

# TLV701x および TLV702x 小型、低消費電力、低電圧コンパレータ

## 1 特長

- 超小型パッケージ: X2SON (0.8 × 0.8mm<sup>2</sup>)
- 標準パッケージ: SOT23、SC70、VSSOP
- 広い電源電圧範囲: 1.6V~6.5V
- 静止電流: 5μA
- 短い伝搬遅延: 260ns
- レール・ツー・レールの同相入力電圧
- 内部ヒステリシス
- プッシュプルおよびオープンドレインの出力オプション
- 入力オーバードライブでの位相反転なし
- 動作時周囲温度: -40°C~125°C

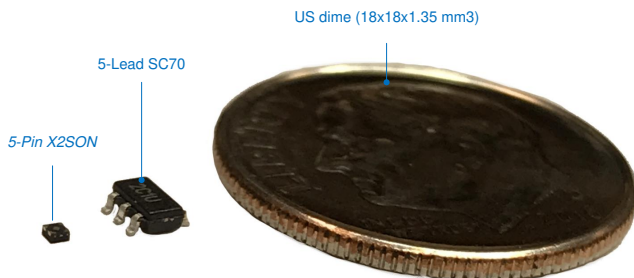
## 2 アプリケーション

- 携帯電話およびタブレット
- 携帯用およびバッテリー駆動の機器
- IR 受信機
- レベル変換器
- スレッショルド検出器および弁別装置
- ウィンドウ・コンパレータ
- ゼロクロス検出器

## 3 概要

TLV7011/7021 (シングル・チャネル) および TLV7012/7022 (デュアル・チャネル) は、低電圧で動作し、レール・ツー・レール入力をサポートするマイクロパワー・コンパレータです。これらのコンパレータは 0.8mm × 0.8mm の超小型リードレス・パッケージと標準のリード・パッケージで供給され、スマートフォンや他の携帯用またはバッテリー駆動アプリケーションなど、スペースに制約のある設計に適しています。

### X2SONパッケージと、SC70および米10セント硬貨との比較



TLV701x および TLV702x は、速度と消費電力の組み合わせが非常に優れており、伝搬遅延は 260ns、静止消費電流は 5μA です。この高速な応答時間と Micro-Power との組み合わせから、電力の限られたシステムでも、フォルト状況を監視して迅速に応答できます。これらのコンパレータの動作電圧範囲は 1.6V~6.5V で、3V および 5V のシステムと互換性があります。

また、これらコンパレータはオーバードライブ入力について出力の位相反転がなく、内部的なヒステリシスを備えています。これらの特長から、このファミリのコンパレータは過酷でノイズの大きな環境において、ゆっくりと変化する入力信号をクリーンなデジタル出力へ変換する必要がある場合に、正確な電圧を監視するため最適です。

### 製品情報<sup>(1)</sup>

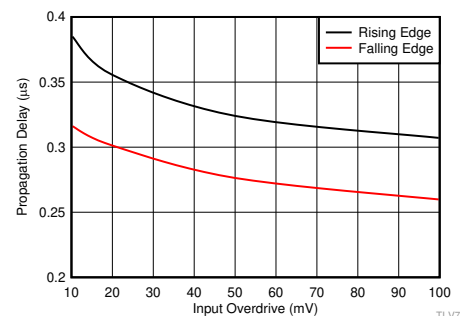
| 型番                  | パッケージ (ピン数) | 本体サイズ(公称)     |
|---------------------|-------------|---------------|
| TLV7011、<br>TLV7021 | X2SON (5)   | 0.80mm×0.80mm |
|                     | SC70 (5)    | 2.00mm×1.25mm |
|                     | SOT-23 (5)  | 2.90mm×1.60mm |
| TLV7012、TLV7022     | VSSOP (8)   | 3mm×3mm       |

(1) 利用可能なすべてのパッケージについては、このデータシートの末尾にある注文情報を参照してください。

### TLV70x1ファミリの低消費電力コンパレータ

| 型番      | 出力       | I <sub>Q</sub> (標準値) | t <sub>PD</sub> (標準値) |
|---------|----------|----------------------|-----------------------|
| TLV701x | プッシュプル   | 5μA                  | 260ns                 |
| TLV702x | オープンドレイン | 5μA                  | 260ns                 |
| TLV703x | プッシュプル   | 335nA                | 3μs                   |
| TLV704x | オープンドレイン | 335nA                | 3μs                   |

### 伝搬遅延とオーバードライブとの関係



T<sub>A</sub> = 25°C, V<sub>CC</sub> = 5V, C<sub>L</sub> = 15pF

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## 4 改訂履歴

|                                                                                  |             |
|----------------------------------------------------------------------------------|-------------|
| <b>Revision D (February 2019) から Revision E に変更</b>                              | <b>Page</b> |
| • デュアル・チャネル・オプションを 追加                                                            | 1           |
| <b>Revision C (March 2018) から Revision D に変更</b>                                 | <b>Page</b> |
| • 「特長」にリード・パッケージ・オプションを 追加                                                       | 1           |
| • SOT23 パッケージのプレビュー・ステータス 削除                                                     | 1           |
| • Deleted preview status of SOT23 package                                        | 4           |
| <b>Revision B (November 2017) から Revision C に変更</b>                              | <b>Page</b> |
| • プレビューのSC70パッケージを量産データに変更                                                       | 1           |
| <b>Revision A (July 2017) から Revision B に変更</b>                                  | <b>Page</b> |
| • 伝播遅延を200nsから260nsに変更                                                           | 1           |
| • データシートにプレビューのSC70およびSOT-23パッケージを追加                                             | 1           |
| • マーケティングの要求に対応して「TLV70x1 ファミリの Micropower コンパレータ」表を追加                           | 1           |
| • 主要な図のタイトルを「伝播遅延とオーバードライブとの関係(TLV7011)」から「伝播遅延とオーバードライブとの関係」に変更                 | 1           |
| • Removed (TLV7011 only) text from several <i>Typical Characteristics</i> graphs | 11          |
| • Removed some <i>Typical Characteristics</i> graphs                             | 11          |
| • Added 図 14                                                                     | 11          |
| • Added 図 21                                                                     | 13          |
| • Added content to the <i>Inputs</i> section                                     | 17          |
| • Added the <i>IR Receiver Analog Front End</i> section                          | 22          |

**2017年5月発行のものから更新**

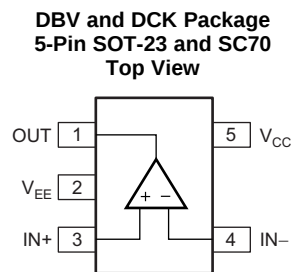
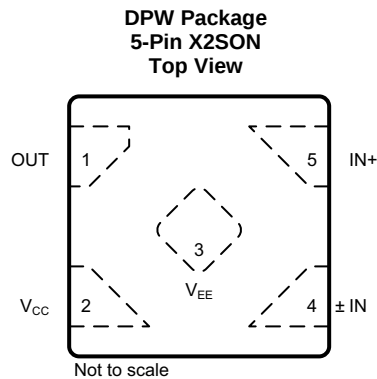
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- デバイスのステータスを「事前情報」から「量産データ」に変更 ..... [1](#)
-

## 5 概要 (続き)

TLV701x は、LED の制御または容量性負荷の駆動を行う際に数ミリアンペアの電流をシンクおよびソースできるプッシュプル出力段を備えています。TLV702x にはオープンドレインの出力段があり、 $V_{CC}$  を超える出力レベルが可能であるため、レベル変換器やバイポーラからシングルエンドへのコンバータに適しています。

## 6 Pin Configuration and Functions

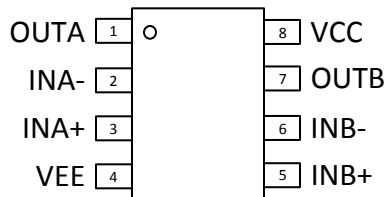


### Pin Functions

| PIN      |       |              | I/O/P <sup>(1)</sup> | DESCRIPTION                     |
|----------|-------|--------------|----------------------|---------------------------------|
| NAME     | X2SON | SOT-23, SC70 |                      |                                 |
| OUT      | 1     | 1            | O                    | Output                          |
| $V_{CC}$ | 2     | 5            | P                    | Positive (highest) power supply |
| $V_{EE}$ | 3     | 2            | P                    | Negative (lowest) power supply  |
| IN–      | 4     | 4            | I                    | Inverting input                 |
| IN+      | 5     | 3            | I                    | Noninverting input              |

(1) I = Input, O = Output, P = Power

**TLV7012/22 DGG Packages  
8-Pin VSSOP  
Top View**



**Pin Functions: TLV7012/22**

| PIN  |     | I/O | DESCRIPTION                                                      |
|------|-----|-----|------------------------------------------------------------------|
| NAME | NO. |     |                                                                  |
| INA- | 2   | I   | Inverting input, channel A                                       |
| INA+ | 3   | I   | Noninverting input, channel A                                    |
| INB- | 6   | I   | Inverting input, channel B                                       |
| INB+ | 5   | I   | Noninverting input, channel B                                    |
| OUTA | 1   | O   | Output, channel A                                                |
| OUTB | 7   | O   | Output, channel B                                                |
| VEE  | 4   | —   | Negative (lowest) supply or ground (for single-supply operation) |
| VCC  | 8   | —   | Positive (highest) supply                                        |

## 7 Specifications

### 7.1 Absolute Maximum Ratings (Single)

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

|                                                   |                             | MIN            | MAX            | UNIT |
|---------------------------------------------------|-----------------------------|----------------|----------------|------|
| Supply voltage ( $V_S = V_{CC} - V_{EE}$ )        |                             |                | 6              | V    |
| Input pins (IN+, IN-) <sup>(2)</sup>              |                             | $V_{EE} - 0.3$ | 6              | V    |
| Current into Input pins (IN+, IN-) <sup>(2)</sup> |                             |                | ±10            | mA   |
| Output (OUT)                                      | TLV7011/7012 <sup>(3)</sup> | $V_{EE} - 0.3$ | $V_{CC} + 0.3$ | V    |
|                                                   | TLV7021/7022                | $V_{EE} - 0.3$ | 6              |      |
| Output short-circuit duration <sup>(4)</sup>      |                             |                | 10             | s    |
| Junction temperature, $T_J$                       |                             |                | 150            | °C   |
| Storage temperature, $T_{stg}$                    |                             | -65            | 150            | °C   |

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) Input terminals are diode-clamped to  $V_{EE}$ . Input signals that can swing 0.3V below  $V_{EE}$  must be current-limited to 10mA or less.
- (3) Output maximum is ( $V_{CC} + 0.3V$ ) or 6V, whichever is less.
- (4) Short-circuit to ground, one comparator per package.

### 7.2 Absolute Maximum Ratings (Dual)

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

|                                              |  | MIN            | MAX            | UNIT |
|----------------------------------------------|--|----------------|----------------|------|
| Supply voltage $V_S = V_{CC} - V_{EE}$       |  | -0.3           | 7              | V    |
| Input pins (IN+, IN-) <sup>(2)</sup>         |  | $V_{EE} - 0.3$ | 7              | V    |
| Current into Input pins (IN+, IN-)           |  |                | ±10            | mA   |
| Output (OUT) (TLV7012) <sup>(3)</sup>        |  | $V_{EE} - 0.3$ | $V_{CC} + 0.3$ | V    |
| Output (OUT) (TLV7022)                       |  | $V_{EE} - 0.3$ | 7              | V    |
| Output short-circuit duration <sup>(4)</sup> |  |                | 10             | s    |
| Junction temperature, $T_J$                  |  |                | 150            | °C   |
| Storage temperature, $T_{stg}$               |  | -65            | 150            | °C   |

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) Input terminals are diode-clamped to  $V_{EE}$ . Input signals that can swing 0.3V below  $V_{EE}$  must be current-limited to 10mA or less.
- (3) Output maximum is ( $V_{CC} + 0.3V$ ) or 7 V, whichever is less.
- (4) Short-circuit to ground, one comparator per package.

### 7.3 ESD Ratings

|             |                         |                                                                                | VALUE | UNIT |
|-------------|-------------------------|--------------------------------------------------------------------------------|-------|------|
| $V_{(ESD)}$ | Electrostatic discharge | Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup>              | ±2000 | V    |
|             |                         | Charged-device model (CDM), per JEDEC specification JESD22-C101 <sup>(2)</sup> | ±1000 |      |

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
- (2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

### 7.4 Recommended Operating Conditions (Single)

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

|                                            |  | MIN            | NOM | MAX            | UNIT |
|--------------------------------------------|--|----------------|-----|----------------|------|
| Supply voltage ( $V_S = V_{CC} - V_{EE}$ ) |  | 1.6            |     | 5.5            | V    |
| Input Voltage Range                        |  | $V_{EE} - 0.1$ |     | $V_{CC} + 0.2$ | V    |
| Ambient temperature, $T_A$                 |  | -40            |     | 125            | °C   |

## 7.5 Recommended Operating Conditions (Dual)

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

|                                        | MIN            | MAX            | UNIT |
|----------------------------------------|----------------|----------------|------|
| Supply voltage $V_S = V_{CC} - V_{EE}$ | 1.6            | 6.5            | V    |
| Input voltage range                    | $V_{CC} - 0.1$ | $V_{EE} + 0.2$ | V    |
| Ambient temperature, $T_A$             | -40            | 125            | °C   |

## 7.6 Thermal Information (Single)

| THERMAL METRIC <sup>(1)</sup> |                                              | TLV7011/TLV7021 |             |            | UNIT |
|-------------------------------|----------------------------------------------|-----------------|-------------|------------|------|
|                               |                                              | DPW (X2SON)     | DBV (SOT23) | DCK (SC70) |      |
|                               |                                              | 5 PINS          | 5 PINS      | 5 PINS     |      |
| $R_{\theta JA}$               | Junction-to-ambient thermal resistance       | 497.5           | 306.3       | 278.8      | °C/W |
| $R_{\theta JC(top)}$          | Junction-to-case (top) thermal resistance    | 275.5           | 228.4       | 188.6      | °C/W |
| $R_{\theta JB}$               | Junction-to-board thermal resistance         | 372.2           | 166.5       | 113.2      | °C/W |
| $\Psi_{JT}$                   | Junction-to-top characterization parameter   | 55.5            | 138.5       | 82.3       | °C/W |
| $\Psi_{JB}$                   | Junction-to-board characterization parameter | 370.3           | 165.3       | 112.4      | °C/W |
| $R_{\theta JC(bot)}$          | Junction-to-case (bottom) thermal resistance | 165.1           | N/A         | N/A        | °C/W |

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

## 7.7 Thermal Information (Dual)

| THERMAL METRIC <sup>(1)</sup> |                                              | TLV7012/TLV7022 | UNIT |
|-------------------------------|----------------------------------------------|-----------------|------|
|                               |                                              | DGK (VSSOP)     |      |
|                               |                                              | 8 PINS          |      |
| $R_{\theta JA}$               | Junction-to-ambient thermal resistance       | 211.7           | °C/W |
| $R_{\theta JC(top)}$          | Junction-to-case (top) thermal resistance    | 96.1            | °C/W |
| $R_{\theta JB}$               | Junction-to-board thermal resistance         | 133.5           | °C/W |
| $\Psi_{JT}$                   | Junction-to-top characterization parameter   | 28.3            | °C/W |
| $\Psi_{JB}$                   | Junction-to-board characterization parameter | 131.7           | °C/W |
| $R_{\theta JC(bot)}$          | Junction-to-case (bottom) thermal resistance | N/A             | °C/W |

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

## 7.8 Electrical Characteristics (Single)

$V_S = 1.8\text{ V}$  to  $5\text{ V}$ ,  $V_{CM} = V_S / 2$ ; minimum and maximum values are at  $T_A = -40^\circ\text{C}$  to  $+125^\circ\text{C}$  (unless otherwise noted). Typical values are at  $T_A = 25^\circ\text{C}$ .

| PARAMETER | TEST CONDITIONS                                  | MIN                                                                   | TYP       | MAX            | UNIT          |
|-----------|--------------------------------------------------|-----------------------------------------------------------------------|-----------|----------------|---------------|
| $V_{IO}$  | Input offset voltage                             |                                                                       | $\pm 0.5$ | $\pm 8$        | mV            |
| $V_{HYS}$ | Hysteresis                                       | 1.2                                                                   | 4.2       | 14             | mV            |
| $V_{CM}$  | Common-mode voltage range                        | $V_{EE}$                                                              |           | $V_{CC} + 0.1$ | V             |
|           |                                                  | $V_{EE} + 0.1$                                                        |           | $V_{CC} + 0.1$ |               |
| $I_B$     | Input bias current                               |                                                                       | 5         |                | pA            |
| $I_{OS}$  | Input offset current                             |                                                                       | 1         |                | pA            |
| $V_{OH}$  | Output voltage high (for TLV7011 only)           | 4.7                                                                   | 4.8       |                | V             |
| $V_{OL}$  | Output voltage low                               |                                                                       | 120       | 220            | mV            |
| $I_{LKG}$ | Open-drain output leakage current (TLV7021 only) |                                                                       | 100       |                | pA            |
| CMRR      | Common-mode rejection ratio                      |                                                                       | 78        |                | dB            |
| PSRR      | Power supply rejection ratio                     |                                                                       | 78        |                | dB            |
| $I_{SC}$  | Short-circuit current                            | $V_S = 5\text{ V}$ , sourcing                                         | 65        |                | mA            |
|           |                                                  | $V_S = 5\text{ V}$ , sinking                                          | 44        |                |               |
| $I_{CC}$  | Supply current                                   | $V_S = 1.8\text{ V}$ , no load, $V_{ID} = -0.1\text{ V}$ (Output Low) | 5         | 10             | $\mu\text{A}$ |

## 7.9 Switching Characteristics (Single)

Typical values are at  $T_A = 25^\circ\text{C}$ ,  $V_{CC} = 5\text{ V}$ ,  $V_{CM} = 2.5\text{ V}$ ;  $C_L = 15\text{ pF}$ , input overdrive =  $100\text{ mV}$  (unless otherwise noted).

| PARAMETER | TEST CONDITIONS                                                                | MIN        | TYP | MAX | UNIT          |
|-----------|--------------------------------------------------------------------------------|------------|-----|-----|---------------|
| $t_{PHL}$ | Propagation delay time, high-to-low ( $R_P = 2.5\text{ k}\Omega$ TLV7021 only) |            | 260 |     | ns            |
| $t_{PLH}$ | Propagation delay time, low-to-high ( $R_P = 2.5\text{ k}\Omega$ TLV7021 only) |            | 310 |     | ns            |
| $t_R$     | Rise time (for TLV7011 only)                                                   | 20% to 80% | 5   |     | ns            |
| $t_F$     | Fall time                                                                      | 80% to 20% | 5   |     | ns            |
| $t_{ON}$  | Power-up time <sup>(1)</sup>                                                   |            | 20  |     | $\mu\text{s}$ |

(1) During power on,  $V_S$  must exceed  $1.6\text{ V}$  for  $t_{ON}$  before the output tracks the input.

