# 具有电压参考的 1.8 V 毫微功耗比较器

查询样品: **TLV3012A-Q1**

## 特性

- 符合汽车应用要求
- 低静态电流 **= 5 μA** （最大值）
- 集成型电压参考 **= 1.242 V**
- 输入共模范围： **= 200 mV**（高于电压轨）
- 电压参考初始误差精度 **= 1%**
- 漏极开路逻辑兼容型输出 **(TLV3011-Q1)**
- 推挽输出 **(TLV3012A-Q1)**
- 低电源电压 **= 1.8 V** 至 **5.5 V**
- 快速相应时间 **= 100 mV** 过驱动的 **6 μs** 传播延迟（**TLV3011-Q1**： $\mathbf{R_{PULL\text{-}UP}}$ **= 10 kΩ**）

## 应用

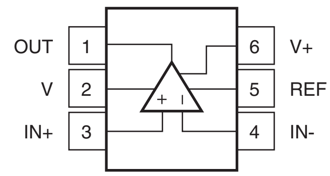
- 电池供电电平检测
- 数据采集
- 系统监控
- 振荡器

## 说明

TLV3011-Q1 是一款低功耗、漏极开路输出比较器。 TLV3012A-Q1 是一款推挽输出比较器。 这两款器件均具有不受约束的片上电压参考，提供 5 μA （最大值）静态电流、200 mV（超过电源轨）输入共模范围以及 1.8 V 至 5.5 V 的单电源工作。 集成型 1.242 V 系列电压参考支持 100 ppm/°C（最大值）的低漂移，在高达 10 nF 电容负载下具有高度的稳定性，并提供高达 0.5 mA （典型值）的输出电流。

TLV3012A-Q1 采用 SC-70 封装。 这两款器件理想适用于 –40°C 至 125°C 的宽泛温度。 ™

**DCK** 封装
**(**顶视图**)**

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English Data Sheet: SBOS551

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.

## PACKAGE ORDERING INFORMATION

### Table 1.

| $T_A$ | PACKAGE[(1)] | ORDERABLE PART NUMBER | TOP SIDE MARKING |
|---|---|---|---|
| -40°C TO 125°C | SOT (SC-70), DCK | TLV3011AQDCKRQ1[(2)] | TBD |
| | SOT (SC-70), DCK | TLV3012AQDCKRQ1 | BPF |

(1) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.
(2) Product preview device.

## ABSOLUTE MAXIMUM RATINGS[(1)]

Over operating free-air temperature range (unless otherwise noted).

| | | | MIN | MAX | UNIT |
|---|---|---|---|---|---|
| | Supply voltage | | | 7 | V |
| | Signal input terminals | Voltage[(2)] | –0.5 | (V+) +0.5 | V |
| | | Current[(2)] | | ±10 | mA |
| | Output short circuit[(3)] | | | Continous | |
| | Operating temperature range | | –40 | 125 | °C |
| $T_{stg}$ | Storage temperature range | | –65 | 150 | °C |
| $T_J$ | Junction temperature | | | 150 | °C |

(1) Stresses beyond those listed under absolute maximum ratings may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under recommended operating conditions is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) All voltage values are with respect to the network ground terminal.
(3) Short circuit to ground

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## ELECTRICAL CHARACTERISTICS: $V_S$ = +1.8 V to +5.5 V

**Boldface** limits apply over the specified temperature range, $T_A$ = –40°C to +125°C.
At $T_A$ = +25°C, $V_{OUT}$ = $V_S$, unless otherwise noted; for TLV3011-Q1, $R_{PULL-UP}$ = 10 kΩ connected to $V_S$.

