |

(1) V_I = V_{IH} or V_{IL}, unless otherwise noted.

5.5 Switching Characteristics

Input t_r, t_f = 6 ns

| PARAMETER | TEST CONDITIONS | V _{CC} (V) | 25°C | | -40°C to 85°C | -55°C to 125°C | UNIT |
|-------------------------------------|--|------------------------|------|-----|---------------|----------------|------|
| | | | TYP | MAX | MAX | MAX | |
| HC TYPES | | | | | | | |
| t _{PLH} , t _{PHL} | Propagation delay, nA, nB, nC, nD to nY | C _L = 50 pF | 2 | 100 | 125 | 150 | ns |
| | | | 4.5 | 20 | 25 | 30 | ns |
| | | | 6 | 17 | 21 | 26 | ns |
| | | C _L = 15 pF | 5 | 8 | | | ns |
| t _{TLH} , t _{THL} | Output transition times (see Figure 1) | C _L = 50 pF | 2 | 75 | 95 | 110 | ns |
| | | | 4.5 | 15 | 19 | 22 | ns |
| | | | 6 | 13 | 16 | 19 | ns |
| C _{IN} | Input capacitance | | | 10 | 10 | 10 | pF |
| C _{PD} | Power dissipation capacitance ^{(1) (2)} | C _L = 15 pF | 5 | 22 | | | pF |

(1) C_{PD} is used to determine the dynamic power consumption, per gate.

(2) P_D = V_{CC}² f_i (C_{PD} + C_L) where f_i = input frequency, C_L = output load capacitance, V_{CC} = supply voltage.

6 Parameter Measurement Information

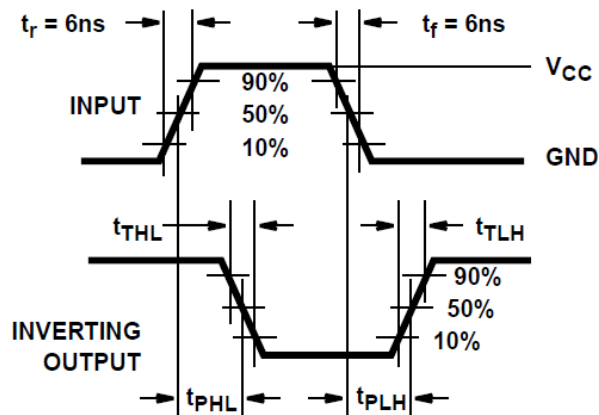


图 6-1. HC and HCU Transition Times and Propagation Delay Times, Combination Logic

7 Detailed Description

7.1 Overview

The ' HC4002 logic gate utilizes silicon gate CMOS technology to achieve operating speeds similar to LSTTL gates with the low power consumption of standard CMOS integrated circuits. All devices have the ability to drive 10 LSTTL loads. The ' HC4002 logic family is functional as well as pin compatible with the standard LS logic family.