## 7.10 Electrical Characteristics (Dual)

$V_S = 1.8\text{ V}$  to  $5\text{ V}$ ,  $V_{CM} = V_S / 2$ ; minimum and maximum values are at  $T_A = -40^\circ\text{C}$  to  $+125^\circ\text{C}$  (unless otherwise noted). Typical values are at  $T_A = 25^\circ\text{C}$ .

| PARAMETER | TEST CONDITIONS                                  | MIN                                                                                | TYP       | MAX            | UNIT          |
|-----------|--------------------------------------------------|------------------------------------------------------------------------------------|-----------|----------------|---------------|
| $V_{IO}$  | Input Offset Voltage                             |                                                                                    | $\pm 0.1$ | $\pm 8$        | mV            |
| $V_{HYS}$ | Hysteresis                                       |                                                                                    | 9         | 15             | mV            |
| $V_{CM}$  | Common-mode voltage range                        | $V_{EE}$                                                                           |           | $V_{CC} + 0.1$ | V             |
| $I_B$     | Input bias current                               |                                                                                    | 2         |                | pA            |
| $I_{OS}$  | Input offset current                             |                                                                                    | 1         |                | pA            |
| $V_{OH}$  | Output voltage high (for TLV7012 only)           | $V_S = 5\text{ V}$ , $V_{EE} = 0\text{ V}$ , $I_O = 3\text{ mA}$                   | 4.65      | 4.8            | V             |
| $V_{OL}$  | Output voltage low                               | $V_S = 5\text{ V}$ , $V_{EE} = 0\text{ V}$ , $I_O = 3\text{ mA}$                   | 250       | 350            | mV            |
| $I_{LKG}$ | Open-drain output leakage current (TLV7022 only) | $V_S = 5\text{ V}$ , $V_{ID} = +0.1\text{ V}$ (output high), $V_{PULLUP} = V_{CC}$ | 100       |                | pA            |
| CMRR      | Common-mode rejection ratio                      | $V_{EE} < V_{CM} < V_{CC}$ , $V_S = 5\text{ V}$                                    | 73        |                | dB            |
| PSRR      | Power supply rejection ratio                     | $V_S = 1.8\text{ V}$ to $5\text{ V}$ , $V_{CM} = V_S / 2$                          | 77        |                | dB            |
| $I_{SC}$  | Short-circuit current                            | $V_S = 5\text{ V}$ , sourcing (for TLV7012 only)                                   | 29        |                | mA            |
|           |                                                  | $V_S = 5\text{ V}$ , sinking                                                       | 33        |                |               |
| $I_{CC}$  | Supply current / Channel                         | $V_S = 1.8\text{ V}$ , no load, $V_{ID} = -0.1\text{ V}$ (Output Low)              | 4.7       | 9              | $\mu\text{A}$ |

## 7.11 Switching Characteristics (Dual)

Typical values are at  $T_A = 25^\circ\text{C}$ ,  $V_S = 5\text{ V}$ ,  $V_{CM} = V_S / 2$ ;  $C_L = 15\text{ pF}$ , input overdrive =  $100\text{ mV}$  (unless otherwise noted).

| PARAMETER | TEST CONDITIONS                                                                              | MIN                                                                                                                      | TYP | MAX | UNIT          |
|-----------|----------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|-----|-----|---------------|
| $t_{PHL}$ | Propagation delay time, high to low (RP = $4.99\text{ k}\Omega$ TLV7022 only) <sup>(1)</sup> |                                                                                                                          | 310 |     | ns            |
| $t_{PLH}$ | Propagation delay time, low-to high (RP = $4.99\text{ k}\Omega$ TLV7022 only) <sup>(1)</sup> |                                                                                                                          | 260 |     | ns            |
| $t_R$     | Rise time (TLV7012 only)                                                                     | Measured from 20% to 80%                                                                                                 | 5   |     | ns            |
| $t_F$     | Fall time                                                                                    | Measured from 20% to 80%                                                                                                 | 5   |     | ns            |
| $t_{ON}$  | Power-up time                                                                                | During power on, $V_{CC}$ must exceed $1.6\text{ V}$ for $200\text{ }\mu\text{s}$ before the output is in correct state. | 20  |     | $\mu\text{s}$ |

(1) The lower limit for RP is  $650\text{ }\Omega$

## 7.12 Timing Diagrams

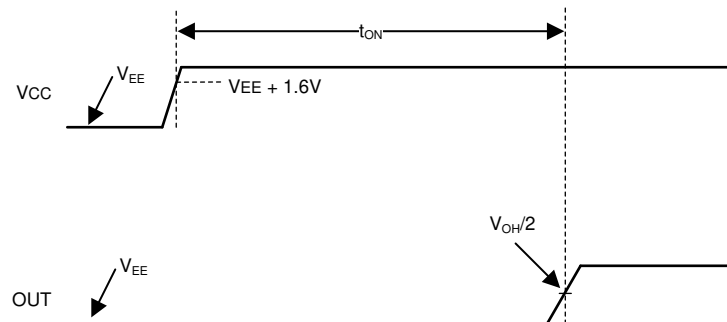


图 1. Start-Up Time Timing Diagram (IN+ > IN-)

## Timing Diagrams (continued)

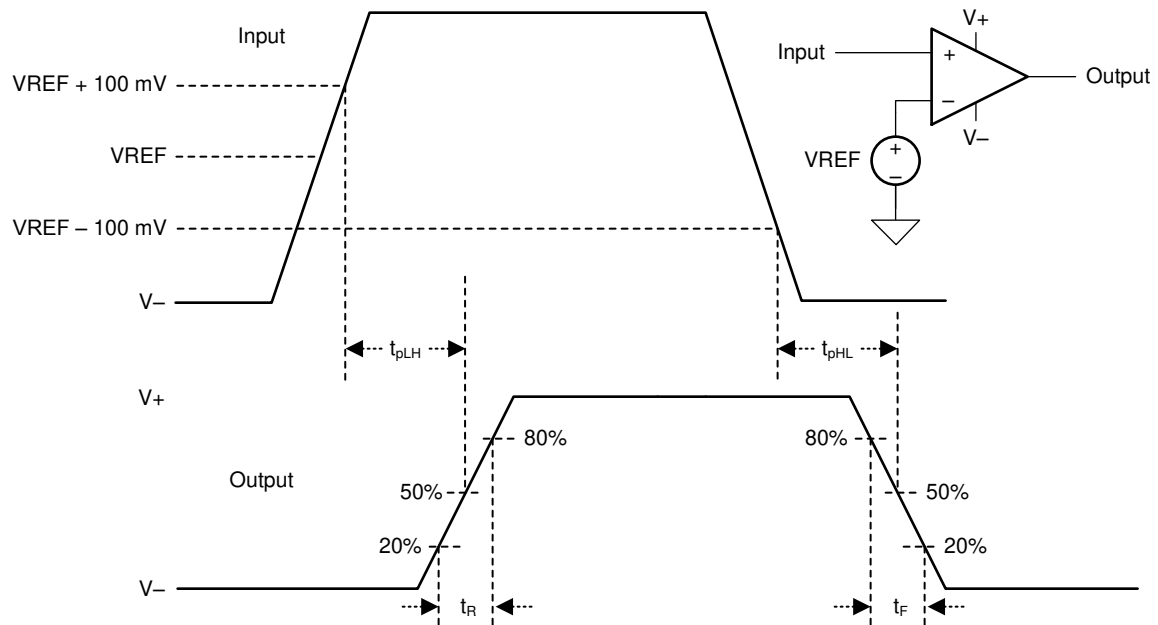
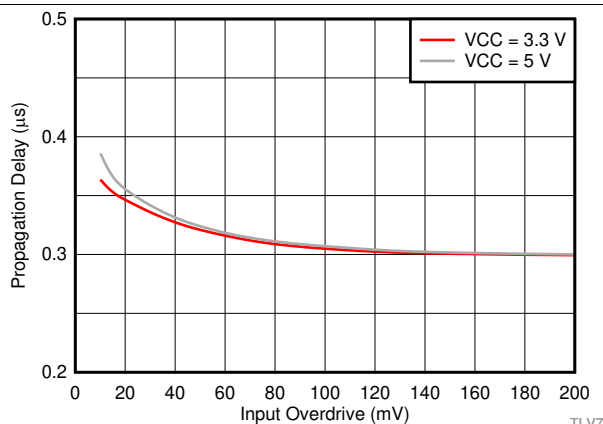


图 2. Propagation Delay Timing Diagram

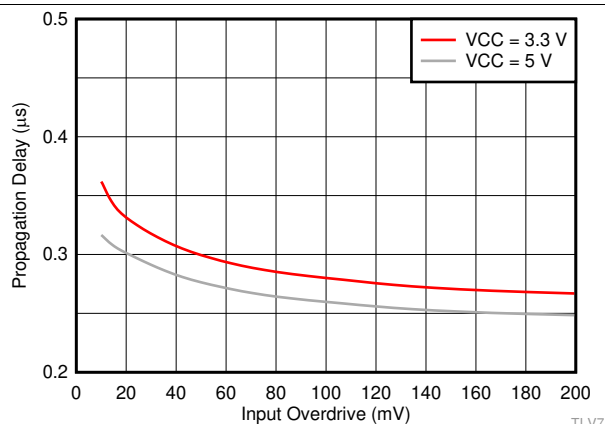
## 7.13 Typical Characteristics

$T_A = 25^\circ\text{C}$ ,  $V_{CC} = 5\text{ V}$ ,  $V_{EE} = 0\text{ V}$ ,  $V_{CM} = V_{CC}/2$ ,  $C_L = 15\text{ pF}$



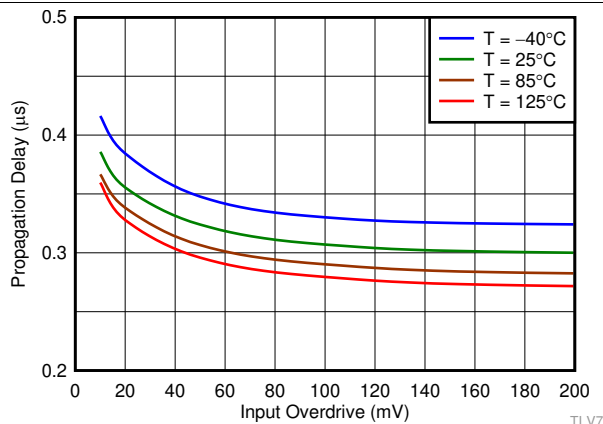
$T_A = 25^\circ\text{C}$ ,

图 3. TLV7011 Propagation Delay (L-H) vs. Input Overdrive



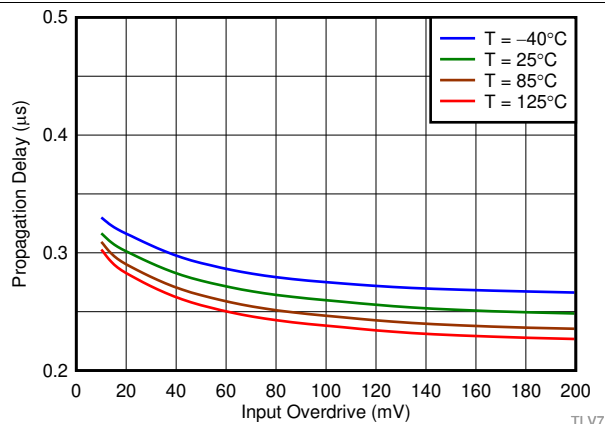
$T_A = 25^\circ\text{C}$

图 4. Propagation Delay (H-L) vs. Input Overdrive



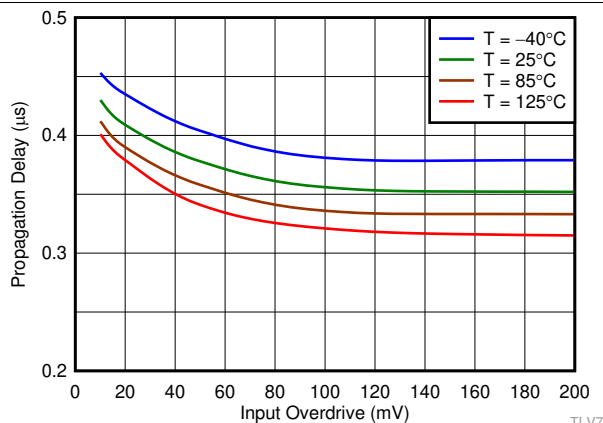
$V_{CC} = 5\text{ V}$

图 5. TLV7011 Propagation Delay (L-H) vs. Input Overdrive



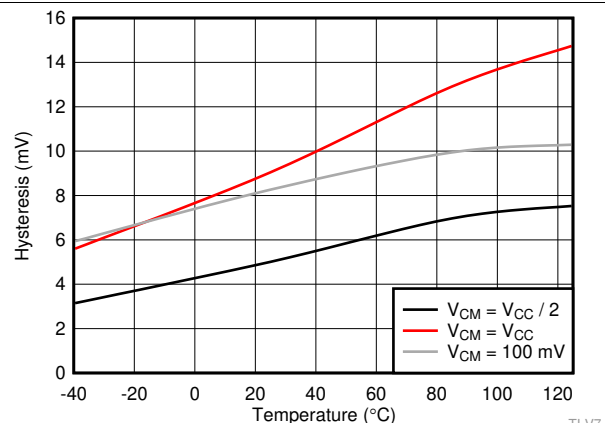
$V_{CC} = 5\text{ V}$

图 6. Propagation Delay (H-L) vs. Input Overdrive



$R_{\text{pull-up}} = 2.5\text{k}$

图 7. TLV7021 Propagation Delay (L-H) vs. Input Overdrive

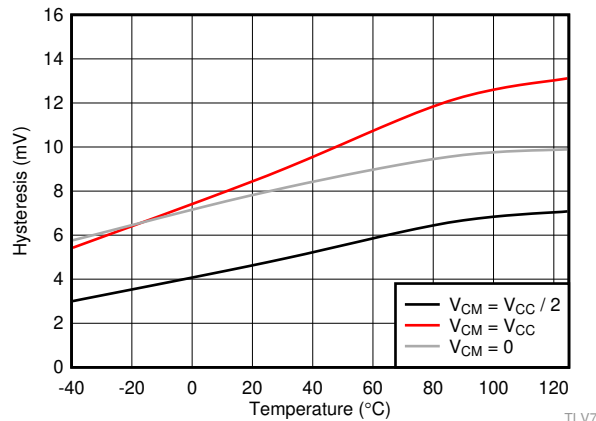


$V_{CC} = 1.8\text{ V}$

图 8. Hysteresis vs. Temperature

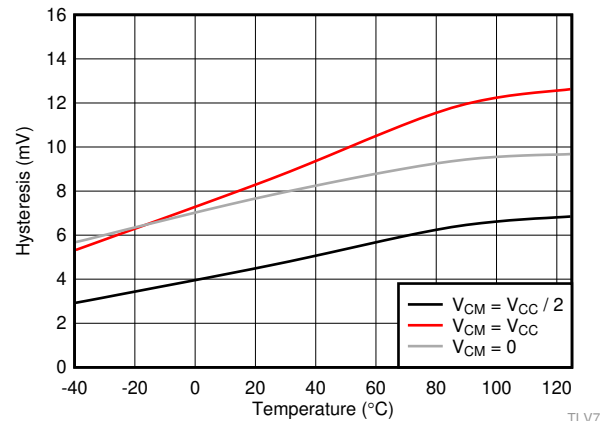
## Typical Characteristics (continued)

$T_A = 25^\circ\text{C}$ ,  $V_{CC} = 5\text{ V}$ ,  $V_{EE} = 0\text{ V}$ ,  $V_{CM} = V_{CC}/2$ ,  $C_L = 15\text{ pF}$



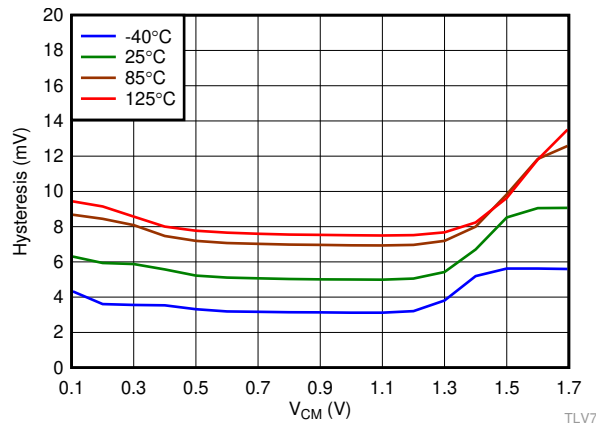
$V_{CC} = 3.3\text{ V}$

Figure 9. Hysteresis vs. Temperature



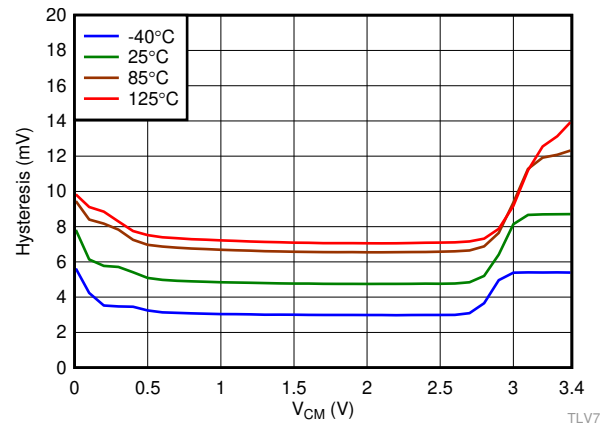
$V_{CC} = 5\text{ V}$

Figure 10. Hysteresis vs. Temperature



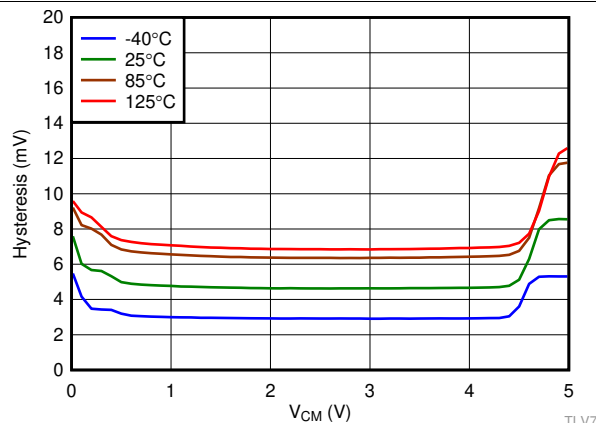
$V_{CC} = 1.8\text{ V}$

Figure 11. Hysteresis vs.  $V_{CM}$



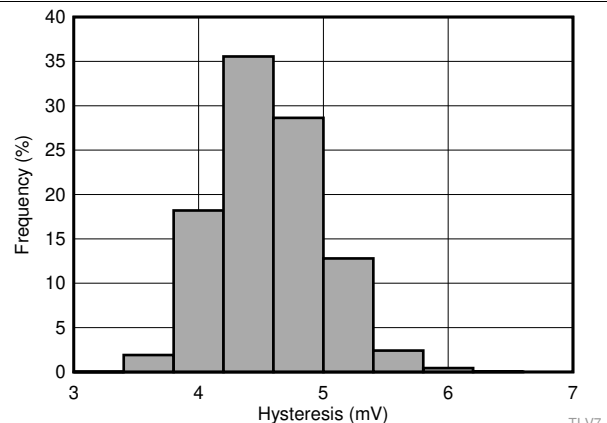
$V_{CC} = 3.3\text{ V}$

Figure 12. Hysteresis vs.  $V_{CM}$



$V_{CC} = 5\text{ V}$

Figure 13. Hysteresis vs.  $V_{CM}$

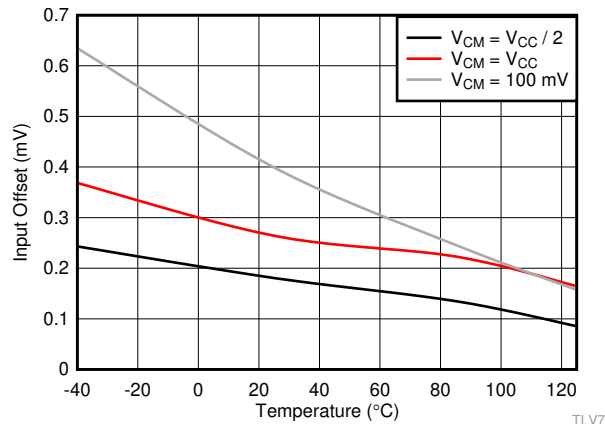


Distribution Taken From 10,777 Comparators

Figure 14. Hysteresis Histogram

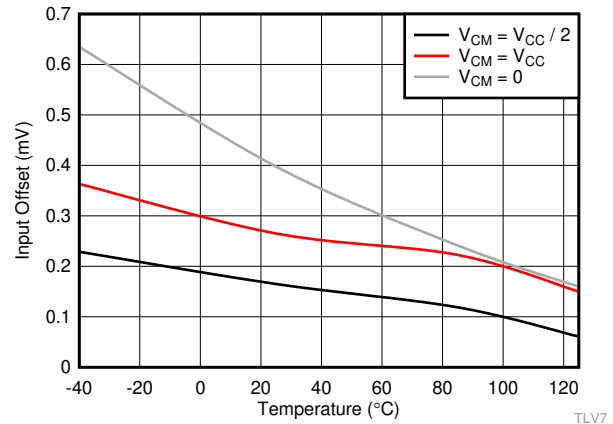
## Typical Characteristics (continued)