| PARAMETER | | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| **Offset Voltage** | | | | | | | |
| $V_{OS}$ | Input offset voltage | | $V_{CM}$ = 0 V, $I_O$ = 0 V | | 0.5 | 15 | mV |
| **$dV_{OS}/dT$** | **Input offset voltage vs temperature** | | **$T_A$ = –40°C to 125°C** | | **±12** | | **μV/°C** |
| PSRR | Power supply rejection ratio | | $V_S$ = 1.8 V to 5.5 V | | 100 | 1000 | μV/V |
| **Input Bias Current** | | | | | | | |
| $I_B$ | Input bias current | | $V_{CM}$ = $V_S$/2 | | ±10 | | pA |
| $I_{OS}$ | Input offset current | | $V_{CM}$ = $V_S$/2 | | ±10 | | pA |
| **Input Voltage Range** | | | | | | | |
| $V_{CM}$ | Common-mode voltage range | | | (V–) – 0.2 | | (V+) + 0.2 | V |
| CMRR | Common-mode rejection ratio | | $V_{CM}$ = –0.2 V to (V+) – 1.5 V | 60 | 74 | | dB |
| | | | $V_{CM}$ = –0.2 V to (V+) + 0.2 V | 54 | 62 | | |
| **Input Impedance** | | | | | | | |
| | Common mode | | | | $10^{13}$ ∥ 2 | | Ω ∥ pF |
| | Differential | | | | $10^{13}$ ∥ 4 | | Ω ∥ pF |
| **Switching Characteristics** | | | | | | | |
| | Propagation delay time | Low to high | f = 10 kHz, $V_{STEP}$ = 1 V, input overdrive = 10 mV | | 12 | | μs |
| | | | f = 10 kHz, $V_{STEP}$ = 1 V, input overdrive = 100 mV | | 6 | | |
| | | High to low | f = 10 kHz, $V_{STEP}$ = 1 V, input overdrive = 10 mV | | 13.5 | | |
| | | | f = 10 kHz, $V_{STEP}$ = 1 V, input overdrive = 100 mV | | 6.5 | | |
| $t_r$ | Rise time | TLV3011-Q1 [1] | | | See [2] | | |
| | | TLV3012A-Q1 | $C_L$ = 10 pF | | 100 | | ns |
| $t_f$ | Fall time | | $C_L$ = 10 pF | | 100 | | ns |
| **Output** | | | | | | | |
| $V_{OL}$ | Voltage output low from rail | | $V_S$ = 5 V, $I_{OUT}$ = –5 mA | | 160 | 200 | mV |
| | Voltage output high from rail | TLV3012A-Q1 | $V_S$ = 5 V, $I_{OUT}$ = 5 mA | | 90 | 200 | mV |
| | Short-circuit current | TLV3012A-Q1 | | | See Typical Characteristics | | |
| **Voltage Reference** | | | | | | | |
| $V_{OUT}$ | Output voltage | | | 1.208 | 1.242 | 1.276 | V |
| | Initial accuracy | | | | | ±1% | |
| $dV_{OUT}/d_T$ | Temperature drift | | –40°C ≤ $T_A$ ≤ 125°C | | 40 | 100 | ppm/°C |
| $dV_{OUT}/dI_{LOAD}$ | Load regulation | Sourcing | 0 mA < $I_{SOURCE}$ ≤ 0.5 mA | | 0.36 | 1 | mV/mA |
| | | Sinking | 0 mA < $I_{SINK}$ ≤ 0.5 mA | | 6.6 | | |
| $I_{LOAD}$ | Output current | | | | 0.5 | | mA |
| $dV_{OUT}/dV_{IN}$ | Line regulation | | 1.8 V ≤ $V_{IN}$ ≤ 5.5 V | | 10 | 100 | μV/V |
| **Noise** | | | | | | | |
| | Reference voltage noise | | f = 0.1 Hz to 10 Hz | | 0.2 | | $mV_{PP}$ |
| **Power Supply** | | | | | | | |
| $V_S$ | Specified voltage | | | 1.8 | | 5.5 | V |
| | Operating voltage range | | | 1.8 | | 5.5 | V |
| $I_Q$ | Quiescent current | | $V_S$ = 5 V, $V_O$ = High | | 2.8 | 5 | μA |
| **Temperature** | | | | | | | |
| | Operating range | | | –40 | | 125 | °C |
| | Storage range | | | –65 | | 150 | °C |
| | Thermal resistance | DCK package | | | 259 | | °C/W |

(1) Product preview device.
(2) $t_r$ depends on $R_{PULL-UP}$ and $C_{LOAD}$.

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## TYPICAL CHARACTERISTICS

At $T_A$ = +25°C, $V_S$ = +1.8 V to +5.5 V, $R_{PULL-UP}$ = 10 kΩ, and Input Overdrive = 100 mV, unless otherwise noted.

**QUIESCENT CURRENT vs TEMPERATURE**

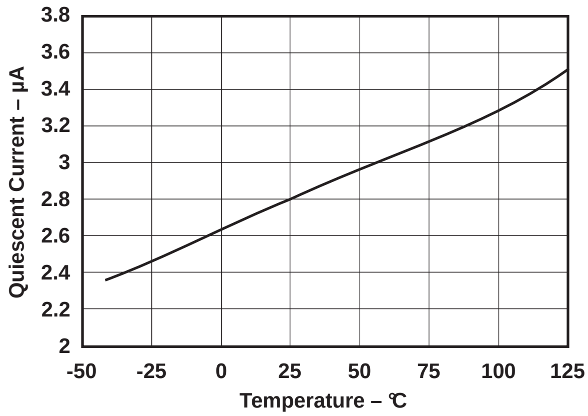


**Figure 1.**

**QUIESCENT CURRENT vs OUTPUT SWITCHING FREQUENCY**

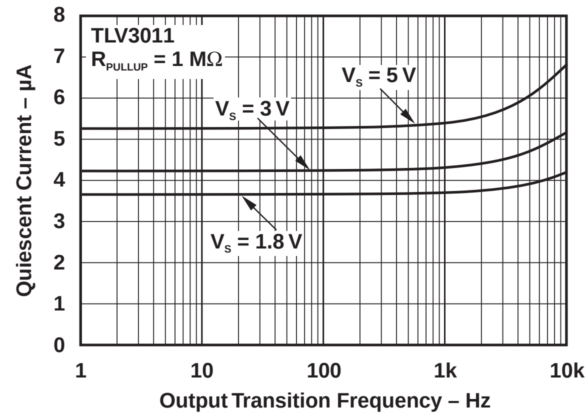


**Figure 2.**

**QUIESCENT CURRENT vs OUTPUT SWITCHING FREQUENCY**

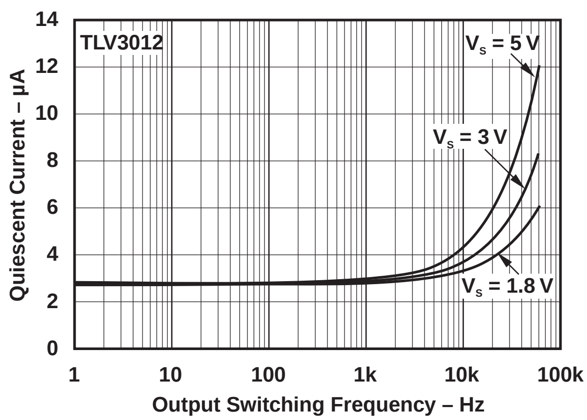


**Figure 3.**

**INPUT BIAS CURRENT vs TEMPERATURE**

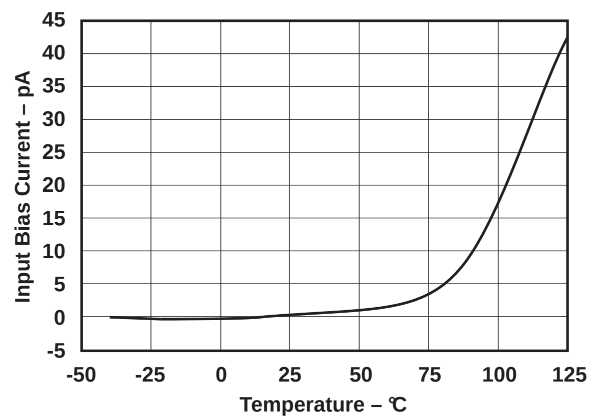


**Figure 4.**


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## TYPICAL CHARACTERISTICS (continued)