7.2 Functional Block Diagram

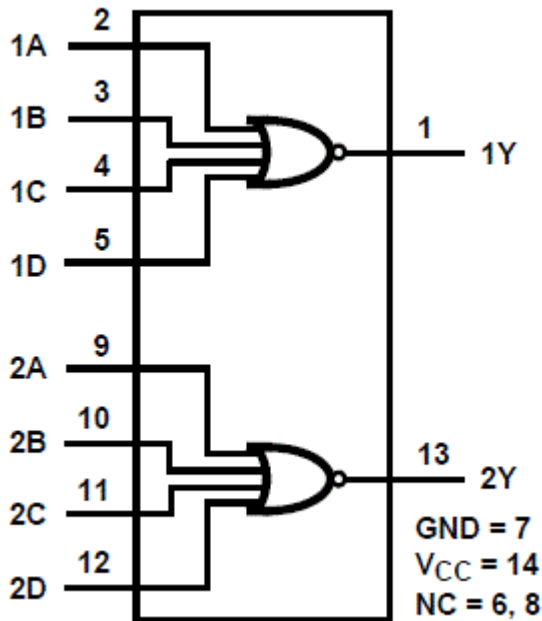


图 7-1. Functional Diagram

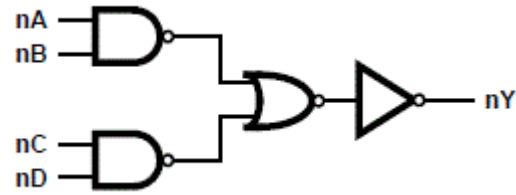


图 7-2. Logic Symbol

7.3 Device Functional Modes

表 7-1. Truth Table⁽¹⁾

| INPUTS | | | | OUTPUT |
|--------|----|----|----|--------|
| nA | nB | nC | nD | nY |
| L | L | L | L | H |
| H | X | X | X | L |
| X | H | X | X | L |
| X | X | H | X | L |
| X | X | X | H | L |

(1) H = High Voltage Level, L = Low Voltage Level, X = Irrelevant

8 Power Supply Recommendations

The power supply can be any voltage between the minimum and maximum supply voltage rating located in the *Recommended Operating Conditions*. Each V_{CC} terminal should have a good bypass capacitor to prevent power disturbance. A 0.1- μ F capacitor is recommended for this device. It is acceptable to parallel multiple bypass caps to reject different frequencies of noise. The 0.1- μ F and 1- μ F capacitors are commonly used in parallel. The bypass capacitor should be installed as close to the power terminal as possible for best results.

9 Layout

9.1 Layout Guidelines

When using multiple-input and multiple-channel logic devices inputs must not ever be left floating. In many cases, functions or parts of functions of digital logic devices are unused; for example, when only two inputs of a triple-input AND gate are used or only 3 of the 4 buffer gates are used. Such unused input pins must not be left unconnected because the undefined voltages at the outside connections result in undefined operational states. All unused inputs of digital logic devices must be connected to a logic high or logic low voltage, as defined by the input voltage specifications, to prevent them from floating. The logic level that must be applied to any particular unused input depends on the function of the device. Generally, the inputs are tied to GND or V_{CC} , whichever makes more sense for the logic function or is more convenient.

10 Device and Documentation Support

TI offers an extensive line of development tools. Tools and software to evaluate the performance of the device, generate code, and develop solutions are listed below.

10.1 接收文档更新通知

要接收文档更新通知，请导航至 ti.com 上的器件产品文件夹。点击 [订阅更新](#) 进行注册，即可每周接收产品信息更改摘要。有关更改的详细信息，请查看任何已修订文档中包含的修订历史记录。

10.2 支持资源

[TI E2E™ 支持论坛](#) 是工程师的重要参考资料，可直接从专家获得快速、经过验证的解答和设计帮助。搜索现有解答或提出自己的问题可获得所需的快速设计帮助。

链接的内容由各个贡献者“按原样”提供。这些内容并不构成 TI 技术规范，并且不一定反映 TI 的观点；请参阅 TI 的 [《使用条款》](#)。

10.3 Trademarks

TI E2E™ is a trademark of Texas Instruments.

所有商标均为其各自所有者的财产。

10.4 Electrostatic Discharge Caution



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

10.5 术语表

[TI 术语表](#) 本术语表列出并解释了术语、首字母缩略词和定义。

11 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.

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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 |
|------------------|---------------|--------------|-----------------|------|-------------|------------------|--------------------------------------|----------------------|--------------|----------------------------|-------------------------|
| CD54HC4002F3A | ACTIVE | CDIP | J | 14 | 25 | Non-RoHS & Green | SNPB | N / A for Pkg Type | -55 to 125 | 8404401CA CD54HC4002F3A | Samples |
| CD74HC4002E | ACTIVE | PDIP | N | 14 | 25 | RoHS & Green | NIPDAU | N / A for Pkg Type | -55 to 125 | CD74HC4002E | Samples |
| CD74HC4002M | OBSOLETE | SOIC | D | 14 | | TBD | Call TI | Call TI | -55 to 125 | HC4002M | |
| CD74HC4002M96 | ACTIVE | SOIC | D | 14 | 2500 | RoHS & Green | NIPDAU SN | Level-1-260C-UNLIM | -55 to 125 | HC4002M | Samples |
| CD74HC4002MT | OBSOLETE | SOIC | D | 14 | | TBD | Call TI | Call TI | -55 to 125 | HC4002M | |
| CD74HC4002PWR | ACTIVE | TSSOP | PW | 14 | 2000 | RoHS & Green | NIPDAU SN | Level-1-260C-UNLIM | -55 to 125 | HJ4002 | 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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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.