$T_A = 25^\circ\text{C}$ ,  $V_{CC} = 5\text{ V}$ ,  $V_{EE} = 0\text{ V}$ ,  $V_{CM} = V_{CC}/2$ ,  $C_L = 15\text{ pF}$



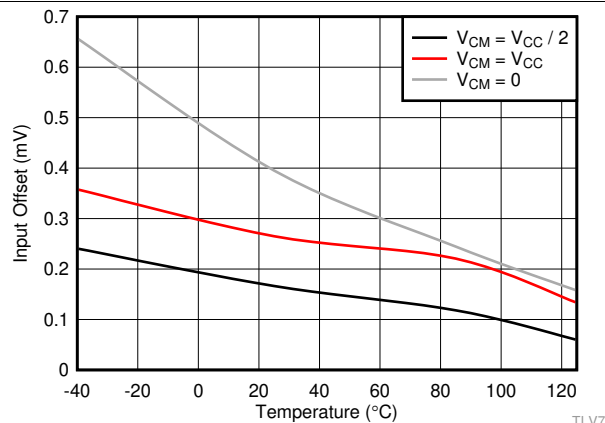
$V_{CC} = 1.8\text{ V}$

FIG 15. Input Offset vs. Temperature



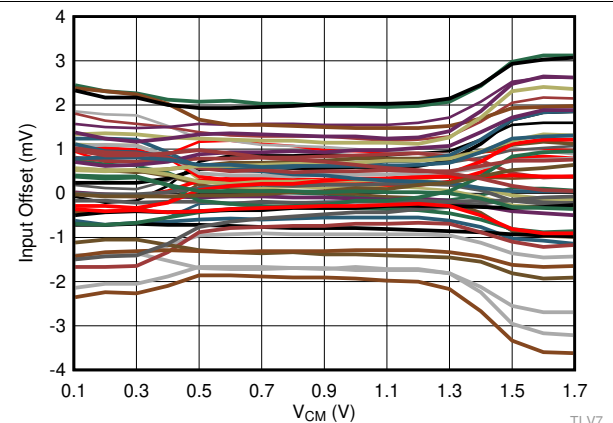
$V_{CC} = 3.3\text{ V}$

FIG 16. Input Offset vs. Temperature



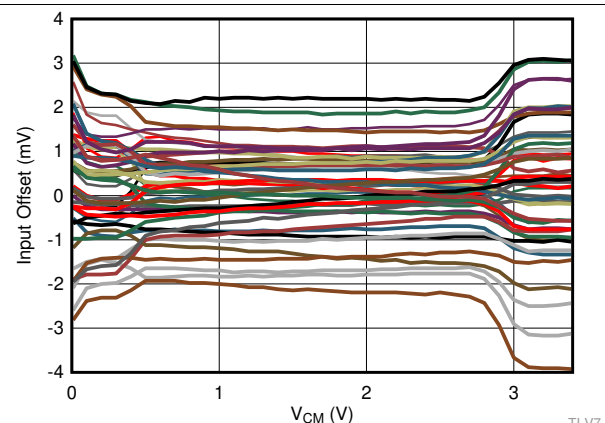
$V_{CC} = 5\text{ V}$

FIG 17. Input Offset vs. Temperature



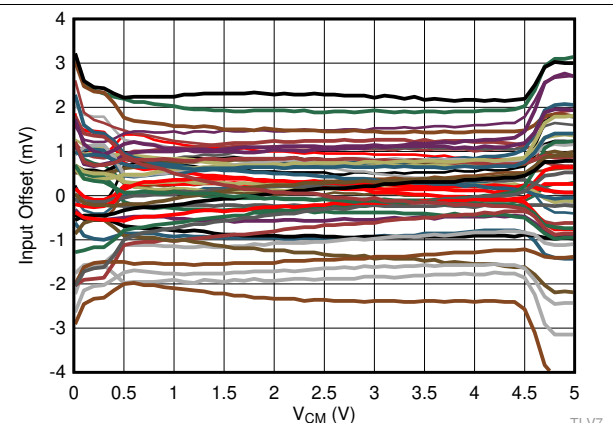
$V_{CC} = 1.8\text{ V}$ , 50 devices

FIG 18. Input Offset Voltage vs.  $V_{CM}$



$V_{CC} = 3.3\text{ V}$ , 50 devices

FIG 19. Input Offset Voltage vs.  $V_{CM}$

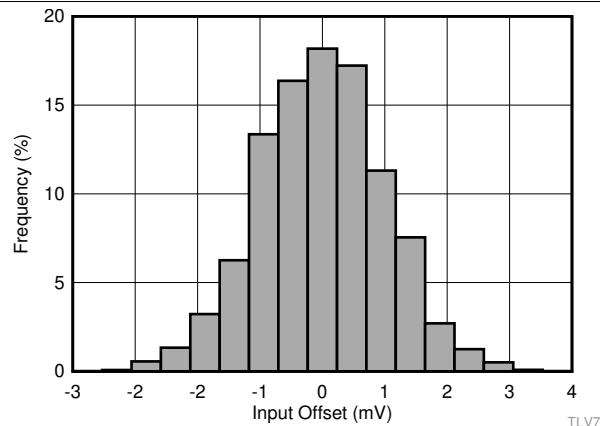


$V_{CC} = 5\text{ V}$ , 50 devices

FIG 20. Input Offset Voltage vs.  $V_{CM}$

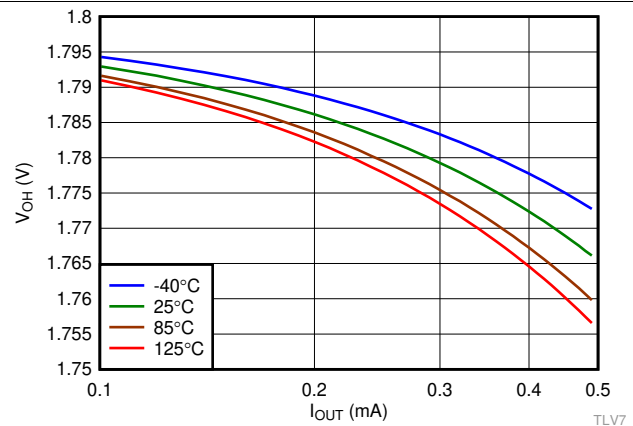
## Typical Characteristics (continued)

$T_A = 25^\circ\text{C}$ ,  $V_{CC} = 5\text{ V}$ ,  $V_{EE} = 0\text{ V}$ ,  $V_{CM} = V_{CC}/2$ ,  $C_L = 15\text{ pF}$



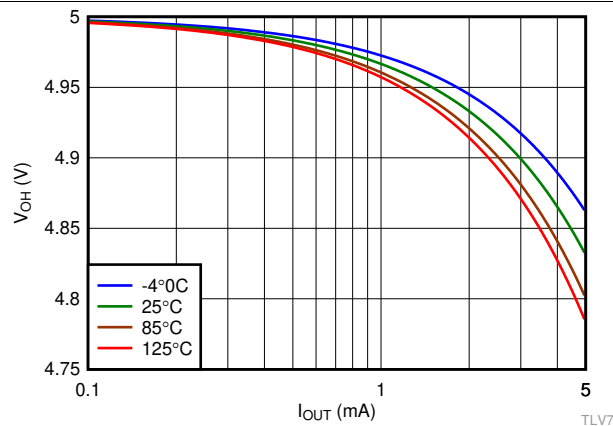
Distribution Taken From 10,777 Comparators

FIG 21. Input Offset Voltage Histogram



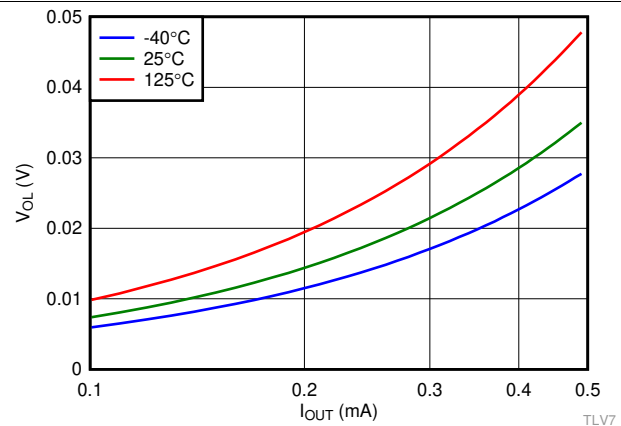
$V_{CC} = 1.8\text{ V}$

FIG 22. TLV7011 Output Voltage High vs. Output Source Current



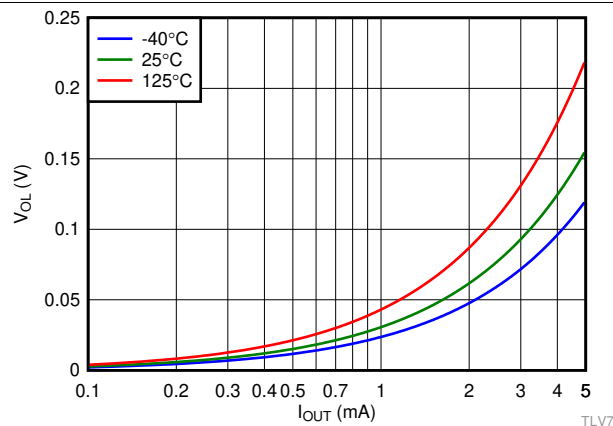
$V_{CC} = 5\text{ V}$

FIG 23. TLV7011 Output Voltage High vs. Output Source Current



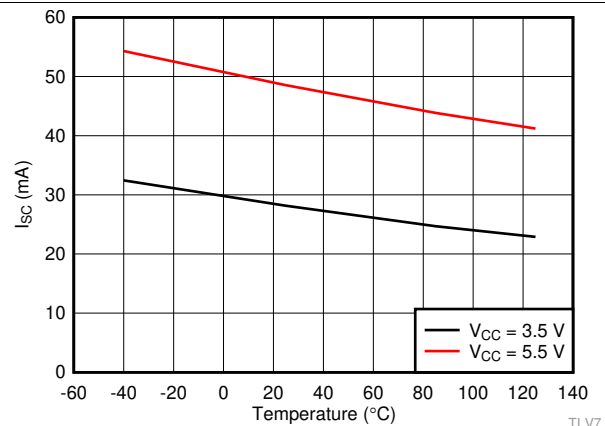
$V_{CC} = 1.8\text{ V}$

FIG 24. Output Voltage Low vs. Output Sink Current



$V_{CC} = 5\text{ V}$

FIG 25. Output Voltage Low vs. Output Sink Current

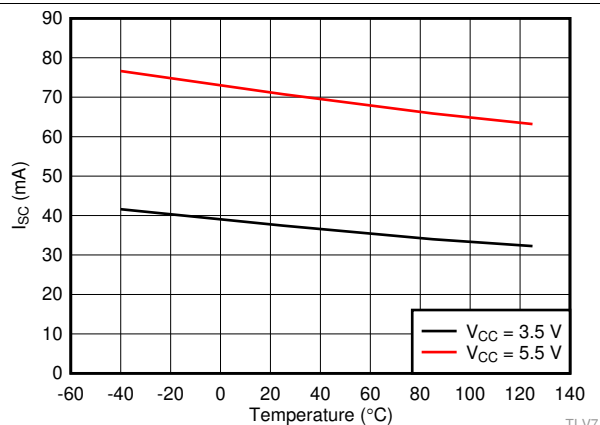


$V_{CM} = V_{CC}/2$

FIG 26. Output Short-Circuit (Sink) Current vs. Temperature

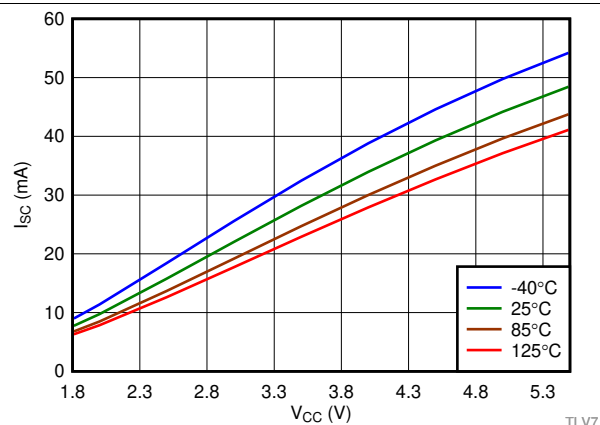
## Typical Characteristics (continued)

$T_A = 25^\circ\text{C}$ ,  $V_{CC} = 5\text{ V}$ ,  $V_{EE} = 0\text{ V}$ ,  $V_{CM} = V_{CC}/2$ ,  $C_L = 15\text{ pF}$



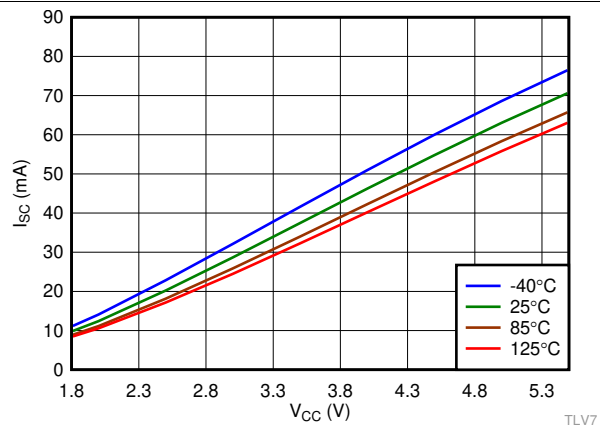
$V_{CM} = V_{CC}/2$

FIG 27. TLV7011 Output Short-Circuit (Source) Current vs. Temperature



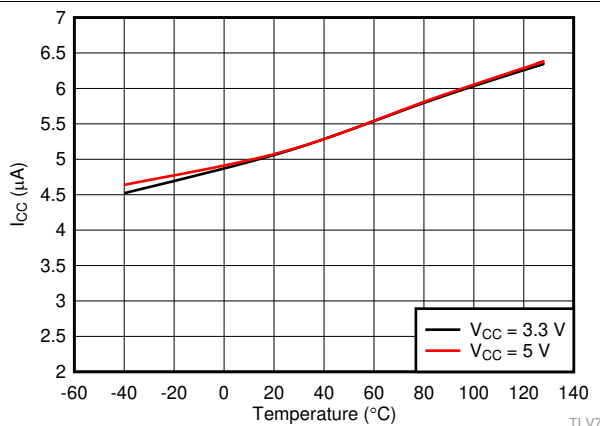
$V_{CM} = V_{CC}/2$

FIG 28. Output Short Circuit (Sink) vs.  $V_{CC}$



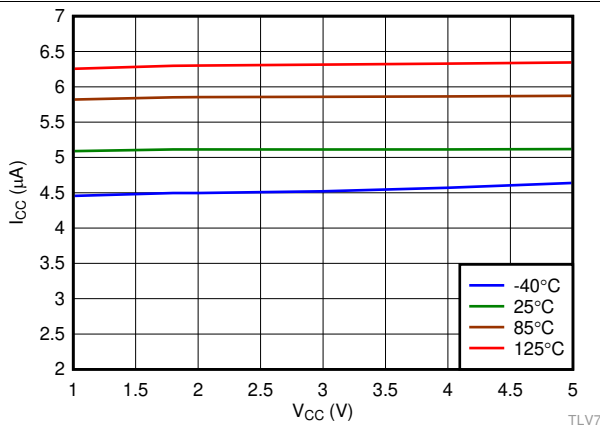
$V_{CM} = V_{CC}/2$

FIG 29. TLV7011 Output Short Circuit (Source) vs.  $V_{CC}$



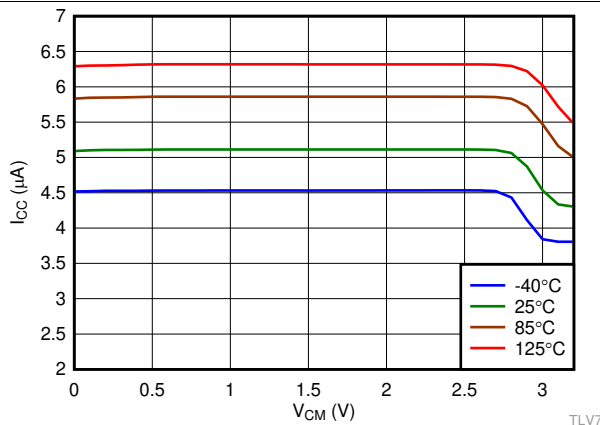
$V_{CM} = V_{CC}/2$

FIG 30.  $I_{CC}$  vs. Temperature



$V_{CM} = V_{CC}/2$

FIG 31.  $I_{CC}$  vs.  $V_{CC}$

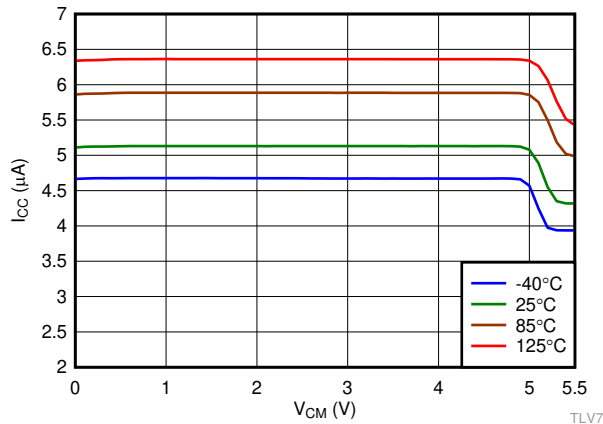


$V_{CC} = 3.3\text{ V}$

FIG 32.  $I_{CC}$  vs.  $V_{CM}$

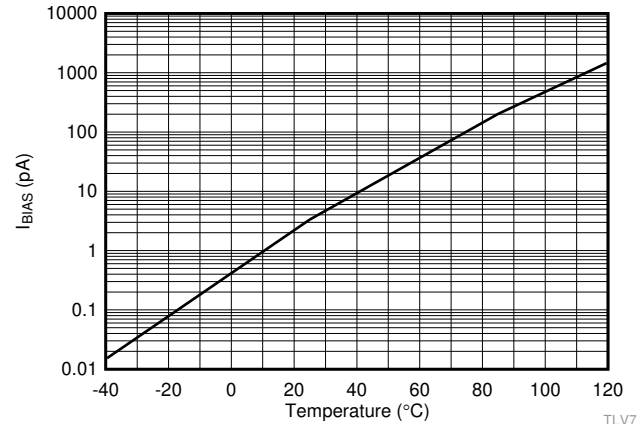
## Typical Characteristics (continued)