At $T_A$ = +25°C, $V_S$ = +1.8 V to +5.5 V, $R_{PULL\text{-}UP}$ = 10 kΩ, and Input Overdrive = 100 mV, unless otherwise noted.

**OUTPUT LOW**
**vs**
**OUTPUT CURRENT**

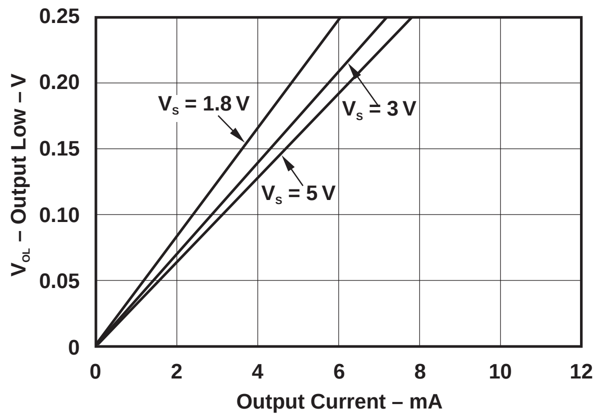


**Figure 5.**

**OUTPUT HIGH**
**vs**
**OUTPUT CURRENT**

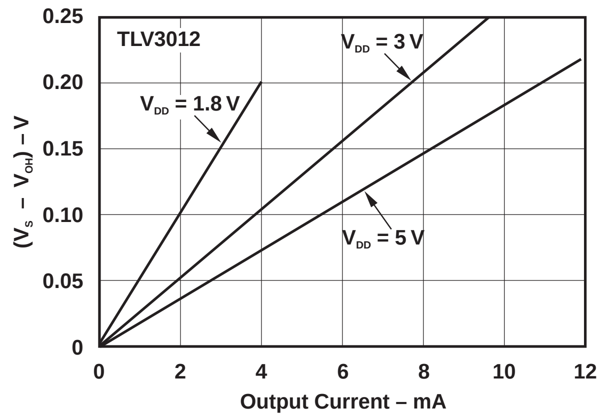


**Figure 6.**

**PROPAGATION DELAY ($t_{PLH}$)**
**vs**
**CAPACITIVE LOAD**

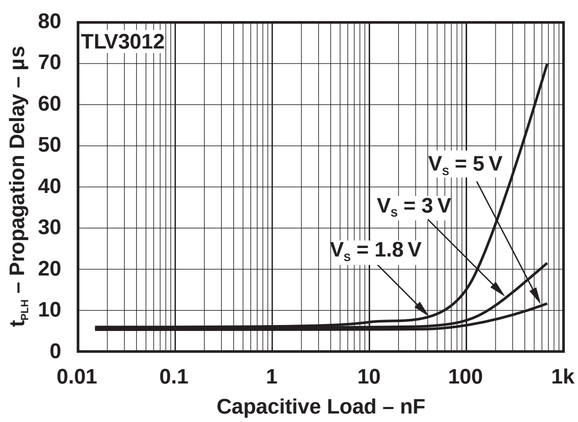


**Figure 7.**

**PROPAGATION DELAY ($t_{PHL}$)**
**vs**
**CAPACITIVE LOAD**

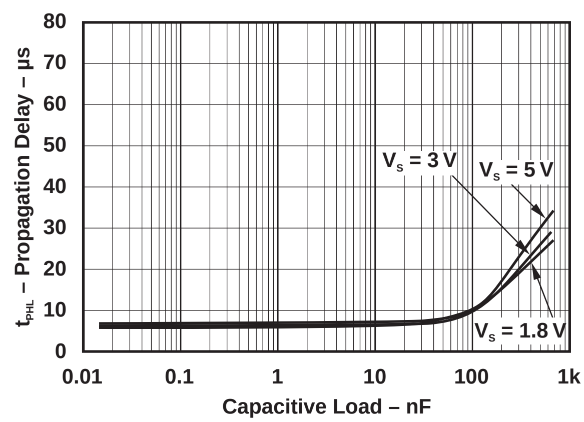


**Figure 8.**

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## TYPICAL CHARACTERISTICS (continued)

At $T_A$ = +25°C, $V_S$ = +1.8 V to +5.5 V, $R_{PULL-UP}$ = 10 kΩ, and Input Overdrive = 100 mV, unless otherwise noted.

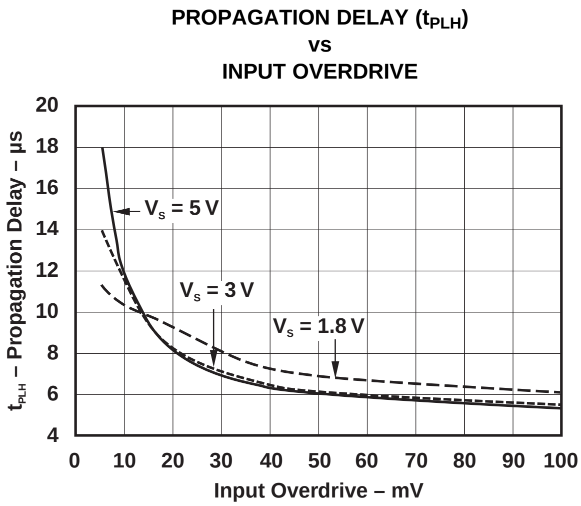


Figure 9.