OTHER QUALIFIED VERSIONS OF CD54HC4002, CD74HC4002 :

- Catalog : [CD74HC4002](#)
- Military : [CD54HC4002](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product
- Military - QML certified for Military and Defense Applications

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 |
|---------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| CD74HC4002M96 | SOIC | D | 14 | 2500 | 330.0 | 16.4 | 6.5 | 9.0 | 2.1 | 8.0 | 16.0 | Q1 |
| CD74HC4002PWR | TSSOP | PW | 14 | 2000 | 330.0 | 12.4 | 6.9 | 5.6 | 1.6 | 8.0 | 12.0 | Q1 |
| CD74HC4002PWR | TSSOP | PW | 14 | 2000 | 330.0 | 12.4 | 6.9 | 5.6 | 1.6 | 8.0 | 12.0 | Q1 |
| CD74HC4002PWR | TSSOP | PW | 14 | 2000 | 330.0 | 12.4 | 6.85 | 5.45 | 1.6 | 8.0 | 12.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS

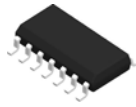

*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---------------|--------------|-----------------|------|------|-------------|------------|-------------|
| CD74HC4002M96 | SOIC | D | 14 | 2500 | 356.0 | 356.0 | 35.0 |
| CD74HC4002PWR | TSSOP | PW | 14 | 2000 | 356.0 | 356.0 | 35.0 |
| CD74HC4002PWR | TSSOP | PW | 14 | 2000 | 356.0 | 356.0 | 35.0 |
| CD74HC4002PWR | TSSOP | PW | 14 | 2000 | 366.0 | 364.0 | 50.0 |

TUBE


*All dimensions are nominal

| Device | Package Name | Package Type | Pins | SPQ | L (mm) | W (mm) | T (μm) | B (mm) |
|-------------|--------------|--------------|------|-----|--------|--------|--------|--------|
| CD74HC4002E | N | PDIP | 14 | 25 | 506 | 13.97 | 11230 | 4.32 |
| CD74HC4002E | N | PDIP | 14 | 25 | 506 | 13.97 | 11230 | 4.32 |

