

# 具有 I<sup>2</sup>C 接口的 128 抽头单通道数字电位器

查询样品: [TPL0401A](#), [TPL0401B](#), [TPL0401C](#)

## 特性

- 单通道、128 位分辨率
- 10kΩ 端到端电阻选项
- 低温度系数: 35ppm/°C
- I<sup>2</sup>C 串行接口
- 2.7V 至 5.5V 单电源运行
- ±20% 电阻容差
- 'A' 和 'B' 版本具有不同的 I<sup>2</sup>C 地址
- 'A' 和 'B' 版本的 'L' 端子是内部的且被连接至接地 (GND)
- 'C' 版本的 'H' 端子是内部的且悬空
- 运行温度为 -40°C 至 125°C
- 采用行业标准 SC70 封装
- 根据 JESD 22 测试得出的静电放电 (ESD) 性能
  - 2000 V 人体模式 (A114B, II 类)

## 应用范围

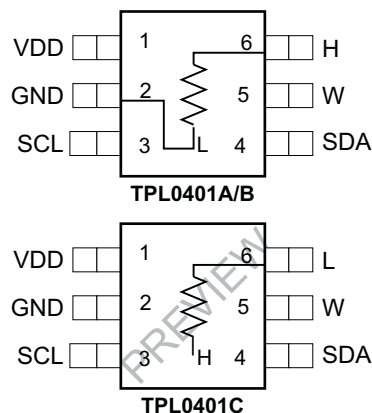
- 低功率 DDR3 电压基准
- 可调电源
- 可调增益放大器和偏移修剪
- 设定点阈值的精度校准
- 传感器微调和校准
- 机械电位器的替代产品

## 说明

TPL0401 是一款单通道线性锥形数字电位器, 带有 128 个抽头位置。TPL0401A/B 有内部且被连接至 GND 的低端子。可使用 I<sup>2</sup>C 接口来调节抽头位置。TPL0401 采用 6 引脚 SC-70 封装, 具有 -40°C 至 125°C 额定温度范围。该器件具有 10kΩ 端到端电阻并可在 2.7V 至 5.5V 的电源电压范围工作。此类产品被广泛用于为低功率 DDR3 内存设置电压基准。

TPL0401A/B 有内部并且被连接至 GND 的低端子。  
TPL0401C 有内部并且悬空的高端子。

SC-70 DCK 封装  
(顶视图)



## 订购信息

| T <sub>A</sub> | 封装 <sup>(1)</sup> |      | 可订购部件号          | 端到端电阻 | I <sup>2</sup> C 地址 | 正面标记     |
|----------------|-------------------|------|-----------------|-------|---------------------|----------|
| -40°C 至 125°C  | SC70--DCK         | 卷带封装 | TPL0401A-10DCKR | 10kΩ  | 0101110             | 7TV      |
|                |                   |      | TPL0401B-10DCKR | 10kΩ  | 0111110             | 7UV      |
|                |                   |      | TPL0401C-50DCKR | 50kΩ  | 0101110             | 待定 (TBD) |

(1) 封装图示, 标准包装数量, 散热数据, 符号以及 PCB 设计指南可从以下网址获得: [www.ti.com/sc/package](http://www.ti.com/sc/package).



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

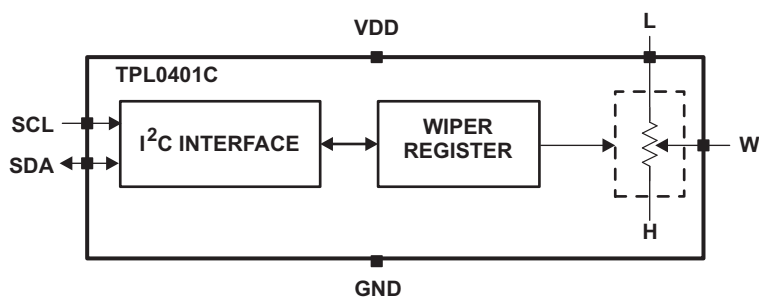
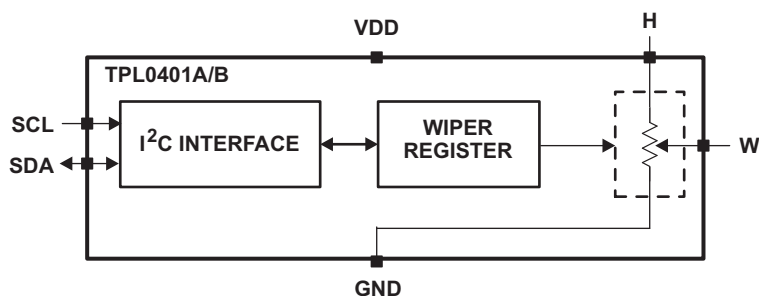