$T_A = 25^\circ\text{C}$ ,  $V_{CC} = 5\text{ V}$ ,  $V_{EE} = 0\text{ V}$ ,  $V_{CM} = V_{CC}/2$ ,  $C_L = 15\text{ pF}$



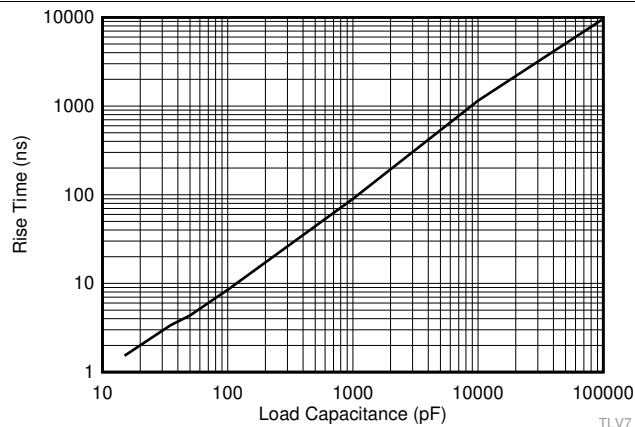
$V_{CC} = 5\text{ V}$

FIG 33.  $I_{CC}$  vs.  $V_{CM}$



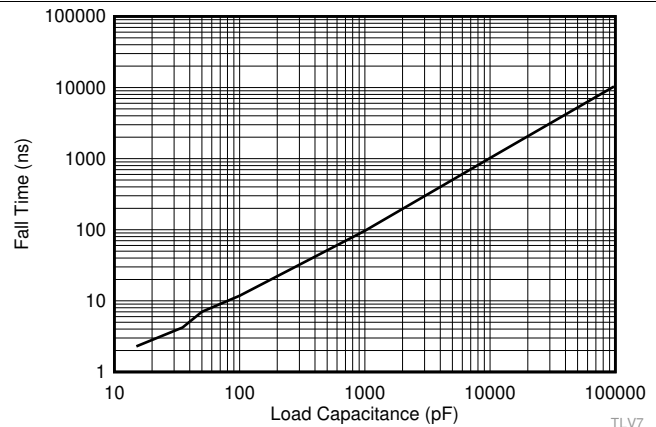
$V_{CC} = 3.3\text{ V}$

FIG 34. Input Bias Current vs. Temperature



$V_{OD} = 100\text{ mV}$

FIG 35. TLV7011 Output Rise Time vs. Load Capacitance



$V_{OD} = 100\text{ mV}$

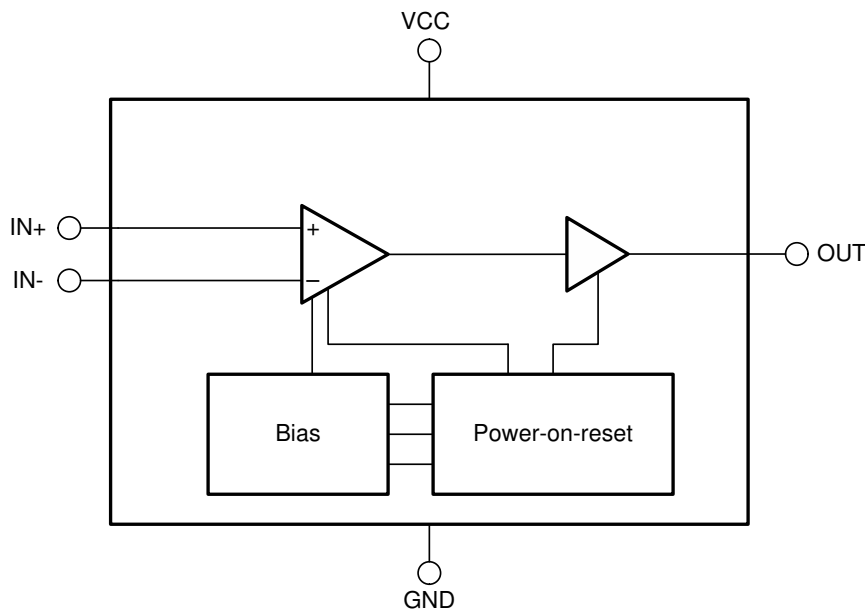
FIG 36. Output Fall Time vs. Load Capacitance

## 8 Detailed Description

### 8.1 Overview

The TLV701x and TLV702x devices are single-channel, micro-power comparators with push-pull and open-drain outputs. Operating down to 1.6 V and consuming only 5  $\mu$ A, the TLV701x and TLV702x are ideally suited for portable and industrial applications. The comparators are available in leadless and leaded packages to offer significant board space saving in space-challenged designs.

### 8.2 Functional Block Diagram



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### 8.3 Feature Description

The TLV701x (push-pull) and TLV702x (open-drain) devices are micro-power comparators that are capable of operating at low voltages. The TLV701x and TLV702x feature a rail-to-rail input stage capable of operating up to 100 mV beyond the VCC power supply rail. The comparators also feature a push-pull and open-drain output stage with internal hysteresis.

### 8.4 Device Functional Modes

The TLV701x and TLV702x have a Power-on-Reset (POR) circuit. While the power supply ( $V_S$ ) is ramping up or ramping down, the POR circuitry will be activated.

For the TLV701x, the POR circuit will hold the output low (at  $V_{EE}$ ) while activated.

For the TLV702x, the POR circuit will keep the output high impedance (logical high) while activated.

When the supply voltage is greater than, or equal to, the minimum supply voltage, the comparator output reflects the state of the differential input ( $V_{ID}$ ).

#### 8.4.1 Inputs

The TLV701x and TLV702x input common-mode extends from  $V_{EE}$  to 100 mV above  $V_{CC}$ . The differential input voltage ( $V_{ID}$ ) can be any voltage within these limits. No phase-inversion of the comparator output will occur when the input pins exceed  $V_{CC}$  and  $V_{EE}$ .

## Device Functional Modes (continued)

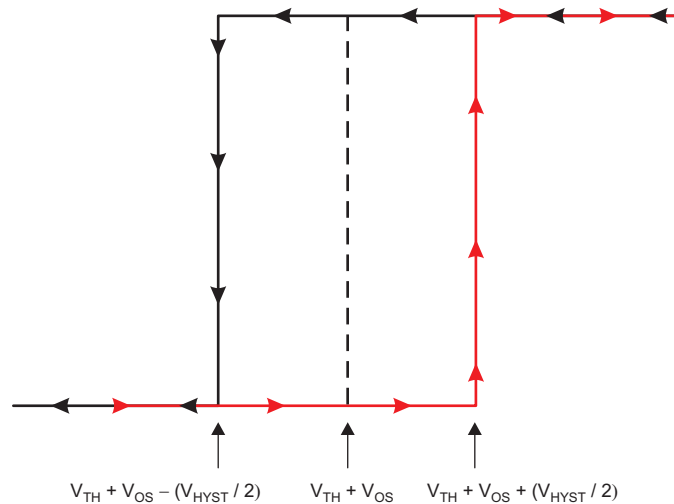
While TI recommends operating the TLV701x and TLV702x within the specified common-mode range, the inputs are fault tolerant to voltages up to 5.5 V independent of the applied  $V_{CC}$  value. Fault tolerant is defined as maintaining the same high input impedance when  $V_{CC}$  is unpowered or within the recommended operating range. Because the inputs of the TLV701x and TLV702x are fault tolerant, the inputs to the comparator can be any value between 0 V and 5.5 V while  $V_{CC}$  is ramping up. This feature allows any supply and input driven sequence as long as the input value and supply are within the specified ranges. In this case, no current limiting resistor is required. This is possible since the  $V_{CC}$  is isolated from the inputs such that it maintains its value even when a higher voltage is applied to the input.

The input bias current is typically 1 pA for input voltages between  $V_{CC}$  and  $V_{EE}$ . The comparator inputs are protected from undervoltage by internal diodes connected to  $V_{EE}$ . As the input voltage goes under  $V_{EE}$ , the protection diodes become forward biased and begin to conduct causing the input bias current to increase exponentially. Input bias current typically doubles for 10°C temperature increases.

### 8.4.2 Internal Hysteresis

The device hysteresis transfer curve is shown in [Figure 37](#). This curve is a function of three components:  $V_{TH}$ ,  $V_{OS}$ , and  $V_{HYST}$ :

- $V_{TH}$  is the actual set voltage or threshold trip voltage.
- $V_{OS}$  is the internal offset voltage between  $V_{IN+}$  and  $V_{IN-}$ . This voltage is added to  $V_{TH}$  to form the actual trip point at which the comparator must respond to change output states.
- $V_{HYST}$  is the internal hysteresis (or trip window) that is designed to reduce comparator sensitivity to noise (4.2 mV for the TLV7011).



**Figure 37. Hysteresis Transfer Curve**

### 8.4.3 Output

The TLV701x feature a push-pull output stage eliminating the need for an external pull-up resistor. On the other hand, the TLV702x feature an open-drain output stage enabling the output logic levels to be pulled up to an external source independent of the supply voltage.

## 9 Application and Implementation

### 注

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 TLV701x and TLV702x are micro-power comparators with reasonable response time. The comparators have a rail-to-rail input stage that can monitor signals beyond the positive supply rail with integrated hysteresis. When higher levels of hysteresis are required, positive feedback can be externally added. The push-pull output stage of the TLV701x is optimal for reduced power budget applications and features no shoot-through current. When level shifting or wire-ORing of the comparator outputs is needed, the TLV702x with its open-drain output stage is well suited to meet the system needs. In either case, the wide operating voltage range, low quiescent current, and micro-package of the TLV701x and TLV702x make these comparators excellent candidates for battery-operated and portable, handheld designs.

#### 9.1.1 Inverting Comparator With Hysteresis for TLV701x

The inverting comparator with hysteresis requires a three-resistor network that is referenced to the comparator supply voltage ( $V_{CC}$ ), as shown in 図 38. When  $V_{IN}$  at the inverting input is less than  $V_A$ , the output voltage is high (for simplicity, assume  $V_O$  switches as high as  $V_{CC}$ ). The three network resistors can be represented as  $R1 \parallel R3$  in series with  $R2$ . 式 1 defines the high-to-low trip voltage ( $V_{A1}$ ).

$$V_{A1} = V_{CC} \times \frac{R2}{(R1 \parallel R3) + R2} \quad (1)$$

When  $V_{IN}$  is greater than  $V_A$ , the output voltage is low, very close to ground. In this case, the three network resistors can be presented as  $R2 \parallel R3$  in series with  $R1$ . Use 式 2 to define the low to high trip voltage ( $V_{A2}$ ).

$$V_{A2} = V_{CC} \times \frac{R2 \parallel R3}{R1 + (R2 \parallel R3)} \quad (2)$$

式 3 defines the total hysteresis provided by the network.

$$\Delta V_A = V_{A1} - V_{A2} \quad (3)$$

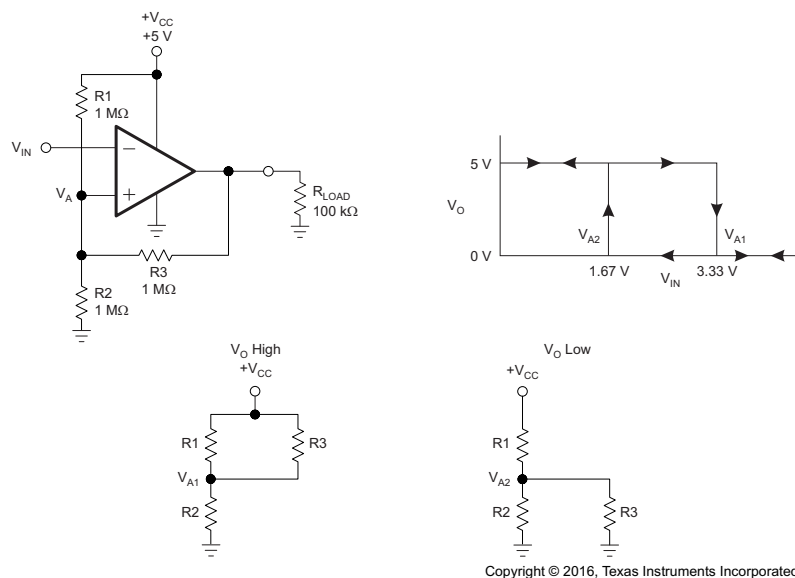


図 38. TLV701x in an Inverting Configuration With Hysteresis

## Application Information (continued)

### 9.1.2 Noninverting Comparator With Hysteresis for TLV701x

A noninverting comparator with hysteresis requires a two-resistor network, as shown in [Figure 39](#), and a voltage reference ( $V_{REF}$ ) at the inverting input. When  $V_{IN}$  is low, the output is also low. For the output to switch from low to high,  $V_{IN}$  must rise to  $V_{IN1}$ . Use [Equation 4](#) to calculate  $V_{IN1}$ .

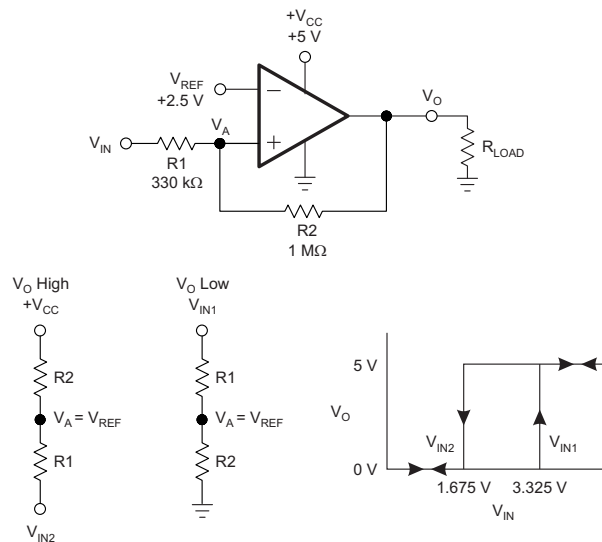
$$V_{IN1} = R1 \times \frac{V_{REF}}{R2} + V_{REF} \quad (4)$$

When  $V_{IN}$  is high, the output is also high. For the comparator to switch back to a low state,  $V_{IN}$  must drop to  $V_{IN2}$  such that  $V_A$  is equal to  $V_{REF}$ . Use [Equation 5](#) to calculate  $V_{IN2}$ .

$$V_{IN2} = \frac{V_{REF} (R1 + R2) - V_{CC} \times R1}{R2} \quad (5)$$

The hysteresis of this circuit is the difference between  $V_{IN1}$  and  $V_{IN2}$ , as shown in [Equation 6](#).

$$\Delta V_{IN} = V_{CC} \times \frac{R1}{R2} \quad (6)$$



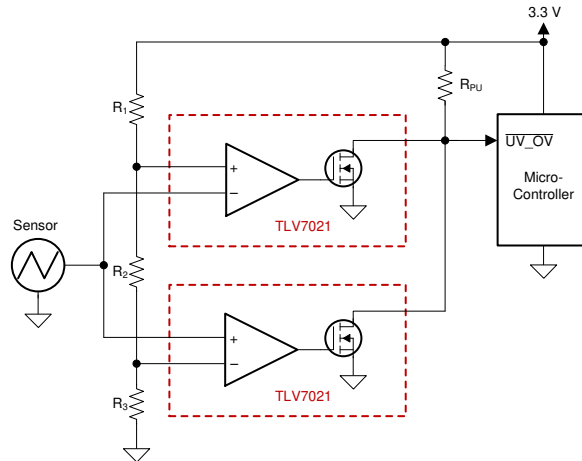
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**Figure 39. TLV701x in a Noninverting Configuration With Hysteresis**

## 9.2 Typical Applications

### 9.2.1 Window Comparator

Window comparators are commonly used to detect undervoltage and overvoltage conditions. [Figure 40](#) shows a simple window comparator circuit.



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**Figure 40. Window Comparator**

#### 9.2.1.1 Design Requirements

For this design, follow these design requirements:

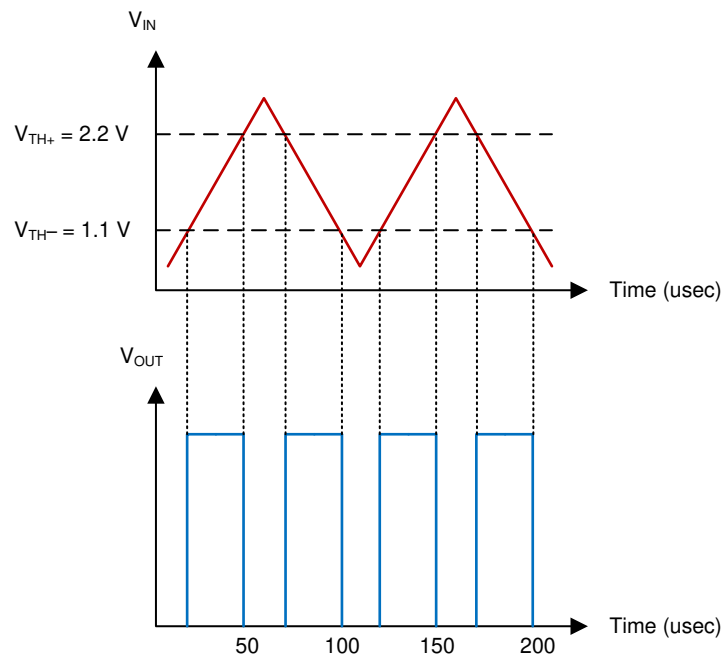
- Alert (logic low output) when an input signal is less than 1.1 V
- Alert (logic low output) when an input signal is greater than 2.2 V
- Alert signal is active low
- Operate from a 3.3-V power supply

#### 9.2.1.2 Detailed Design Procedure

Configure the circuit as shown in [Figure 40](#). Connect  $V_{CC}$  to a 3.3-V power supply and  $V_{EE}$  to ground. Make  $R_1$ ,  $R_2$  and  $R_3$  each 10-M $\Omega$  resistors. These three resistors are used to create the positive and negative thresholds for the window comparator ( $V_{TH+}$  and  $V_{TH-}$ ). With each resistor being equal,  $V_{TH+}$  is 2.2 V and  $V_{TH-}$  is 1.1 V. Large resistor values such as 10-M $\Omega$  are used to minimize power consumption. The sensor output voltage is applied to the inverting and noninverting inputs of the two TLV702x's. The TLV7021 is used for its open-drain output configuration. Using the TLV702x allows the two comparator outputs to be Wire-Or'd together. The respective comparator outputs will be low when the sensor is less than 1.1 V or greater than 2.2 V.  $V_{OUT}$  will be high when the sensor is in the range of 1.1 V to 2.2 V.