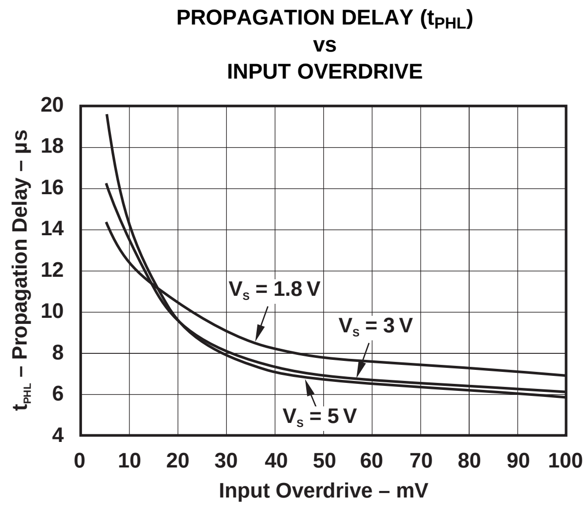


Figure 10.

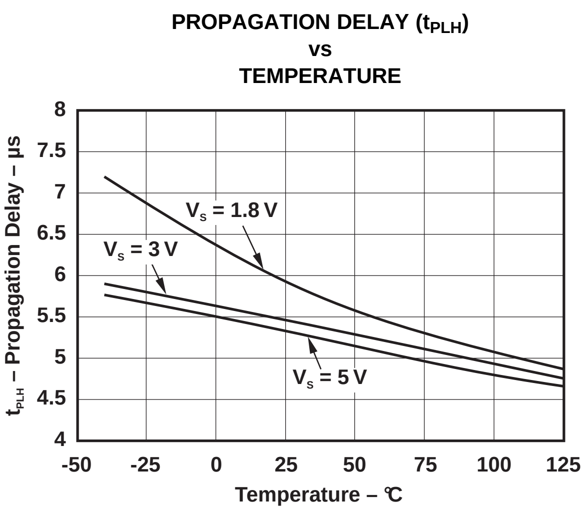


Figure 11.

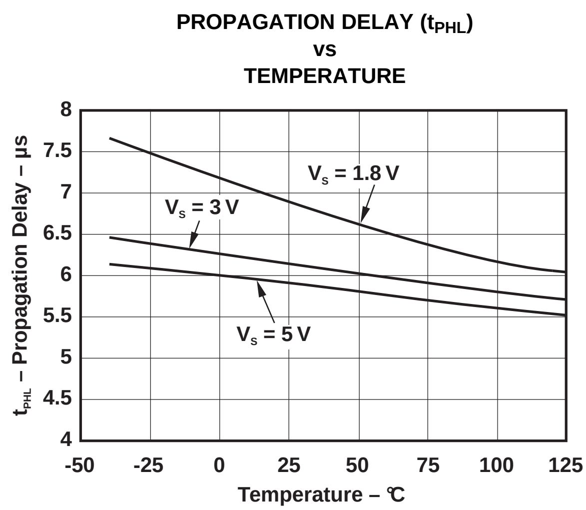


Figure 12.

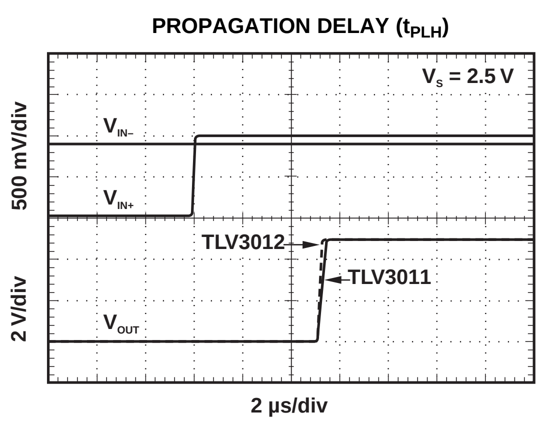


Figure 13.

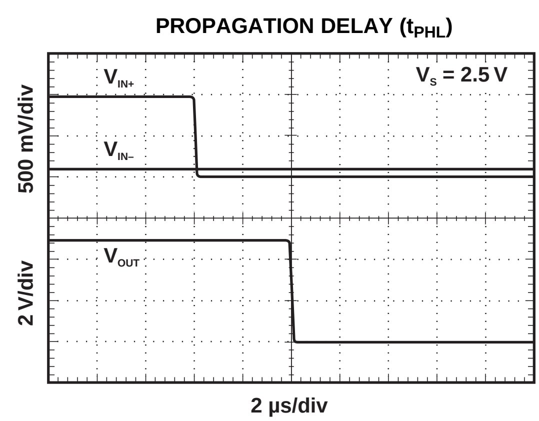


Figure 14.


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## TYPICAL CHARACTERISTICS (continued)

At $T_A$ = +25°C, $V_S$ = +1.8 V to +5.5 V, $R_{PULL\text{-}UP}$ = 10 kΩ, and Input Overdrive = 100 mV, unless otherwise noted.