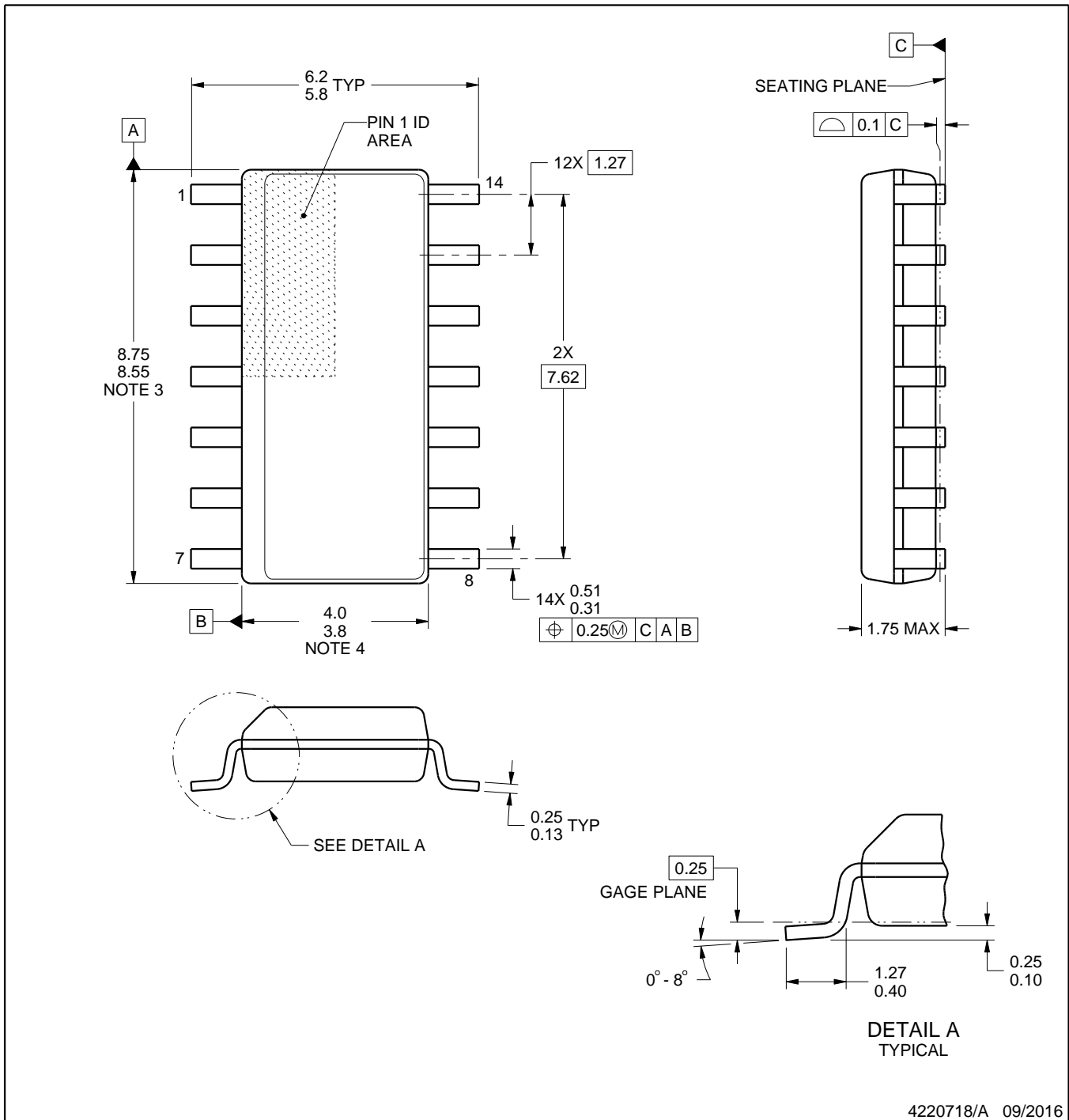


D0014A

PACKAGE OUTLINE

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



4220718/A 09/2016

NOTES:

1. All linear dimensions are in millimeters. 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 0.43 mm, per side.
5. Reference JEDEC registration MS-012, variation AB.

EXAMPLE BOARD LAYOUT

D0014A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



LAND PATTERN EXAMPLE
SCALE:8X



SOLDER MASK DETAILS

4220718/A 09/2016

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

D0014A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:8X

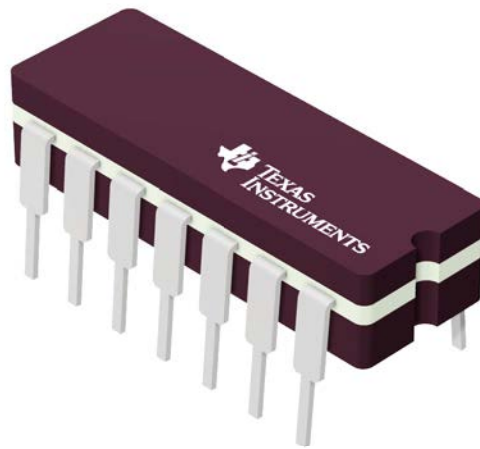
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NOTES: (continued)

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.

J 14

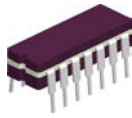
GENERIC PACKAGE VIEW
CDIP - 5.08 mm max height
CERAMIC DUAL IN LINE PACKAGE



Images above are just a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.