## Typical Applications (continued)

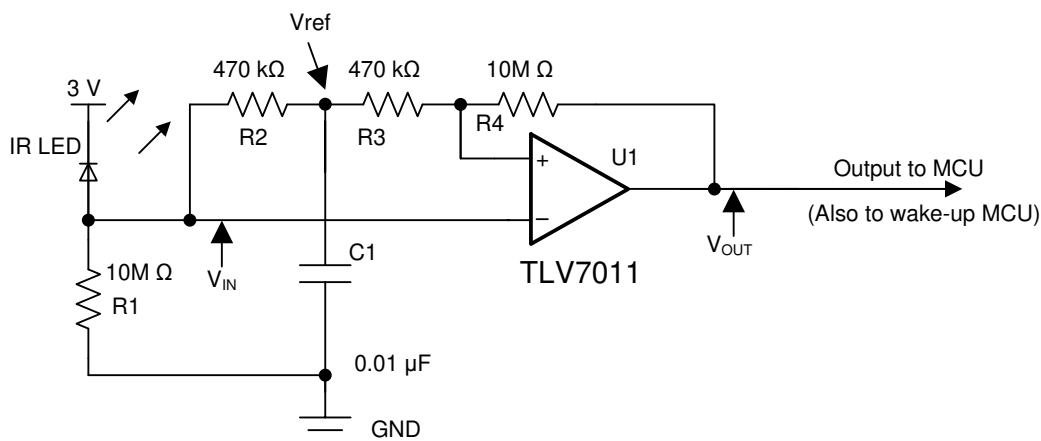
### 9.2.1.3 Application Curve



✎ 41. Window Comparator Results

### 9.2.2 IR Receiver Analog Front End

A single TLV7011 device can be used to build a complete IR receiver analog front end (AFE). The nanoamp quiescent current and low input bias current make it possible to be powered with a coin cell battery, which could last for years.



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✎ 42. IR Receiver Analog Front End Using TLV7011

#### 9.2.2.1 Design Requirements

For this design, follow these design requirements:

- Use a proper resistor ( $R_1$ ) value to generate an adequate signal amplitude applied to the inverting input of the comparator.
- The low input bias current  $I_B$  (2 pA typical) ensures that a greater value of  $R_1$  to be used.

## Typical Applications (continued)

- The RC constant value ( $R_2$  and  $C_1$ ) must support the targeted data rate (that is, 9,600 bauds) to maintain a valid tripping threshold.
- The hysteresis introduced with  $R_3$  and  $R_4$  helps to avoid spurious output toggles.

### 9.2.2.2 Detailed Design Procedure

The IR receiver AFE design is highly streamlined and optimized.  $R_1$  converts the IR light energy induced current into voltage and applies to the inverting input of the comparator. Because a reverse biased IR LED is used as the IR receiver, a higher I/V transimpedance gain is required to boost the amplitude of reduced current. A 10M resistor is used as  $R_1$  to support a 1-V, 100-nA transimpedance gain. This is made possible with the picoamps Input bias current  $I_B$  (5pA typical). The RC network of  $R_2$  and  $C_1$  establishes a reference voltage  $V_{ref}$  which tracks the mean amplitude of the IR signal. The RC constant of  $R_2$  and  $C_1$  (about 4.7 ms) is chosen for  $V_{ref}$  to track the received IR current fluctuation but not the actual data bit stream. The noninverting input is connected to  $V_{ref}$  and the output over the  $R_3$  and  $R_4$  resistor network which provides additional hysteresis for improved guard against spurious toggles.

To reduce the current drain from the coin cell battery, data transmission must be short and infrequent.

### 9.2.2.3 Application Curve

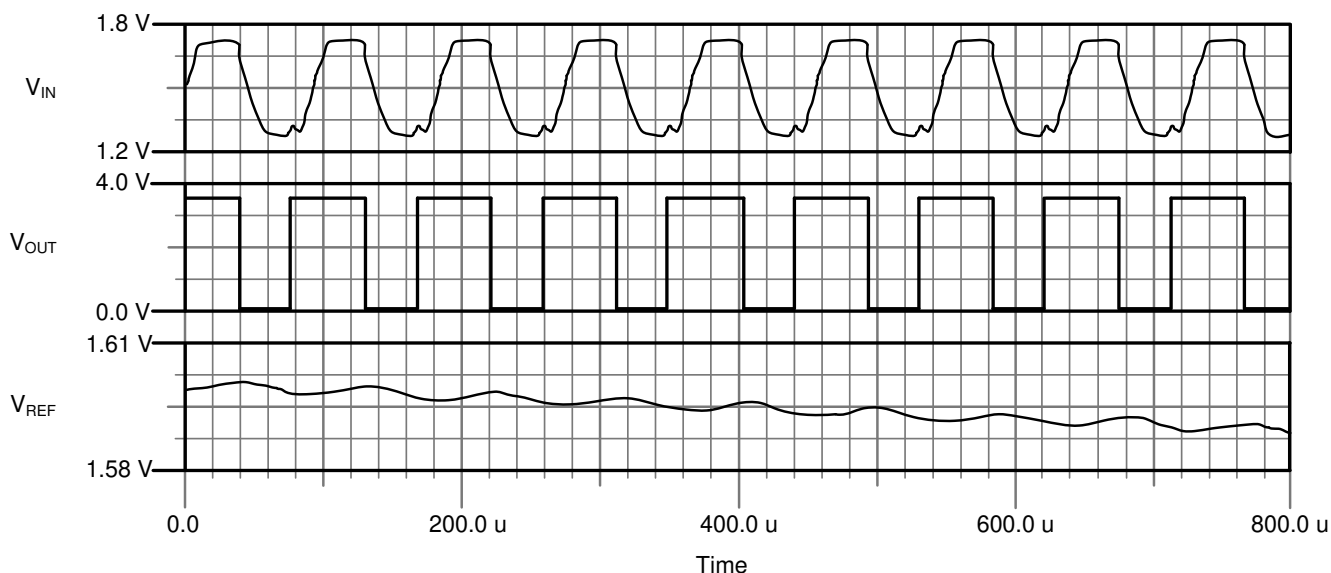
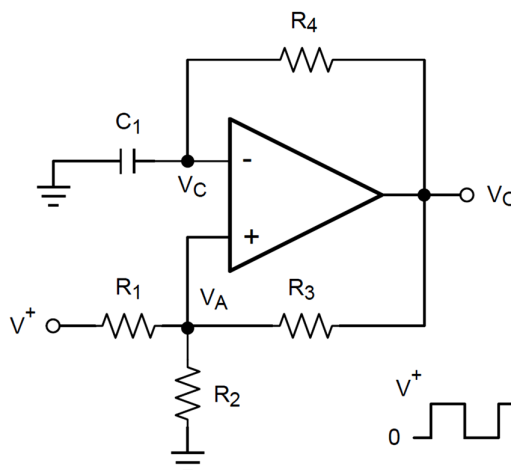


FIG 43. IR Receiver AFE Waveforms

## Typical Applications (continued)

### 9.2.3 Square-Wave Oscillator

Square-wave oscillator can be used as low cost timing reference or system supervisory clock source.



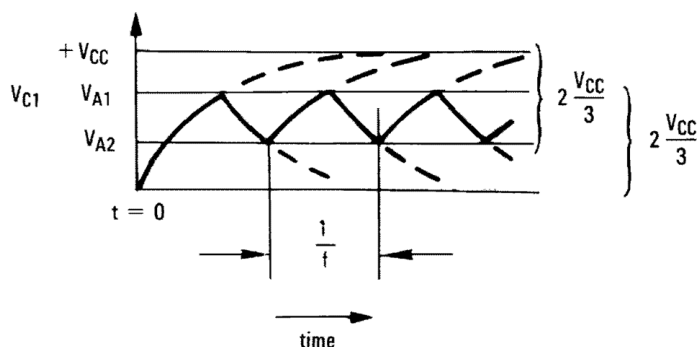
✎ 44. Square-Wave Oscillator

#### 9.2.3.1 Design Requirements

The square-wave period is determined by the RC time constant of the capacitor and resistor. The maximum frequency is limited by propagation delay of the device and the capacitance load at the output. The low input bias current allows a lower capacitor value and larger resistor value combination for a given oscillator frequency, which may help to reduce BOM cost and board space.

#### 9.2.3.2 Detailed Design Procedure

The oscillation frequency is determined by the resistor and capacitor values. The following calculation provides details of the steps.



✎ 45. Square-Wave Oscillator Timing Thresholds

First consider the output of Figure ✎ 44 is high which indicates the inverted input  $V_C$  is lower than the noninverting input ( $V_A$ ). This causes the  $C_1$  to be charged through  $R_4$ , and the voltage  $V_C$  increases until it is equal to the noninverting input. The value of  $V_A$  at the point is calculated by 式 7.

$$V_{A1} = \frac{V_{CC} \times R_2}{R_2 + R_1 \parallel R_3} \quad (7)$$

if  $R_1 = R_2 = R_3$ , then  $V_{A1} = 2 V_{CC} / 3$

## Typical Applications (continued)

At this time the comparator output trips pulling down the output to the negative rail. The value of  $V_A$  at this point is calculated by 式 8.

$$V_{A2} = \frac{V_{CC}(R_2 \parallel R_3)}{R_1 + R_2 \parallel R_3} \quad (8)$$

if  $R_1 = R_2 = R_3$ , then  $V_{A2} = V_{CC}/3$

The  $C_1$  now discharges through the  $R_4$ , and the voltage  $V_{CC}$  decreases until it reaches  $V_{A2}$ . At this point, the output switches back to the starting state. The oscillation period equals to the time duration from for  $C_1$  from  $2V_{CC}/3$  to  $V_{CC}/3$  then back to  $2V_{CC}/3$ , which is given by  $R_4 C_1 \times \ln 2$  for each trip. Therefore, the total time duration is calculated as  $2 R_4 C_1 \times \ln 2$ . The oscillation frequency can be obtained by 式 9:

$$f = 1 / (2 R_4 \times C_1 \times \ln 2) \quad (9)$$

### 9.2.3.3 Application Curve

Figure 46 shows the simulated results of tan oscillator using the following component values:

- $R_1 = R_2 = R_3 = R_4 = 100 \text{ k}\Omega$
- $C_1 = 100 \text{ pF}$ ,  $C_L = 20 \text{ pF}$
- $V_+ = 5 \text{ V}$ ,  $V_- = \text{GND}$
- $C_{\text{stray}}$  (not shown) from  $V_A$  TO GND =  $10 \text{ pF}$

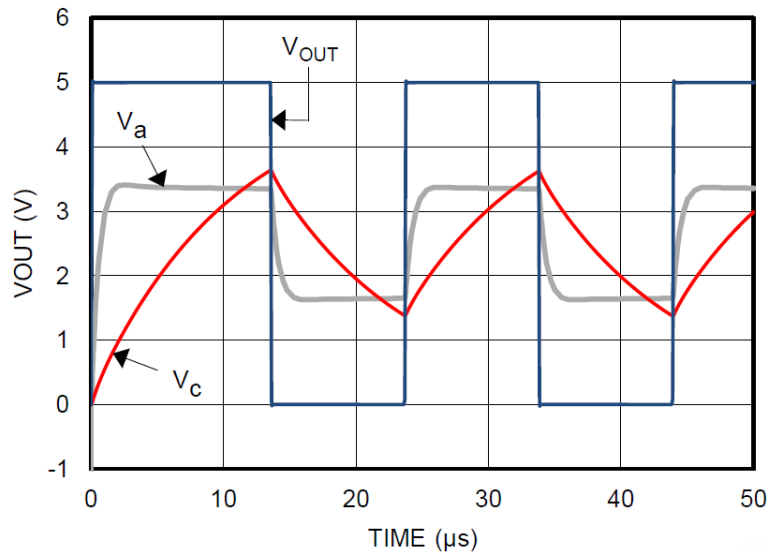


Figure 46. Square-Wave Oscillator Output Waveform

## 10 Power Supply Recommendations

The TLV701x and TLV702x have a recommended operating voltage range ( $V_S$ ) of 1.6 V to 5.5 / 6.5 V.  $V_S$  is defined as  $V_{CC} - V_{EE}$ . Therefore, the supply voltages used to create  $V_S$  can be single-ended or bipolar. For example, single-ended supply voltages of 5 V and 0 V and bipolar supply voltages of +2.5 V and –2.5 V create comparable operating voltages for  $V_S$ . However, when bipolar supply voltages are used, it is important to realize that the logic low level of the comparator output is referenced to  $V_{EE}$ .

Output capacitive loading and output toggle rate will cause the average supply current to rise over the quiescent current.

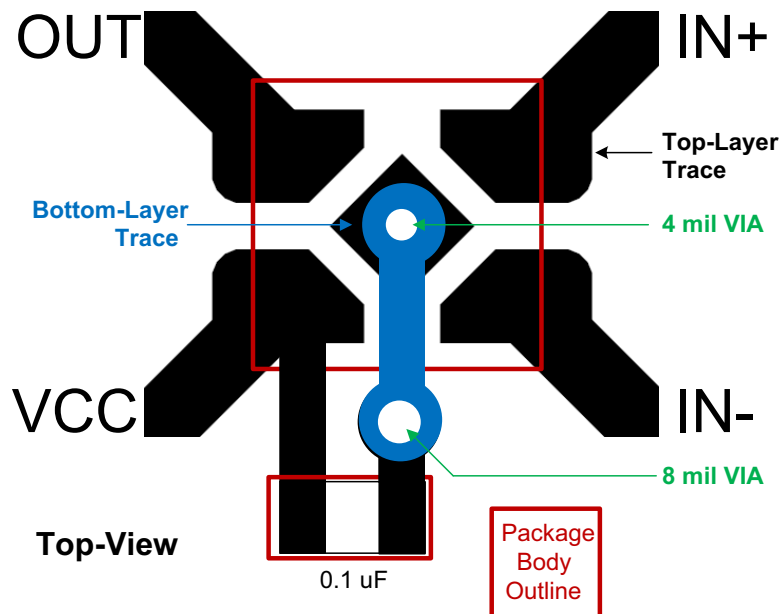
## 11 Layout

### 11.1 Layout Guidelines

To reduce PCB fabrication cost and improve reliability, TI recommends using a 4-mil via at the center pad connected to the ground trace or plane on the bottom layer.

A power-supply bypass capacitor of 100 nF is recommended when supply output impedance is high, supply traces are long, or when excessive noise is expected on the supply lines. Bypass capacitors are also recommended when the comparator output drives a long trace or is required to drive a capacitive load. Due to the fast rising and falling edge rates and high-output sink and source capability of the TLV7011 and TLV7021 output stages, higher than normal quiescent current can be drawn from the power supply. Under this circumstance, the system would benefit from a bypass capacitor across the supply pins.

### 11.2 Layout Example



✎ 47. Layout Example

## 12 デバイスおよびドキュメントのサポート

### 12.1 デバイス・サポート

#### 12.1.1 開発サポート

##### 12.1.1.1 評価基板

TLV70x1デバイス・ファミリーを使用する回路の初期性能評価に役立てるため、評価基板(EVM)を利用可能です。[TLV7011 Micro-PowerコンパレータDIPアダプタ評価基板](#)は、テキサス・インスツルメンツWebサイトの製品フォルダで請求でき、TI eStoreから直接お求めにもなれます。

### 12.2 関連リンク

次の表に、クイック・アクセス・リンクを示します。カテゴリには、技術資料、サポートおよびコミュニティ・リソース、ツールとソフトウェア、およびサンプル注文またはご購入へのクイック・アクセスが含まれます。

**表 1. 関連リンク**

| 製品      | プロダクト・フォルダ              | サンプルとご購入                | 技術資料                    | ツールとソフトウェア              | サポートとコミュニティ             |
|---------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|
| TLV7011 | <a href="#">ここをクリック</a> | <a href="#">ここをクリック</a> | <a href="#">ここをクリック</a> | <a href="#">ここをクリック</a> | <a href="#">ここをクリック</a> |
| TLV7021 | <a href="#">ここをクリック</a> | <a href="#">ここをクリック</a> | <a href="#">ここをクリック</a> | <a href="#">ここをクリック</a> | <a href="#">ここをクリック</a> |

### 12.3 ドキュメントの更新通知を受け取る方法

ドキュメントの更新についての通知を受け取るには、[ti.com](#)のデバイス製品フォルダを開いてください。右上の「アラートを受け取る」をクリックして登録すると、変更されたすべての製品情報に関するダイジェストを毎週受け取れます。変更の詳細については、修正されたドキュメントに含まれている改訂履歴をご覧ください。

### 12.4 コミュニティ・リソース

[TI E2E™ support forums](#) are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

Linked content is 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](#).

### 12.5 商標

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All other trademarks are the property of their respective owners.