**PROPAGATION DELAY ($t_{PLH}$)**

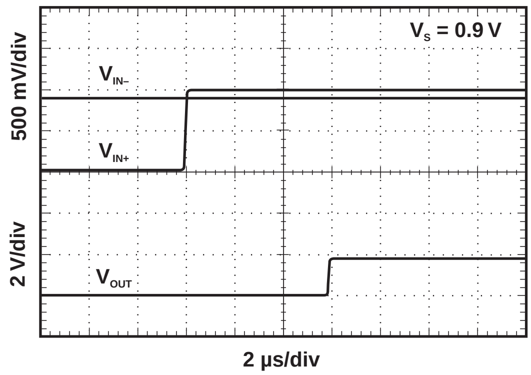


**Figure 15.**

**PROPAGATION DELAY ($t_{PHL}$)**

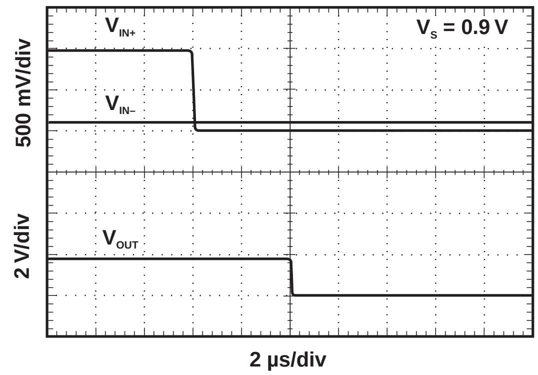


**Figure 16.**

**REFERENCE VOLTAGE vs OUTPUT LOAD CURRENT (SOURCING)**

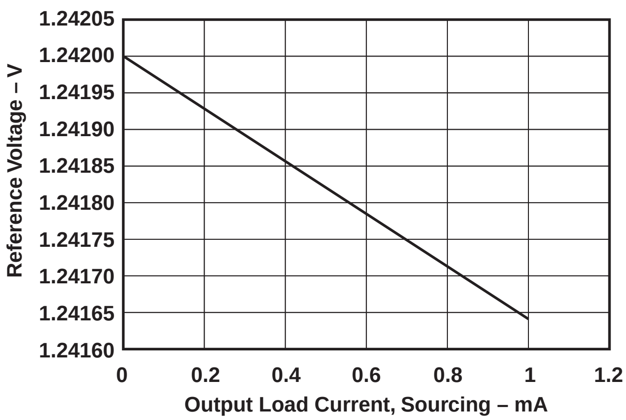


**Figure 17.**

**REFERENCE VOLTAGE vs OUTPUT LOAD CURRENT (SINKING)**

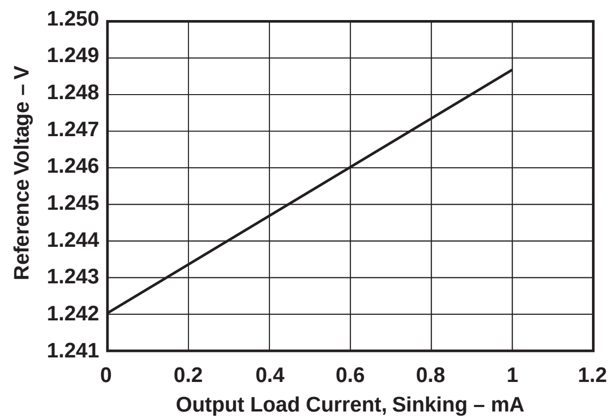


**Figure 18.**

**REFERENCE VOLTAGE vs TEMPERATURE**

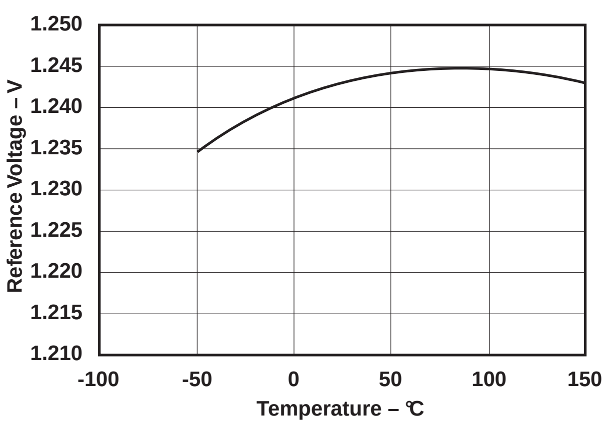


**Figure 19.**

**SHORT-CIRCUIT CURRENT vs SUPPLY VOLTAGE**

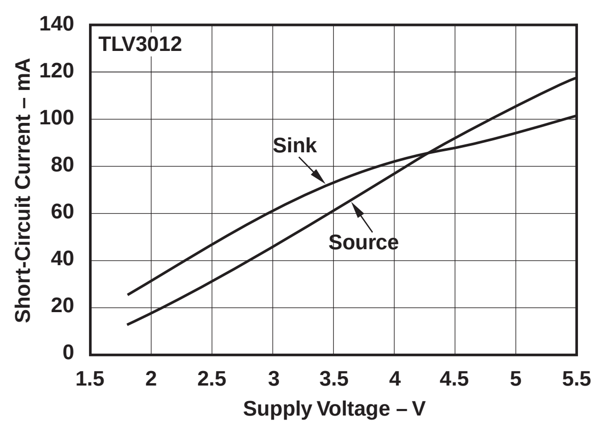


**Figure 20.**

## TYPICAL CHARACTERISTICS (continued)

At $T_A$ = +25°C, $V_S$ = +1.8 V to +5.5 V, $R_{PULL-UP}$ = 10 kΩ, and Input Overdrive = 100 mV, unless otherwise noted.