4040083-5/G

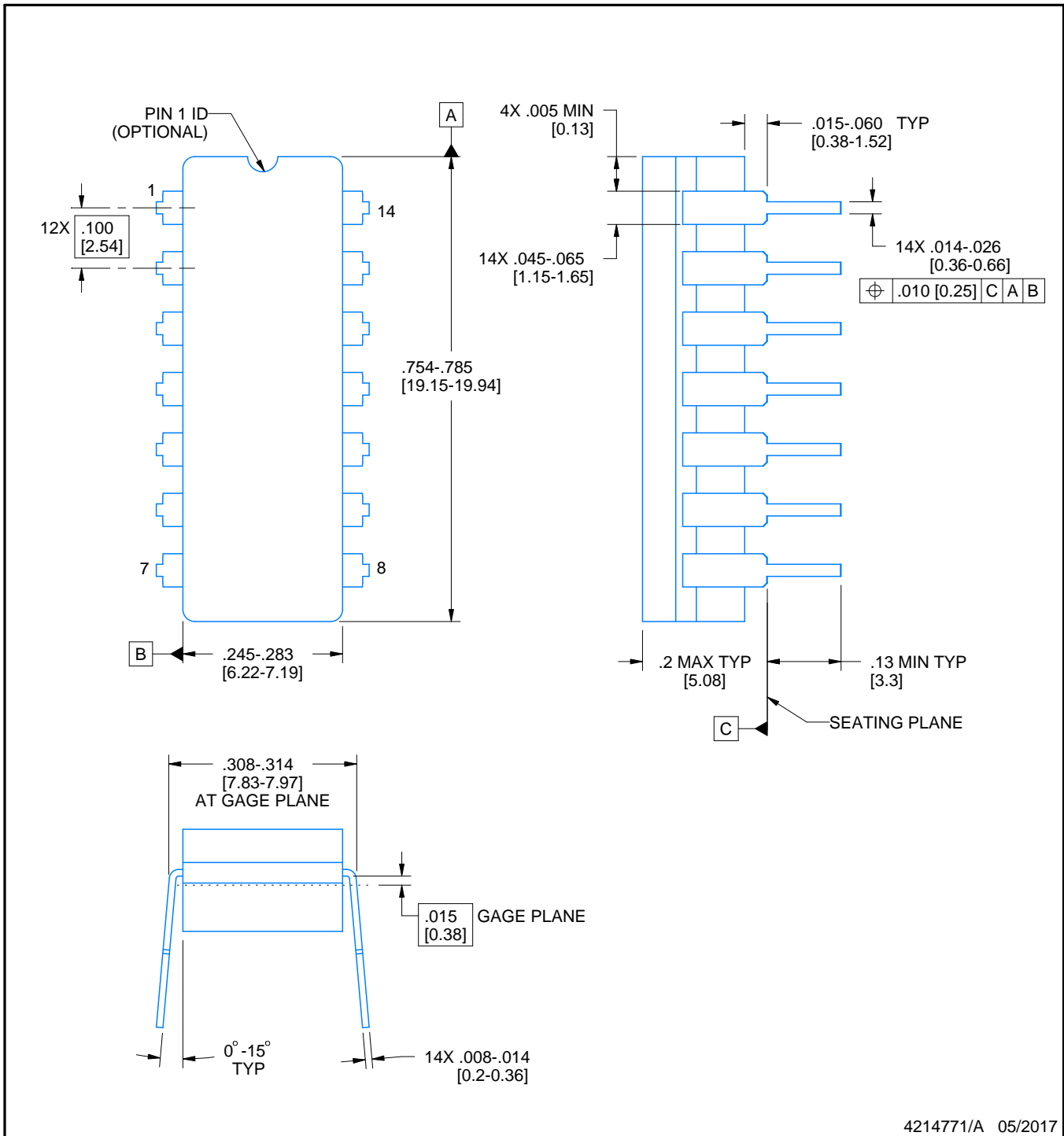
J0014A



PACKAGE OUTLINE

CDIP - 5.08 mm max height

CERAMIC DUAL IN LINE PACKAGE



4214771/A 05/2017

NOTES:

1. All controlling linear dimensions are in inches. Dimensions in brackets are in millimeters. Any dimension in brackets or parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This package is hermetically sealed with a ceramic lid using glass frit.
4. Index point is provided on cap for terminal identification only and on press ceramic glass frit seal only.
5. Falls within MIL-STD-1835 and GDIP1-T14.