### 12.6 静電気放電に関する注意事項



すべての集積回路は、適切なESD保護方法を用いて、取扱いと保存を行うようにして下さい。

静電気放電はわずかな性能の低下から完全なデバイスの故障に至るまで、様々な損傷を与えます。高精度の集積回路は、損傷に対して敏感であり、極めてわずかなパラメータの変化により、デバイスに規定された仕様に適合しなくなる場合があります。

### 12.7 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

## 13 メカニカル、パッケージ、および注文情報

以降のページには、メカニカル、パッケージ、および注文に関する情報が記載されています。この情報は、そのデバイスについて利用可能な最新のデータです。このデータは予告なく変更されることがあり、ドキュメントが改訂される場合もあります。本データシートのブラウザ版を使用されている場合は、画面左側の説明をご覧ください。

## PACKAGING INFORMATION

| Orderable Device | Status<br>(1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan<br>(2) | Lead finish/<br>Ball material<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|------------------|---------------|--------------|-----------------|------|-------------|-----------------|--------------------------------------|----------------------|--------------|-------------------------|-------------------------|
| TLV7011DBVR      | ACTIVE        | SOT-23       | DBV             | 5    | 3000        | RoHS & Green    | NIPDAUAG                             | Level-1-260C-UNLIM   | -40 to 125   | 1IC2                    | <a href="#">Samples</a> |
| TLV7011DCKR      | ACTIVE        | SC70         | DCK             | 5    | 3000        | RoHS & Green    | NIPDAU                               | Level-2-260C-1 YEAR  | -40 to 125   | 19N                     | <a href="#">Samples</a> |
| TLV7011DCKT      | ACTIVE        | SC70         | DCK             | 5    | 250         | RoHS & Green    | NIPDAU                               | Level-2-260C-1 YEAR  | -40 to 125   | 19N                     | <a href="#">Samples</a> |
| TLV7011DPWR      | ACTIVE        | X2SON        | DPW             | 5    | 3000        | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 125   | 7N                      | <a href="#">Samples</a> |
| TLV7012DDFR      | ACTIVE        | SOT-23-THIN  | DDF             | 8    | 3000        | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 125   | 7012                    | <a href="#">Samples</a> |
| TLV7012DGKR      | ACTIVE        | VSSOP        | DGK             | 8    | 2500        | RoHS & Green    | NIPDAU   SN<br>  NIPDAUAG            | Level-1-260C-UNLIM   | -40 to 125   | 7012                    | <a href="#">Samples</a> |
| TLV7012DSGR      | ACTIVE        | WSO          | DSG             | 8    | 3000        | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 125   | 7012                    | <a href="#">Samples</a> |
| TLV7021DBVR      | ACTIVE        | SOT-23       | DBV             | 5    | 3000        | RoHS & Green    | NIPDAUAG                             | Level-1-260C-UNLIM   | -40 to 125   | 1ID2                    | <a href="#">Samples</a> |
| TLV7021DCKR      | ACTIVE        | SC70         | DCK             | 5    | 3000        | RoHS & Green    | NIPDAU   SN                          | Level-2-260C-1 YEAR  | -40 to 125   | 19O                     | <a href="#">Samples</a> |
| TLV7021DCKT      | ACTIVE        | SC70         | DCK             | 5    | 250         | RoHS & Green    | NIPDAU   SN                          | Level-2-260C-1 YEAR  | -40 to 125   | 19O                     | <a href="#">Samples</a> |
| TLV7021DPWR      | ACTIVE        | X2SON        | DPW             | 5    | 3000        | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 125   | 7P                      | <a href="#">Samples</a> |
| TLV7022DDFR      | ACTIVE        | SOT-23-THIN  | DDF             | 8    | 3000        | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 125   | 7022                    | <a href="#">Samples</a> |
| TLV7022DGKR      | ACTIVE        | VSSOP        | DGK             | 8    | 2500        | RoHS & Green    | NIPDAUAG   SN                        | Level-1-260C-UNLIM   | -40 to 125   | 7022                    | <a href="#">Samples</a> |
| TLV7022DSGR      | ACTIVE        | WSO          | DSG             | 8    | 3000        | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 125   | 7022                    | <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  $\leq 1000$ ppm threshold. Antimony trioxide based flame retardants must also meet the  $\leq 1000$ ppm threshold requirement.

<sup>(3)</sup> MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

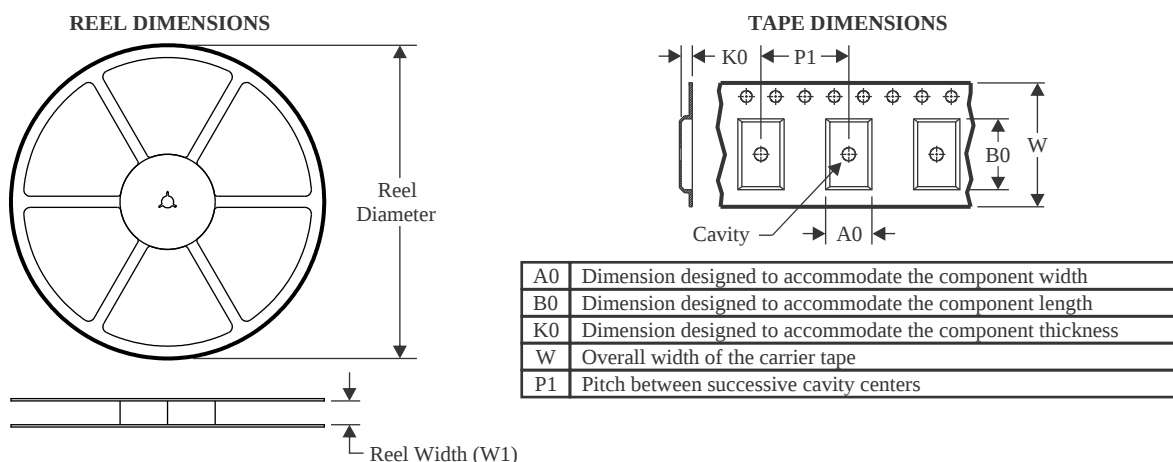
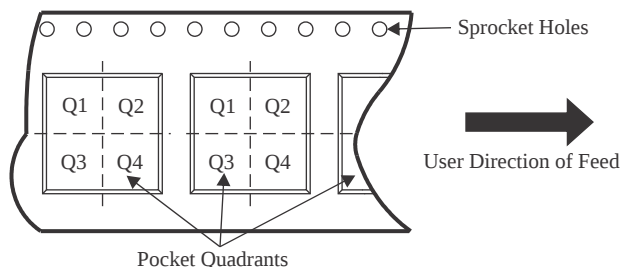
<sup>(4)</sup> There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

<sup>(5)</sup> 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.

<sup>(6)</sup> 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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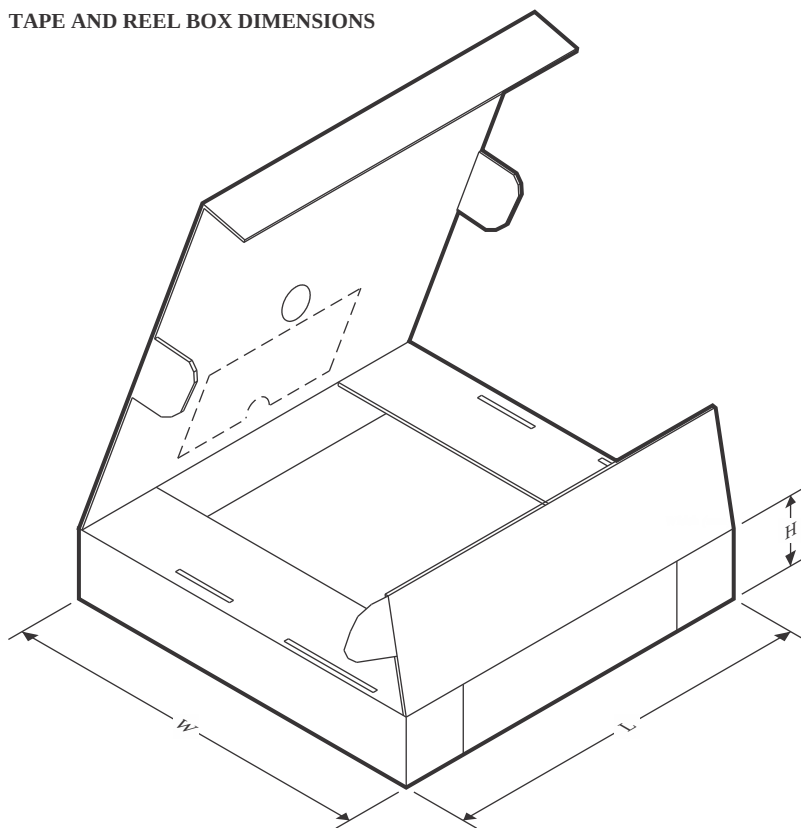
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**TAPE AND REEL INFORMATION**

**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**


\*All dimensions are nominal

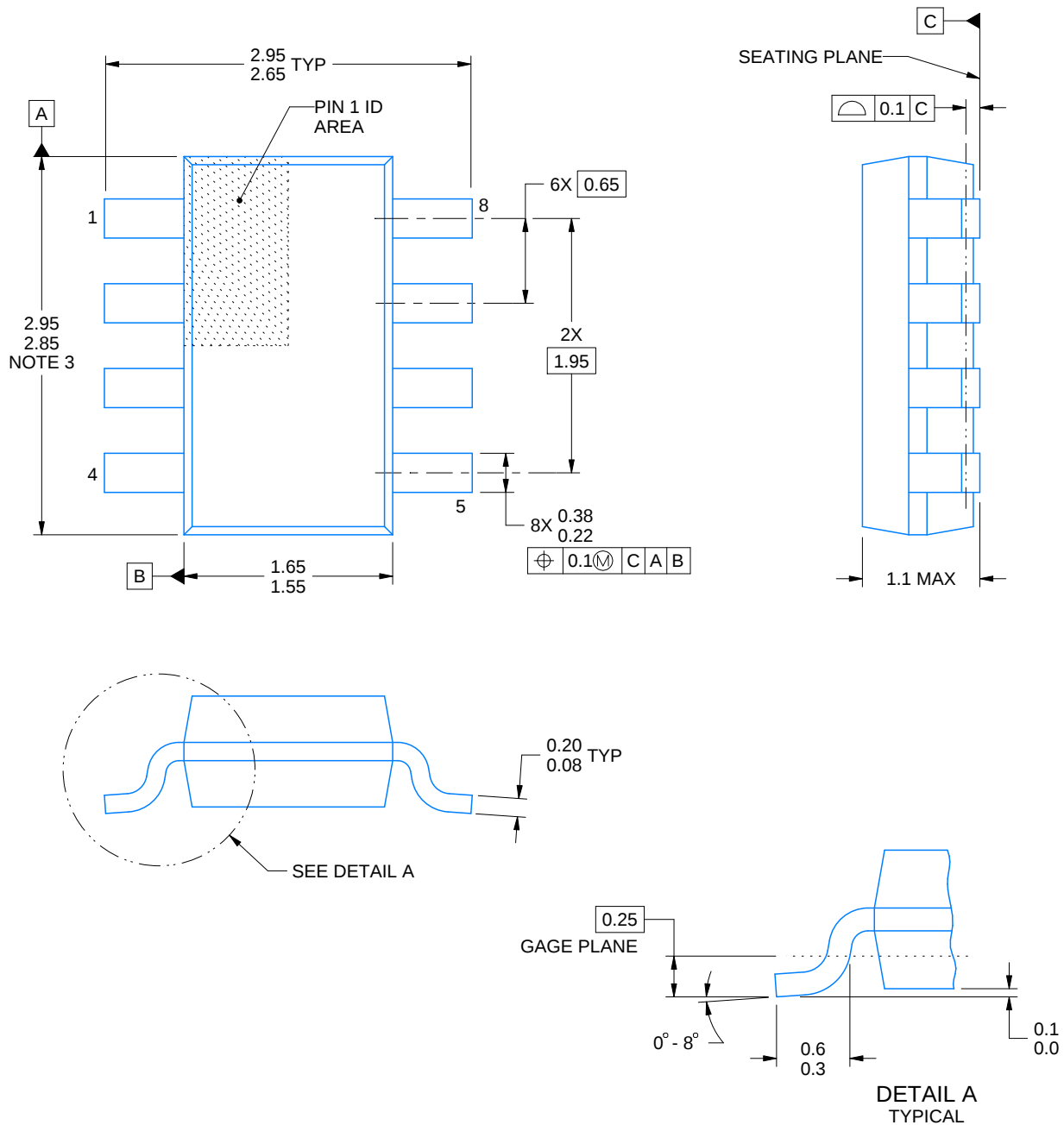
| Device      | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|-------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TLV7011DBVR | SOT-23       | DBV             | 5    | 3000 | 180.0              | 8.4                | 3.23    | 3.17    | 1.37    | 4.0     | 8.0    | Q3            |
| TLV7011DCKR | SC70         | DCR             | 5    | 3000 | 178.0              | 9.0                | 2.4     | 2.5     | 1.2     | 4.0     | 8.0    | Q3            |
| TLV7011DCKT | SC70         | DCR             | 5    | 250  | 178.0              | 9.0                | 2.4     | 2.5     | 1.2     | 4.0     | 8.0    | Q3            |
| TLV7011DPWR | X2SON        | DPW             | 5    | 3000 | 178.0              | 8.4                | 0.91    | 0.91    | 0.5     | 2.0     | 8.0    | Q2            |
| TLV7012DDFR | SOT-23-THIN  | DDF             | 8    | 3000 | 180.0              | 8.4                | 3.2     | 3.2     | 1.4     | 4.0     | 8.0    | Q3            |
| TLV7012DGKR | VSSOP        | DGK             | 8    | 2500 | 330.0              | 12.4               | 5.3     | 3.4     | 1.4     | 8.0     | 12.0   | Q1            |
| TLV7012DSGR | WSON         | DSG             | 8    | 3000 | 180.0              | 8.4                | 2.3     | 2.3     | 1.15    | 4.0     | 8.0    | Q2            |
| TLV7021DBVR | SOT-23       | DBV             | 5    | 3000 | 180.0              | 8.4                | 3.23    | 3.17    | 1.37    | 4.0     | 8.0    | Q3            |
| TLV7021DCKR | SC70         | DCR             | 5    | 3000 | 180.0              | 8.4                | 2.3     | 2.5     | 1.2     | 4.0     | 8.0    | Q3            |
| TLV7021DCKT | SC70         | DCR             | 5    | 250  | 180.0              | 8.4                | 2.3     | 2.5     | 1.2     | 4.0     | 8.0    | Q3            |
| TLV7021DPWR | X2SON        | DPW             | 5    | 3000 | 178.0              | 8.4                | 0.91    | 0.91    | 0.5     | 2.0     | 8.0    | Q2            |
| TLV7022DDFR | SOT-23-THIN  | DDF             | 8    | 3000 | 180.0              | 8.4                | 3.2     | 3.2     | 1.4     | 4.0     | 8.0    | Q3            |
| TLV7022DGKR | VSSOP        | DGK             | 8    | 2500 | 330.0              | 12.4               | 5.3     | 3.4     | 1.4     | 8.0     | 12.0   | Q1            |
| TLV7022DSGR | WSON         | DSG             | 8    | 3000 | 180.0              | 8.4                | 2.3     | 2.3     | 1.15    | 4.0     | 8.0    | Q2            |

## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

| Device      | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|-------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TLV7011DBVR | SOT-23       | DBV             | 5    | 3000 | 183.0       | 183.0      | 20.0        |
| TLV7011DCKR | SC70         | DCK             | 5    | 3000 | 190.0       | 190.0      | 30.0        |
| TLV7011DCKT | SC70         | DCK             | 5    | 250  | 190.0       | 190.0      | 30.0        |
| TLV7011DPWR | X2SON        | DPW             | 5    | 3000 | 205.0       | 200.0      | 33.0        |
| TLV7012DDFR | SOT-23-THIN  | DDF             | 8    | 3000 | 210.0       | 185.0      | 35.0        |
| TLV7012DGKR | VSSOP        | DGK             | 8    | 2500 | 366.0       | 364.0      | 50.0        |
| TLV7012DSGR | WSON         | DSG             | 8    | 3000 | 210.0       | 185.0      | 35.0        |
| TLV7021DBVR | SOT-23       | DBV             | 5    | 3000 | 183.0       | 183.0      | 20.0        |
| TLV7021DCKR | SC70         | DCK             | 5    | 3000 | 210.0       | 185.0      | 35.0        |
| TLV7021DCKT | SC70         | DCK             | 5    | 250  | 210.0       | 185.0      | 35.0        |
| TLV7021DPWR | X2SON        | DPW             | 5    | 3000 | 205.0       | 200.0      | 33.0        |
| TLV7022DDFR | SOT-23-THIN  | DDF             | 8    | 3000 | 210.0       | 185.0      | 35.0        |
| TLV7022DGKR | VSSOP        | DGK             | 8    | 2500 | 366.0       | 364.0      | 50.0        |
| TLV7022DSGR | WSON         | DSG             | 8    | 3000 | 210.0       | 185.0      | 35.0        |



4222047/C 10/2022

## NOTES:

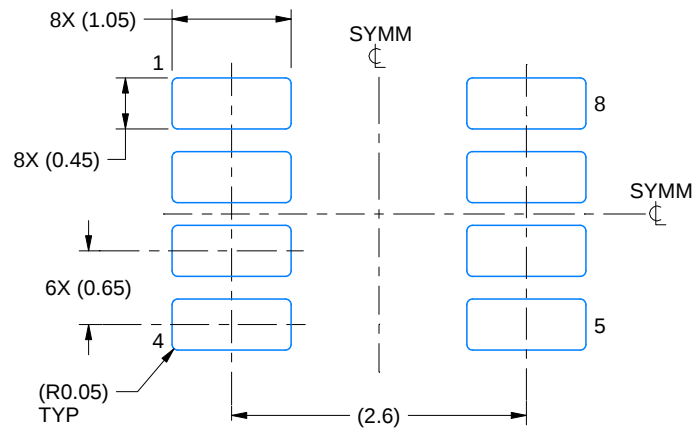
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.