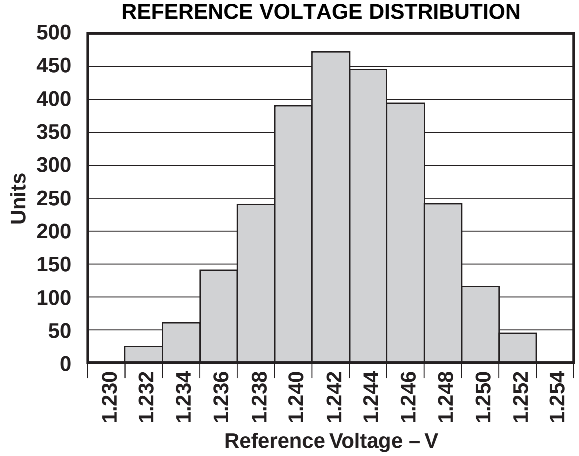


Figure 21.


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## APPLICATION INFORMATION

The TLV3011-Q1is a low-power, open-drain comparator with on-chip 1.242-V series reference. The open-drain output allows multiple devices to be driven by a single pullup resistor to accomplish an OR function, making the TLV3011-Q1useful for logic applications.

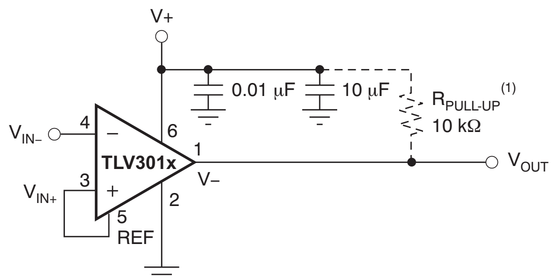
The TLV3012A-Q1 comparator with on-chip 1.242-V series reference has a push-pull output stage optimal for reduced power budget applications and features no shoot-through current.

A typical supply current of 2.8 μA and small packaging combine with 1.8-V supply requirements to make the TLV3011-Q1and TLV3012A-Q1 optimal for battery and portable designs.

### Board Layout

Typical connections for the TLV3011-Q1and TLV3012A-Q1 are shown in Figure 22. The TLV3011-Q1is an open-drain output device. A pull-up resistor must be connected between the comparator output and supply to enable operation.

To minimize supply noise, power supplies should be capacitively decoupled by a 0.01-μF ceramic capacitor in parallel with a 1-μF electrolytic capacitor. Comparators are sensitive to input noise and precautions such as proper grounding (use of ground plane), supply bypassing, and guarding of high-impedance nodes minimize the effects of noise and help to ensure specified performance.




(1) Use $R_{PULL-UP}$ with TLV3011-Q1 only.

**Figure 22. Basic Connections of the TLV3011-Q1 and TLV3012A-Q1**

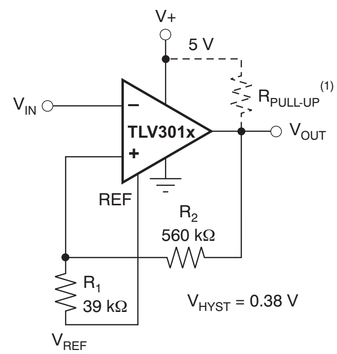
### Open-Drain Output (TLV3011-Q1)

The open-drain output of the TLV3011-Q1is useful in logic applications. The value of the pull-up resistor and supply voltage used affects current consumption because of the additional current drawn when the output is in a low state. This effect can be seen in Figure 3.

### External Hysteresis

Comparator inputs have no noise immunity within the range of specified offset voltage (±12 mV). For noisy input signals, the comparator output may display multiple switching as input signals move through the switching threshold. The typical comparator threshold of the TLV3011-Q1and TLV3012A-Q1 is ±0.5 mV. To prevent multiple switching within the comparator threshold of the TLV3011-Q1or TLV3012A-Q1, external hysteresis may be added by connecting a small amount of feedback to the positive input. Figure 23 shows a typical topology used to introduce hysteresis, described by this equation:

$$V_{HYST} = \frac{V+ \times R_1}{R_1 + R_2}$$




(1) Use $R_{PULL-UP}$ with TLV3011-Q1 only.

**Figure 23. Adding Hysteresis**

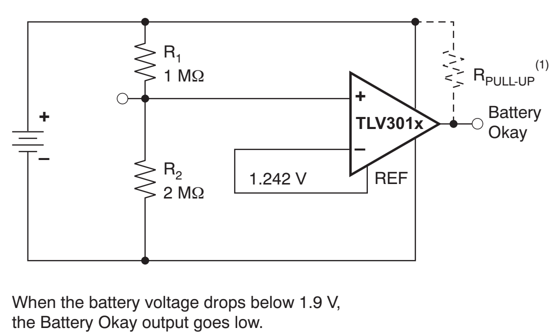
$V_{HYST}$ sets the value of the transition voltage required to switch the comparator output by increasing the threshold region, thereby reducing sensitivity to noise.

## Applications

### Battery-Level Detect

The low power consumption and 1.8-V supply voltage of the TLV3011-Q1make it an excellent candidate for battery-powered applications. Figure 24 shows the TLV3011-Q1configured as a low battery level detector for a 3-V battery.

$$\text{Battery Okay trip voltage} = 1.242 \frac{R_1 + R_2}{R_2}$$




(1) Use $R_{PULL-UP}$ with TLV3011-Q1 only.