EXAMPLE BOARD LAYOUT

J0014A

CDIP - 5.08 mm max height

CERAMIC DUAL IN LINE PACKAGE



LAND PATTERN EXAMPLE
NON-SOLDER MASK DEFINED
SCALE: 5X



4214771/A 05/2017

N (R-PDIP-T**)

PLASTIC DUAL-IN-LINE PACKAGE

16 PINS SHOWN



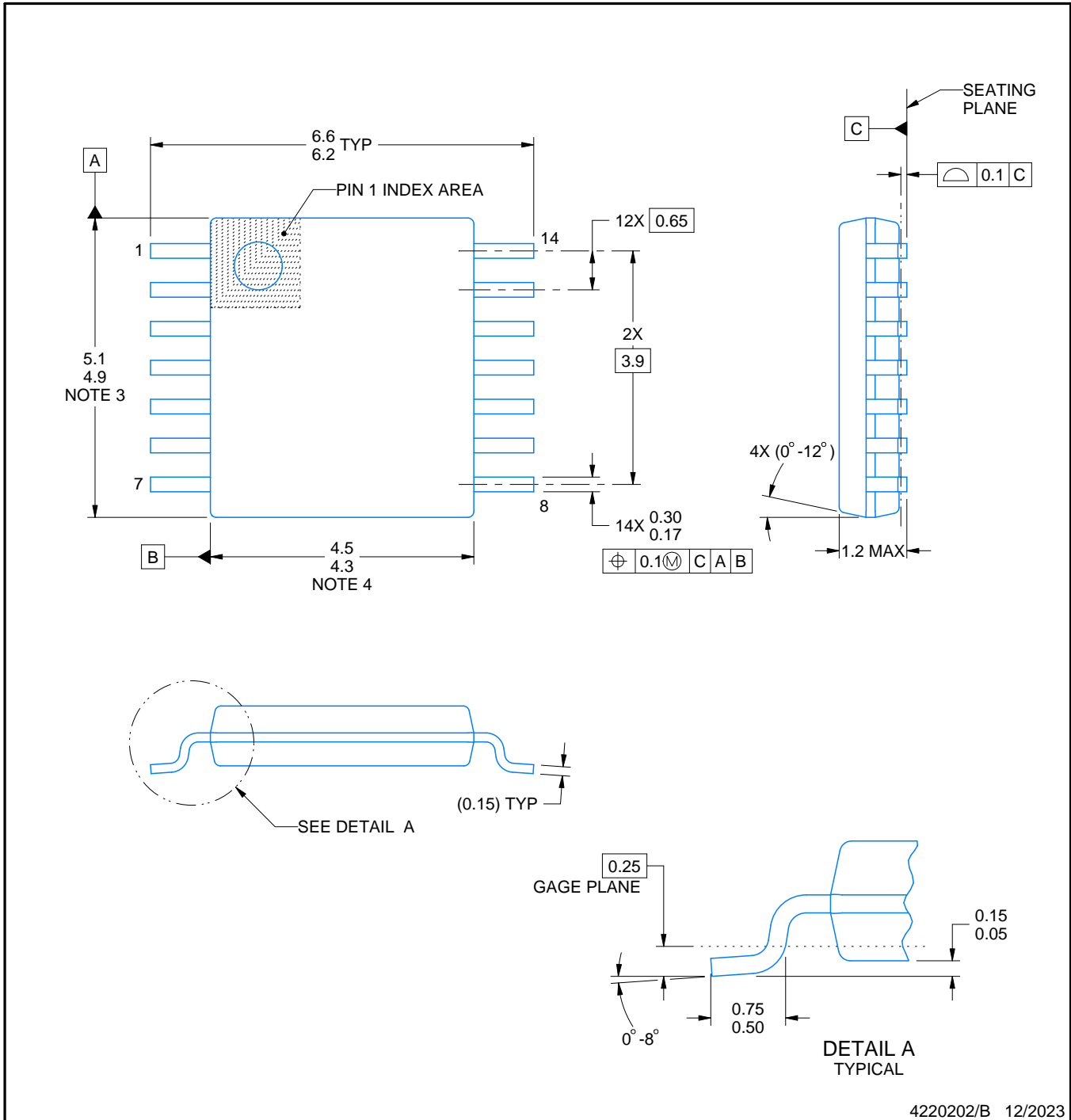
- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).
 - The 20 pin end lead shoulder width is a vendor option, either half or full width.