# EXAMPLE BOARD LAYOUT

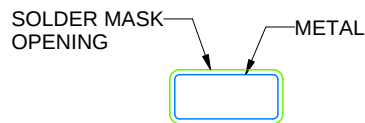
DDF0008A

SOT-23 - 1.1 mm max height

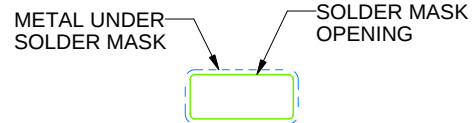
PLASTIC SMALL OUTLINE



LAND PATTERN EXAMPLE  
SCALE:15X



NON SOLDER MASK  
DEFINED



SOLDER MASK  
DEFINED

SOLDER MASK DETAILS

4222047/C 10/2022

NOTES: (continued)

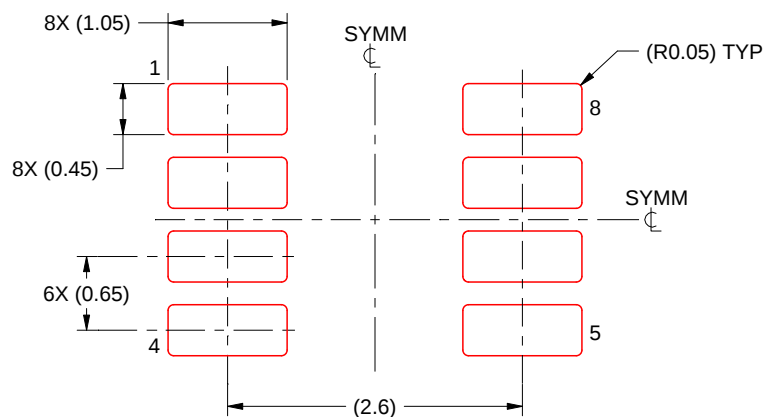
4. Publication IPC-7351 may have alternate designs.
5. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

## EXAMPLE STENCIL DESIGN

DDF0008A

SOT-23 - 1.1 mm max height

PLASTIC SMALL OUTLINE



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE:15X

4222047/C 10/2022

NOTES: (continued)

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

## GENERIC PACKAGE VIEW

**DPW 5**

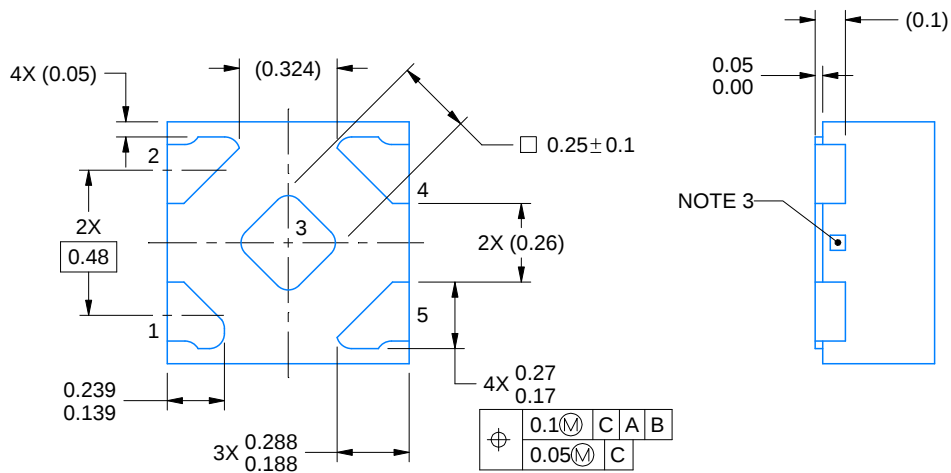
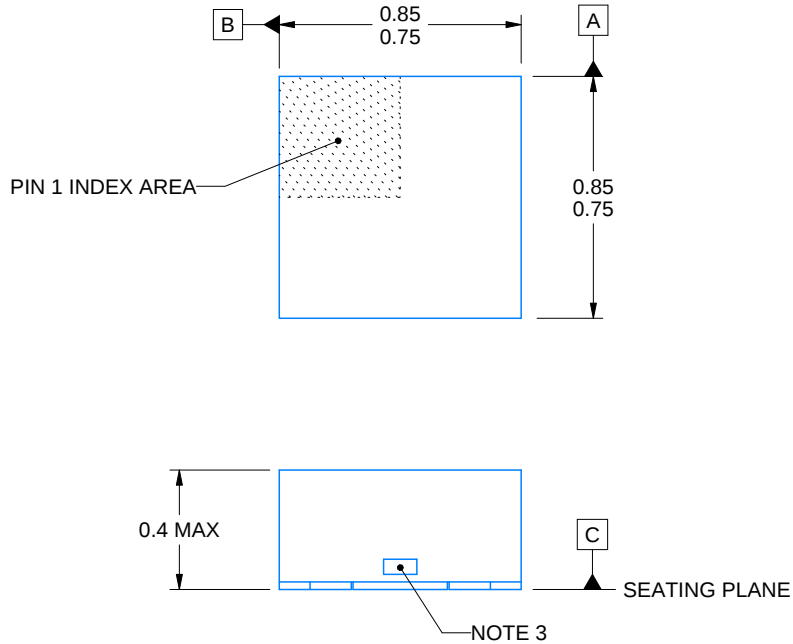
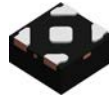
**X2SON - 0.4 mm max height**

PLASTIC SMALL OUTLINE - NO LEAD



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

4211218-3/D



4223102/D 03/2022

## NOTES:

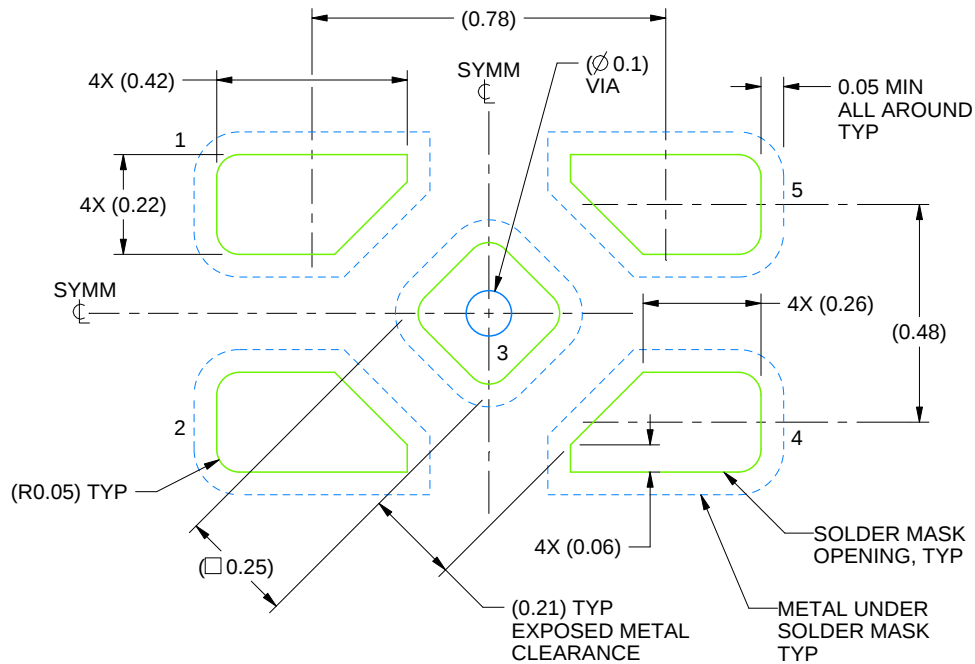
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The size and shape of this feature may vary.

# EXAMPLE BOARD LAYOUT

DPW0005A

X2SON - 0.4 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



LAND PATTERN EXAMPLE  
SOLDER MASK DEFINED  
SCALE:60X

4223102/D 03/2022

NOTES: (continued)

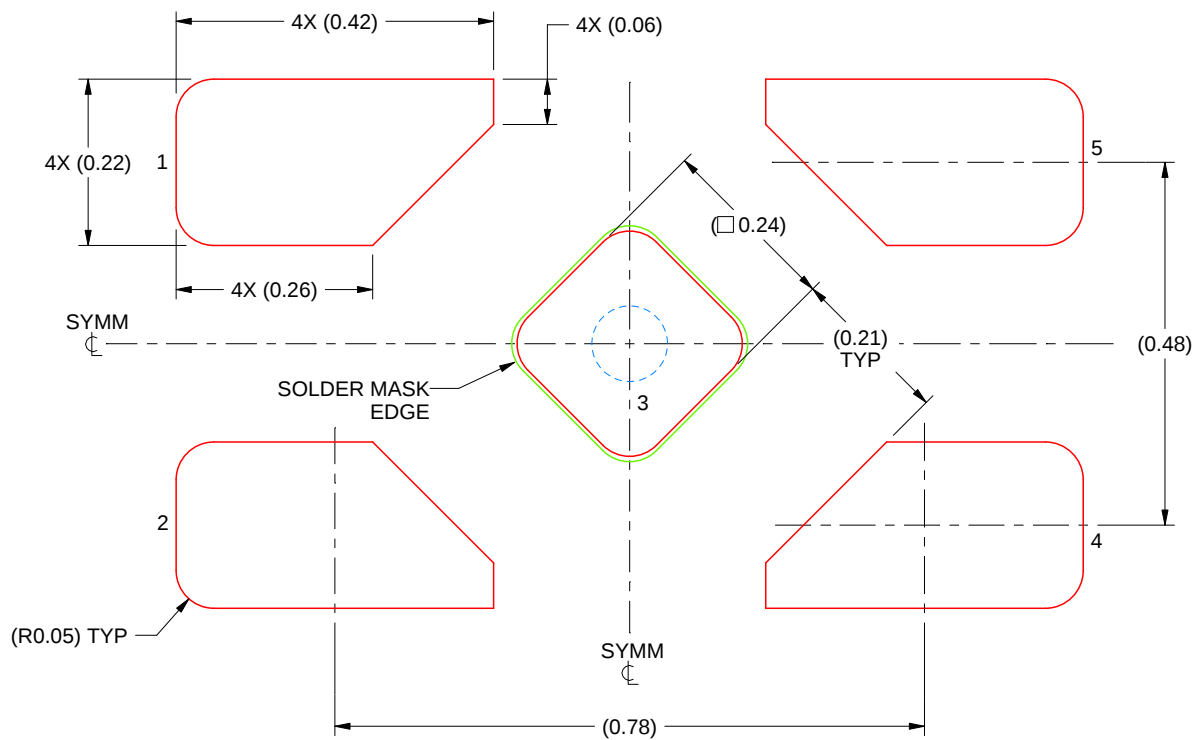
4. This package is designed to be soldered to a thermal pad on the board. For more information, refer to QFN/SON PCB application note in literature No. SLUA271 ([www.ti.com/lit/sluea271](http://www.ti.com/lit/sluea271)).

# EXAMPLE STENCIL DESIGN

DPW0005A

X2SON - 0.4 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



SOLDER PASTE EXAMPLE  
BASED ON 0.1 mm THICK STENCIL

EXPOSED PAD 3  
92% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE  
SCALE:100X

4223102/D 03/2022

NOTES: (continued)

5. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

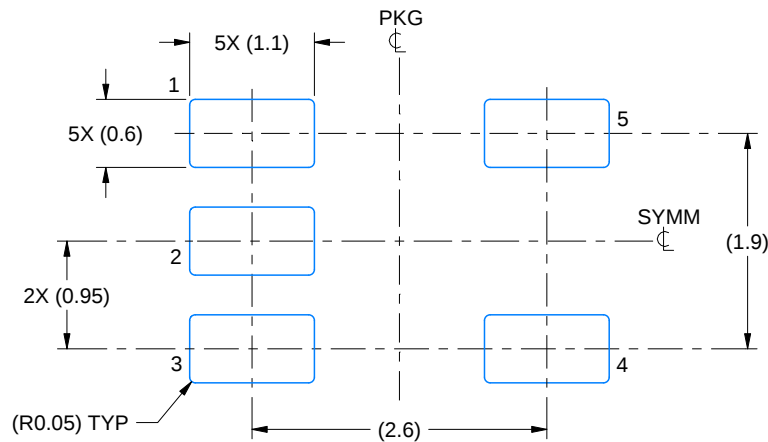


# EXAMPLE BOARD LAYOUT

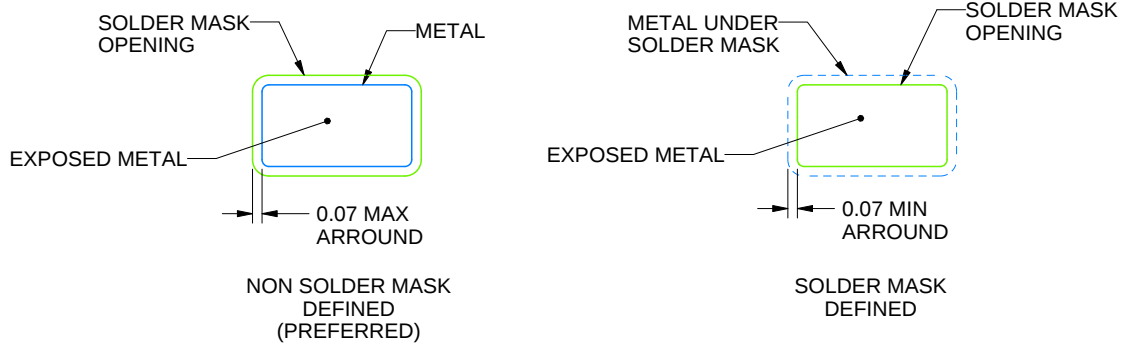
DBV0005A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:15X



SOLDER MASK DETAILS

4214839/J 02/2024

NOTES: (continued)

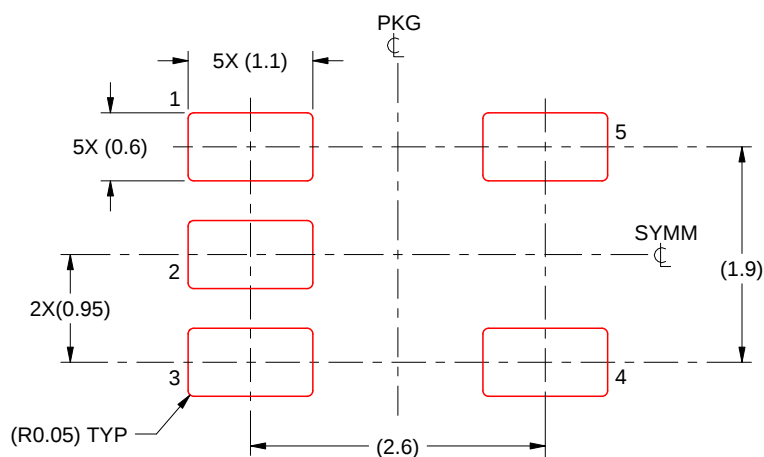
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

## EXAMPLE STENCIL DESIGN

DBV0005A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE:15X

4214839/J 02/2024

NOTES: (continued)

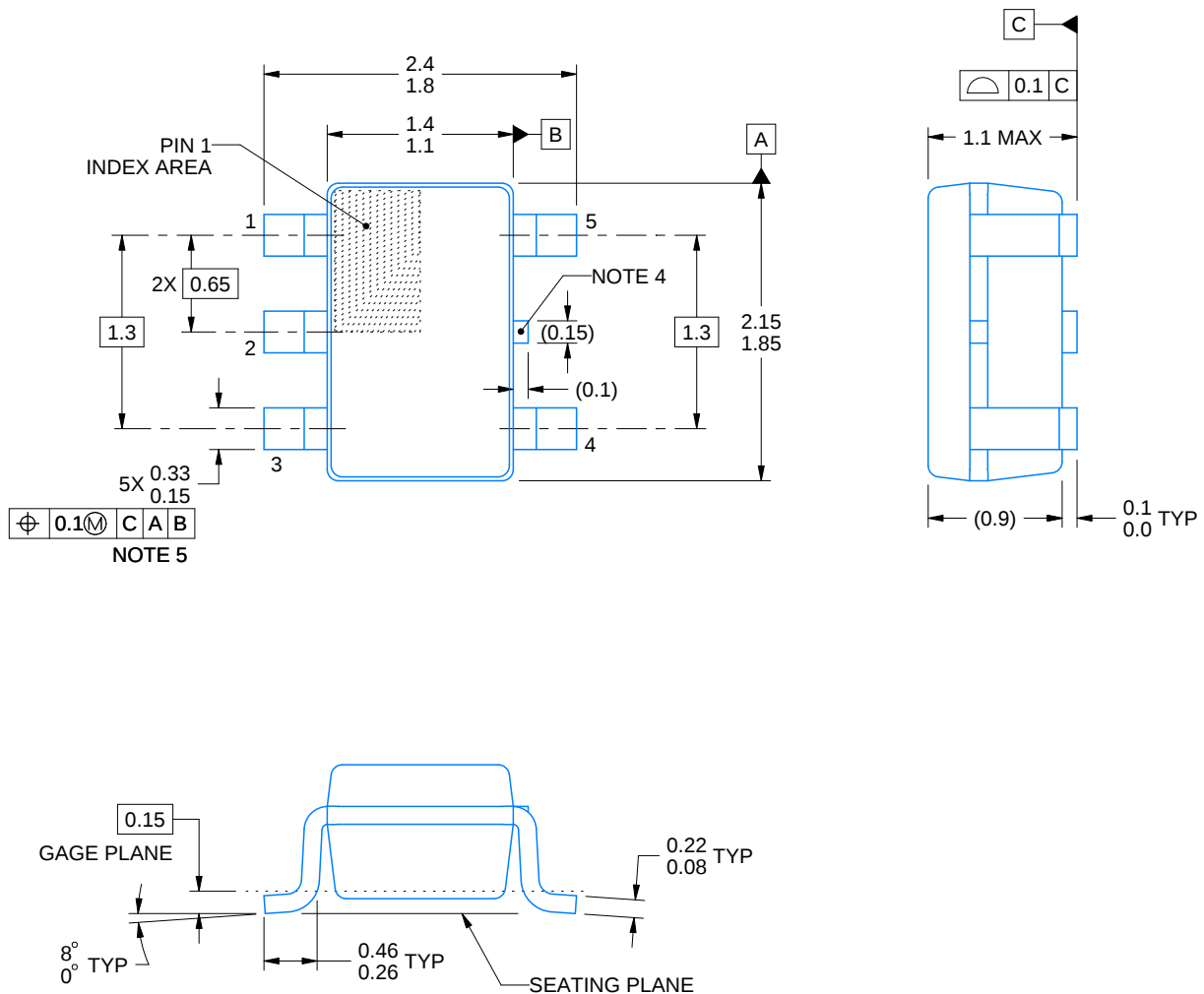
8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

**DCK0005A**

## PACKAGE OUTLINE

### SOT - 1.1 max height

SMALL OUTLINE TRANSISTOR



4214834/D 07/2023

NOTES:

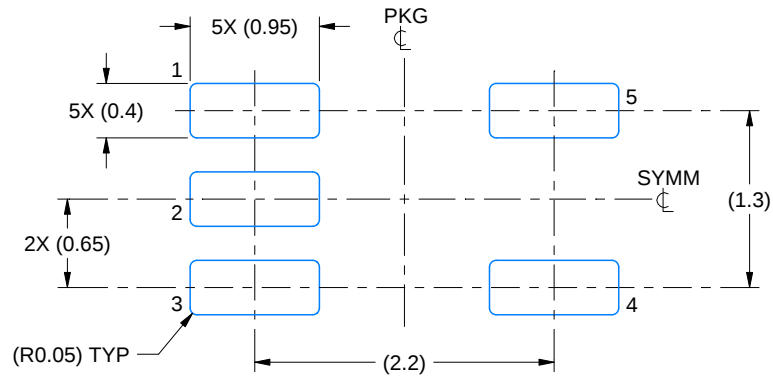
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Reference JEDEC MO-203.
4. Support pin may differ or may not be present.
5. Lead width does not comply with JEDEC.