**Figure 24. TLV3011-Q1 Configured as Low Battery Level Detector**

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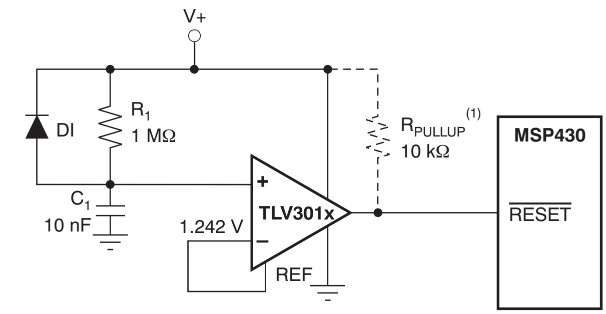
### Power-On Reset

The reset circuit shown in Figure 25 provides a time-delayed release of reset to the MSP430 microcontroller. Operation of the circuit is based on a stabilization time constant of the supply voltage, rather than on a predetermined voltage value. The negative input is a reference voltage created by the internal voltage reference. The positive input is an RC circuit that provides a power-up delay. When power is applied, the output of the comparator is low, holding the processor in the reset condition. Only after allowing time for the supply voltage to stabilize does the positive input of the comparator become higher than the negative input, resulting in a high output state, releasing the processor for operation. The stabilization time required for the supply voltage is adjustable by the selection of the RC component values. Use of a lower-valued resistor in this portion of the circuit does not increase current consumption, because no current flows through the RC circuit after the supply has stabilized.




(1) Use $R_{PULL-UP}$ with TLV3011-Q1 only.

**Figure 25. TLV3011-Q1 or TLV3012A-Q1 Configured as Power-Up Reset Circuit for the MSP430**

The reset delay needed depends on the power-up characteristics of the system power supply. $R_1$ and $C_1$ are selected to allow enough time for the power supply to stabilize. $D_1$ provides rapid reset if power is lost. In this example, the $R_1 \times C_1$ time constant is 10 ms.

### Relaxation Oscillator

The TLV3012A-Q1 can be configured as a relaxation oscillator to provide a simple and inexpensive clock output (see Figure 26). The capacitor is charged at a rate of T = 0.69RC and discharges at a rate of 0.69RC. Therefore, the period is T = 1.38RC. $R_1$ may be a different value than $R_2$.