PW0014A



PACKAGE OUTLINE
TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



4220202/B 12/2023

NOTES:

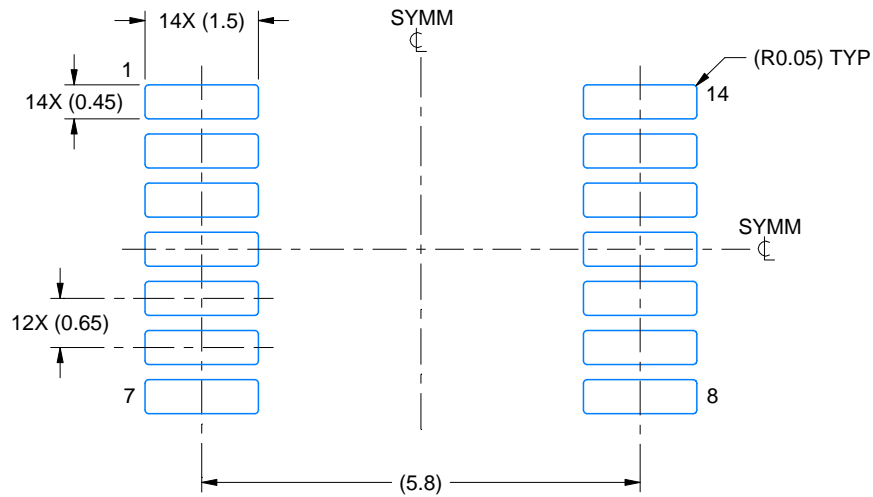
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or 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.

EXAMPLE BOARD LAYOUT

PW0014A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X



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NOTES: (continued)

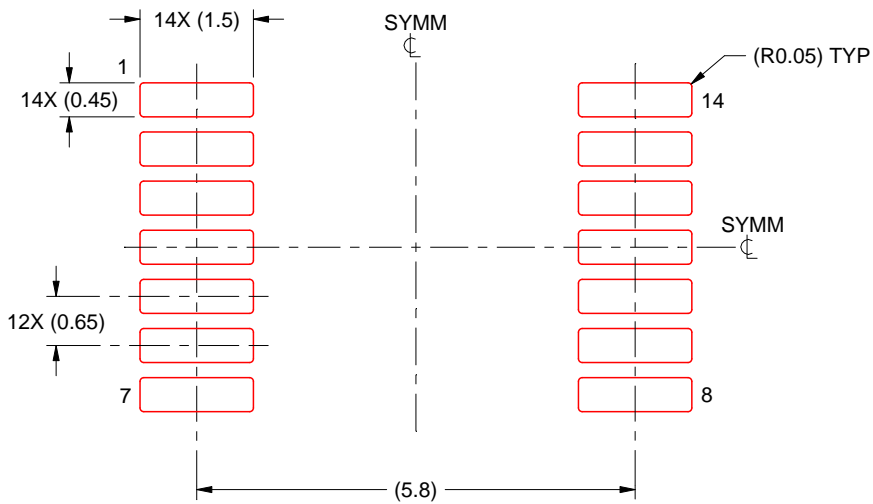
- 6. Publication IPC-7351 may have alternate designs.
- 7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

PW0014A

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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