# EXAMPLE BOARD LAYOUT

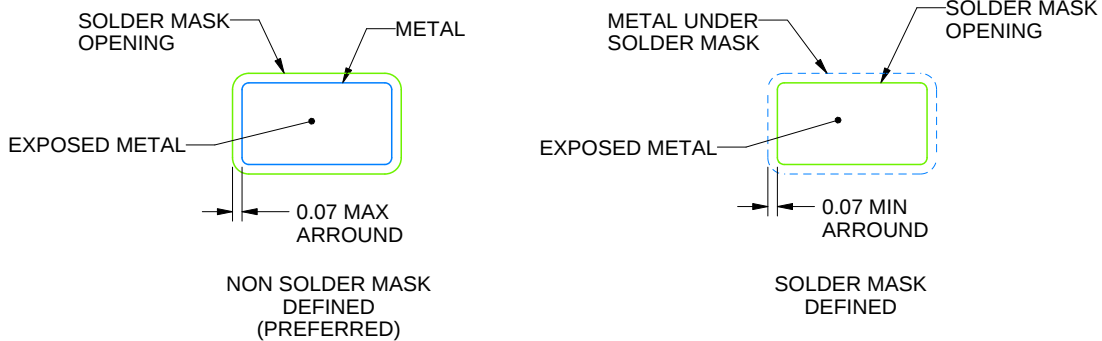
DCK0005A

SOT - 1.1 max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:18X

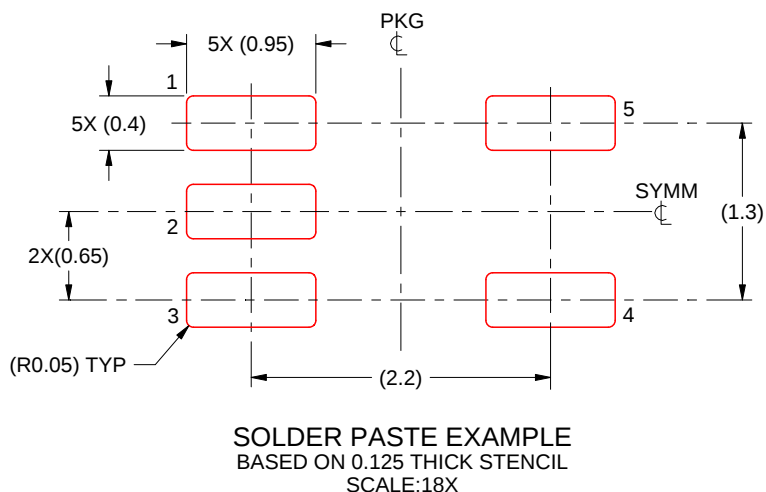


SOLDER MASK DETAILS

4214834/D 07/2023

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.



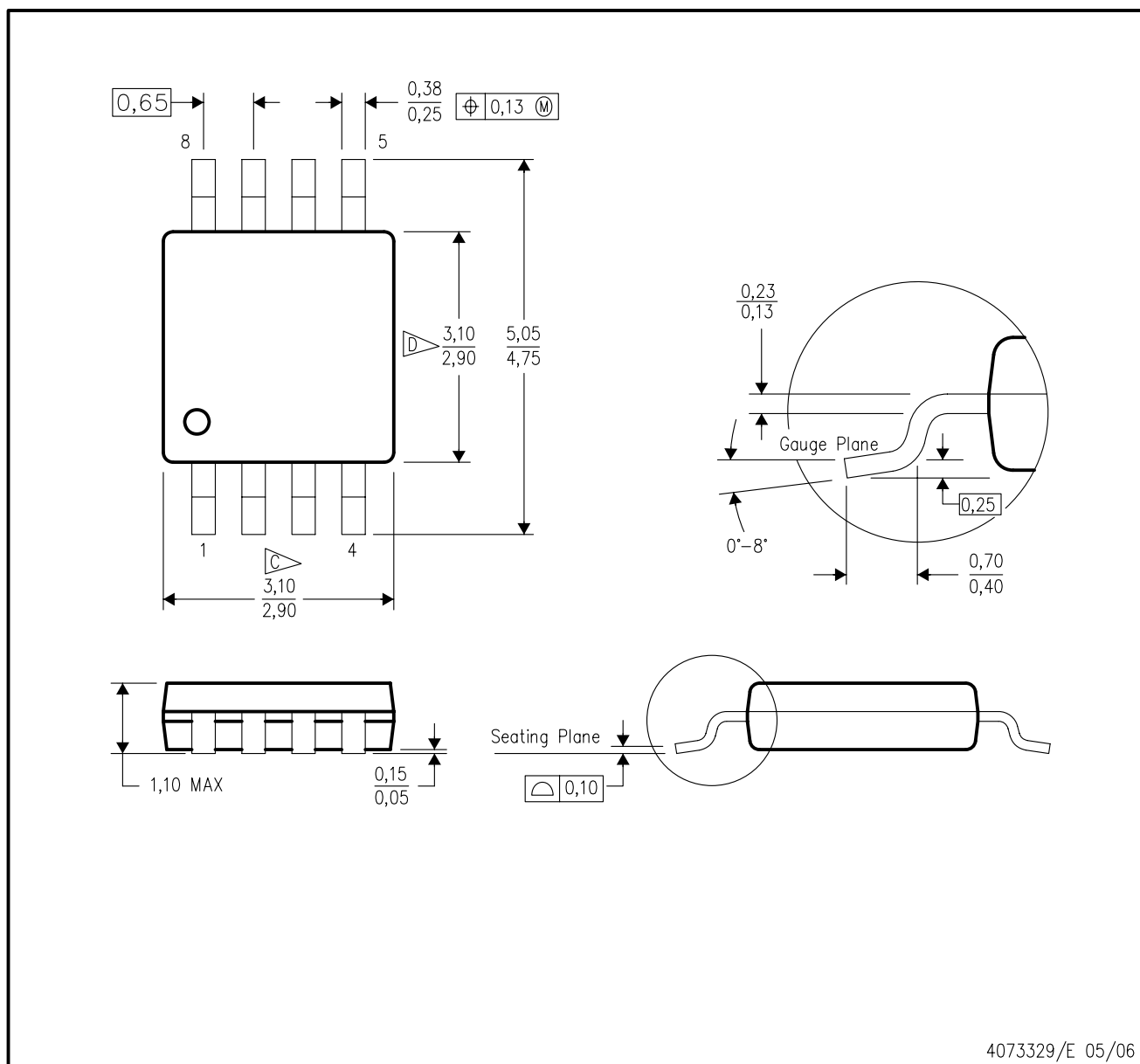
4214834/D 07/2023

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.

DGK (S-PDSO-G8)

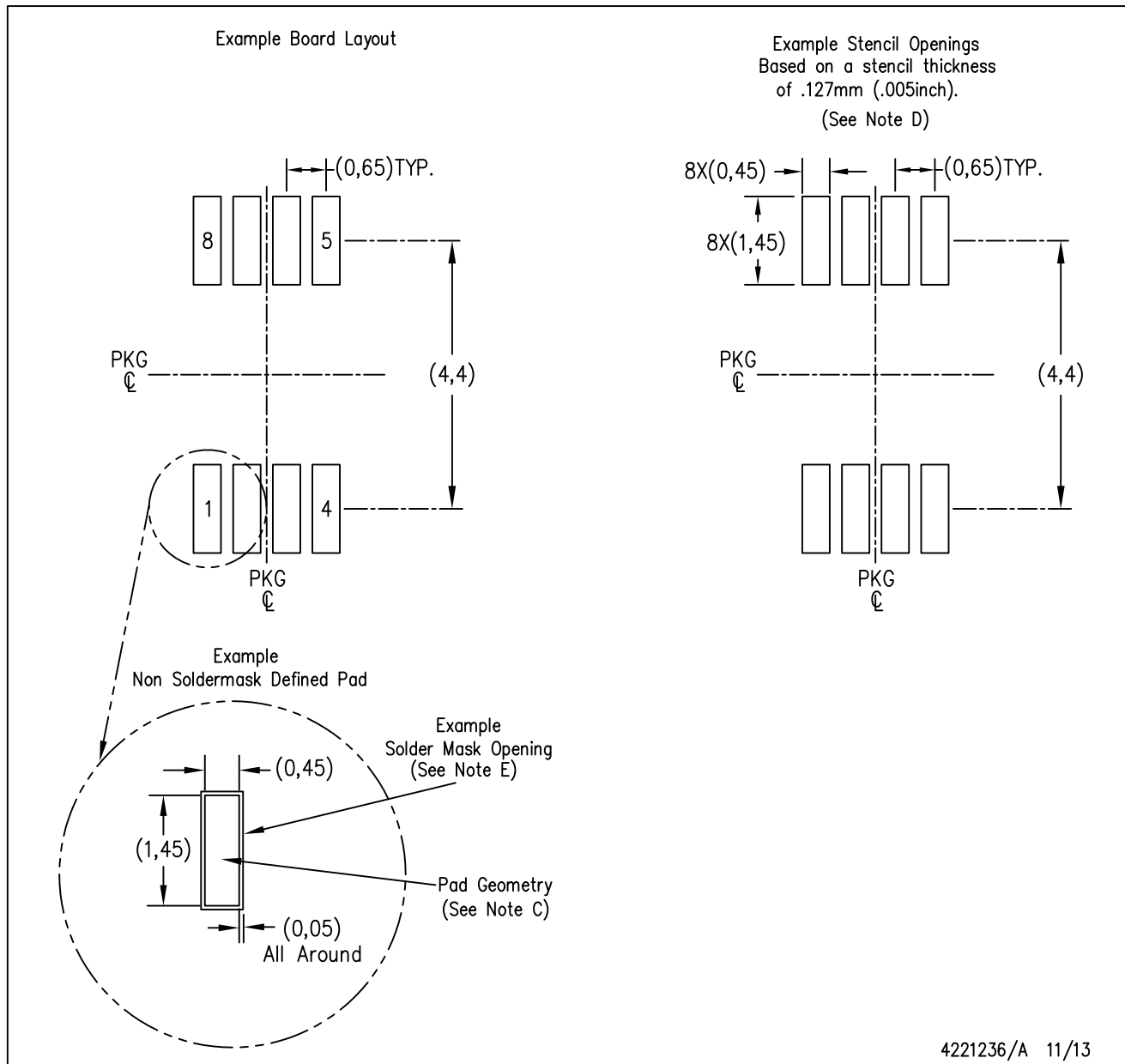
PLASTIC SMALL-OUTLINE PACKAGE



4073329/E 05/06

DGK (S-PDSO-G8)

PLASTIC SMALL OUTLINE PACKAGE



- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Publication IPC-7351 is recommended for alternate designs.
  - Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
  - Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

## GENERIC PACKAGE VIEW

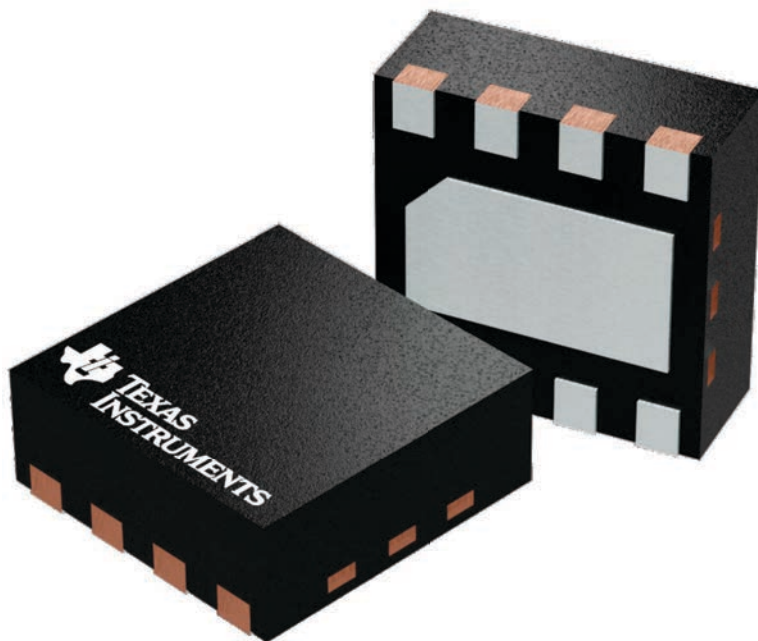
**DSG 8**

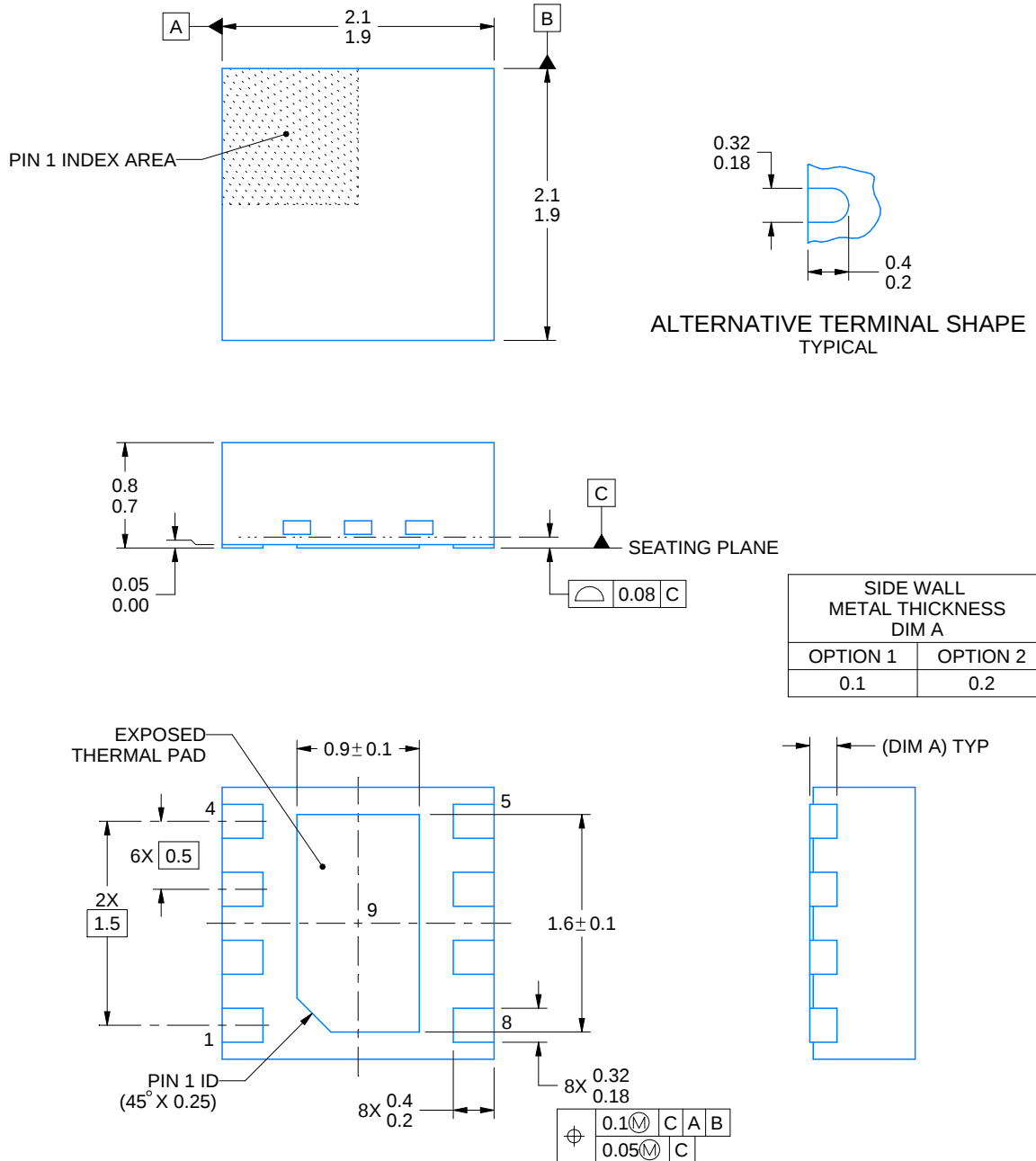
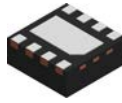
**WSON - 0.8 mm max height**

2 x 2, 0.5 mm pitch

PLASTIC SMALL OUTLINE - NO LEAD

This image is a representation of the package family, actual package may vary.  
Refer to the product data sheet for package details.





4218900/E 08/2022

## NOTES:

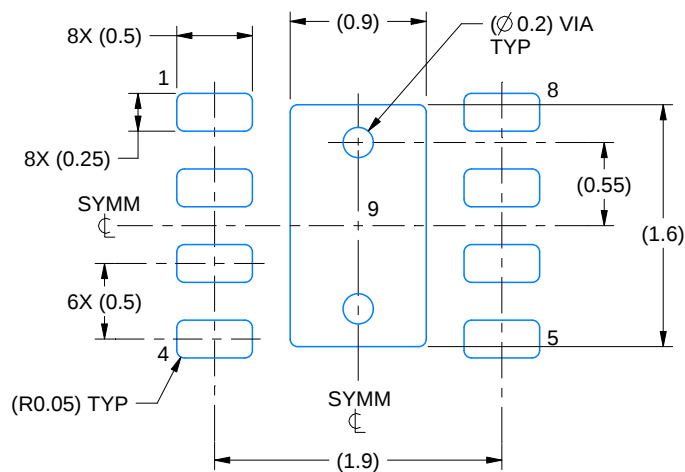
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.

# EXAMPLE BOARD LAYOUT

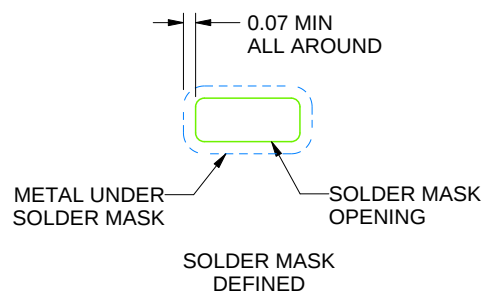
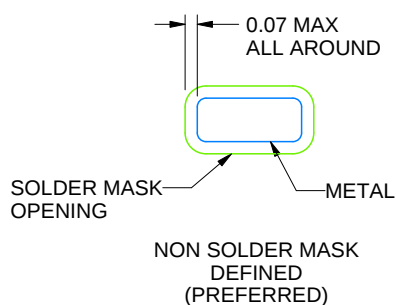
DSG0008A

WSN - 0.8 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



LAND PATTERN EXAMPLE  
SCALE:20X



SOLDER MASK DETAILS

4218900/E 08/2022

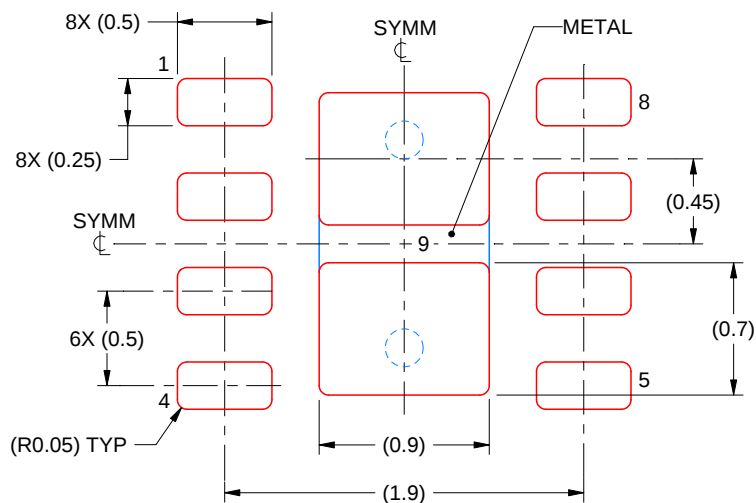
NOTES: (continued)

4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 ([www.ti.com/lit/slue271](http://www.ti.com/lit/slue271)).
5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.

**DSG0008A**

**WSN - 0.8 mm max height**

PLASTIC SMALL OUTLINE - NO LEAD



## SOLDER PASTE EXAMPLE BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD 9:  
87% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE  
SCALE:25X

4218900/E 08/2022

NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

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