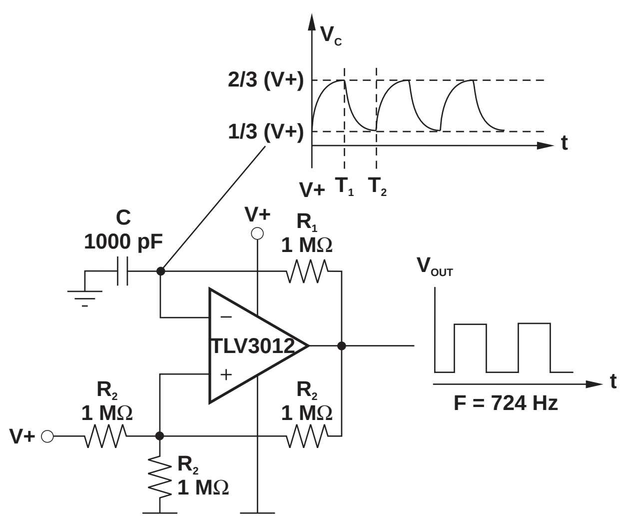



**Figure 26. TLV3012A-Q1 Configured as Relaxation Oscillator**

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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 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| TLV3012AQDCKRQ1 | ACTIVE | SC70 | DCK | 6 | 3000 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | BPF | 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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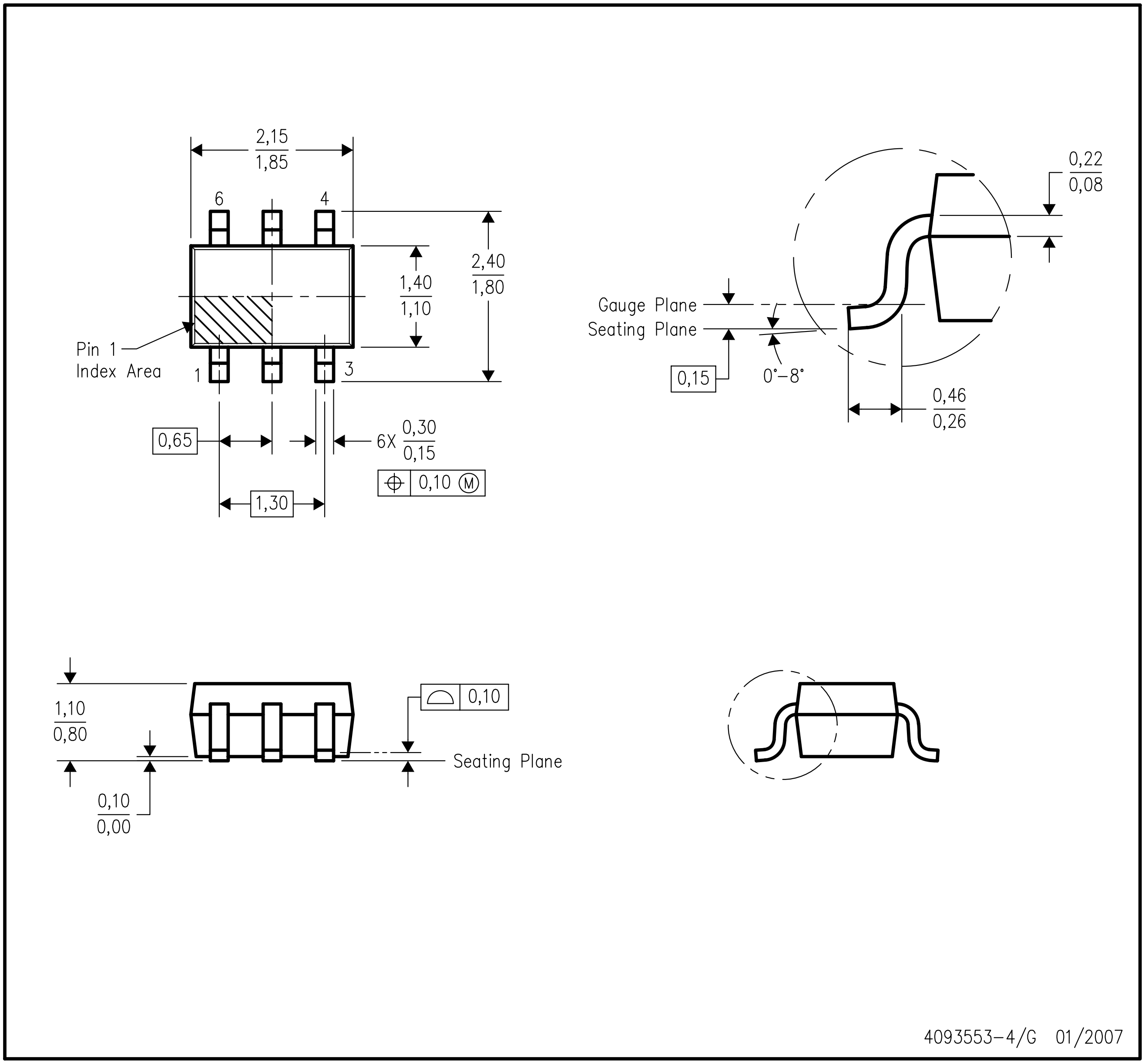
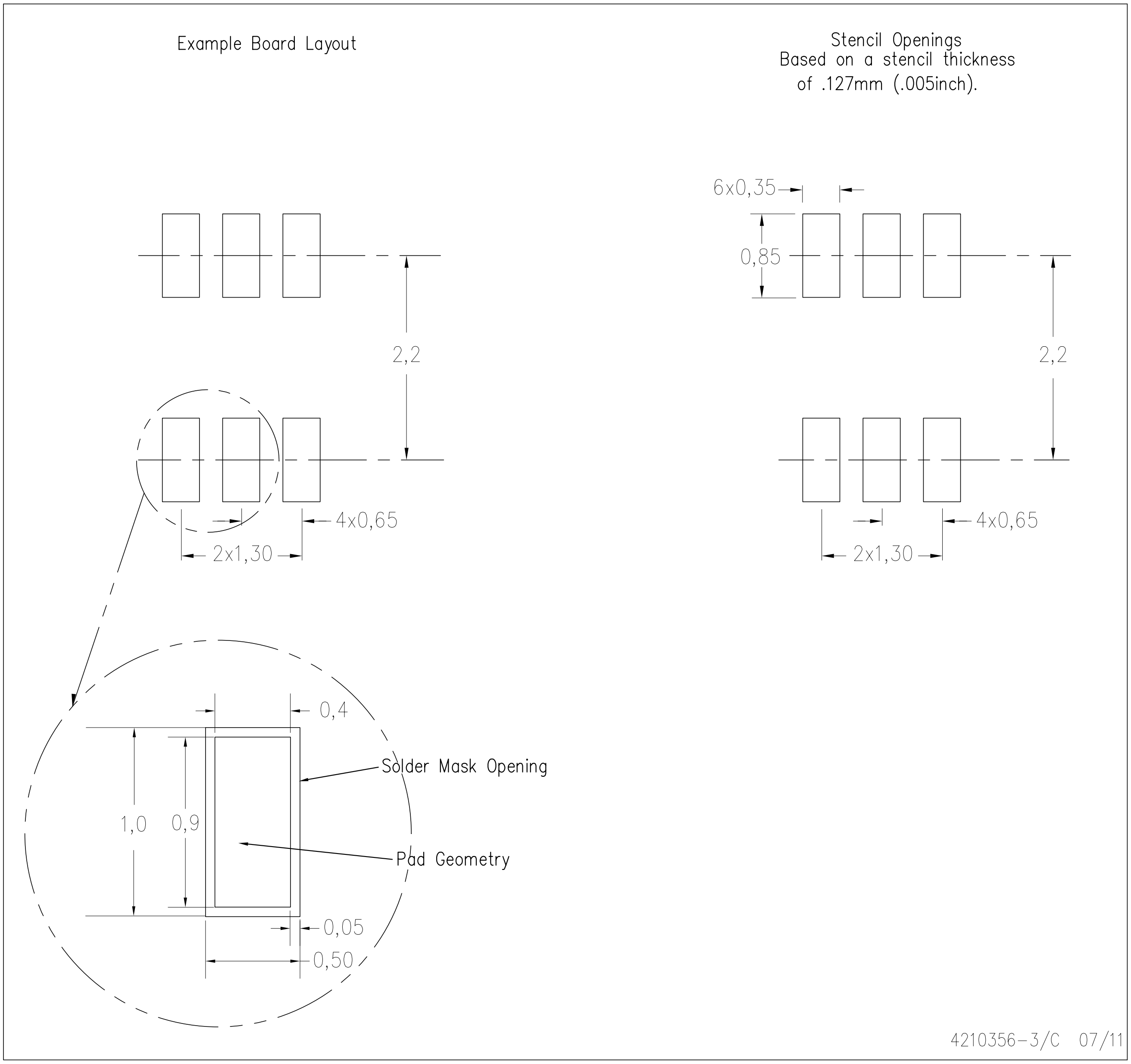
DCK (R-PDSO-G6) PLASTIC SMALL-OUTLINE PACKAGE




NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
D. Falls within JEDEC MO-203 variation AB.

DCK (R–PDSO–G6) PLASTIC SMALL OUTLINE




NOTES:
- A. All linear dimensions are in millimeters.
- B. This drawing is subject to change without notice.
- C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
- D. Publication IPC–7351 is recommended for alternate designs.
- E. 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. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC–7525 for other stencil recommendations.

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