These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

## PIN FUNCTIONS

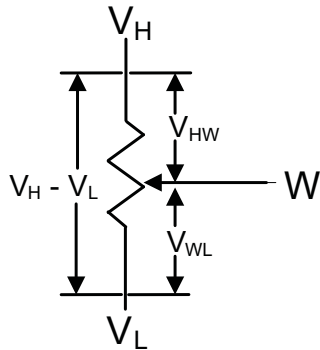
| PIN NUMBER | PIN NAME | TYPE   | DESCRIPTION             |
|------------|----------|--------|-------------------------|
| 1          | VDD      | Power  | Positive Supply Voltage |
| 2          | GND      | Ground | Ground                  |
| 3          | SCL      | Input  | I2C Clock               |
| 4          | SDA      | I/O    | I2C Data                |
| 5          | W        | I/O    | Wiper terminal          |
| 6          | H        | I/O    | High terminal           |
| –          | L        | I/O    | Low terminal            |

## FUNCTIONAL BLOCK DIAGRAM



## DIGITAL POTENTIOMETER CONFIGURATIONS

### VOLTAGE DIVIDER MODE

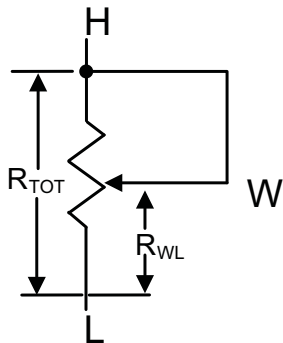


$$V_{HW} = (V_H - V_L) \times (1 - (D/128))$$

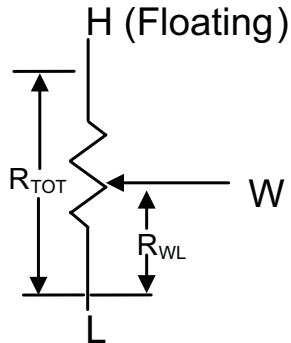
$$V_{WL} = (V_H - V_L) \times D/128$$

Where D = Decimal Value of Wiper Code

### RHEOSTAT MODE A



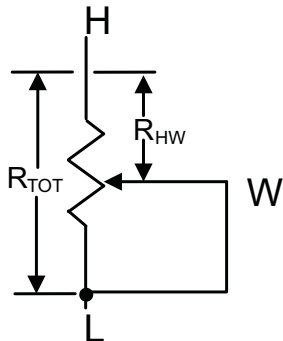
OR



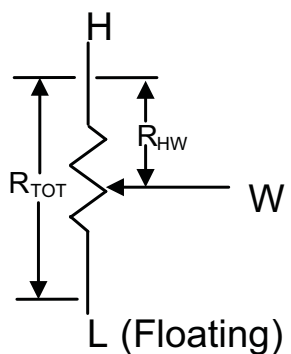
$$R_{WL} = R_{TOT} \times D/128$$

Where D = Decimal Value of Wiper Code

### RHEOSTAT MODE B



OR



$$R_{HW} = R_{TOT} \times (1 - (D/128))$$

Where D = Decimal Value of Wiper Code

**Figure 1. DPOT Configurations**

## ABSOLUTE MAXIMUM RATINGS<sup>(1)(2)(3)</sup>

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

|                       |                                          | MIN  | MAX          | UNIT |
|-----------------------|------------------------------------------|------|--------------|------|
| $V_{DD}$ to GND       | Supply voltage range                     | –0.3 | 7            | V    |
| All other pins to GND |                                          | –0.3 | $V_{DD}+0.3$ | V    |
| $I_H$                 | Pulse current                            |      | ±20          | mA   |
| $I_L$                 | Continuous current                       |      | ±5           | mA   |
| $I_W$                 |                                          |      | ±1.3         | mA   |
| $V_I$                 | Digital input voltage range              | –0.3 | $V_{DD}+0.3$ | V    |
| $\theta_{JA}$         | Package thermal impedance <sup>(4)</sup> |      | 259          | °C/W |
| $T_{stg}$             | Storage temperature range                | –65  | 150          | °C   |

- (1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those specified is not implied.
- (2) The algebraic convention, whereby the most negative value is a minimum and the most positive value is a maximum
- (3) All voltages are with respect to ground, unless otherwise specified.
- (4) The package thermal impedance is calculated in accordance with JESD 51-7.

## RECOMMENDED OPERATING CONDITIONS

|            | DESCRIPTION                      | MIN          | MAX          | Unit |
|------------|----------------------------------|--------------|--------------|------|
| $V_{DD}$   | Supply Voltage                   | 2.7          | 5.5          | V    |
| $V_W, V_H$ | Terminal Voltage                 | 0            | $V_{DD}$     | V    |
| $V_{IH}$   | Voltage Input High ( SCLK, SDA ) | 0.7 $V_{DD}$ |              | V    |
| $V_{IL}$   | Voltage Input Low ( SCLK, SDA )  |              | 0.3 $V_{DD}$ | V    |
| $I_W$      | Wiper Current                    |              | ±2           | mA   |
| $T_A$      | Ambient Operating temperature    | –40          | 128          | °C   |

## ANALOG SPECIFICATIONS

Typical values are specified at 25°C and V<sub>DD</sub>=3.3V

| PARAMETER                                                                                                 |                                                   | CONDITIONS                                                                                          | MIN   | TYP   | MAX  | UNIT   |
|-----------------------------------------------------------------------------------------------------------|---------------------------------------------------|-----------------------------------------------------------------------------------------------------|-------|-------|------|--------|
| R <sub>TOTAL</sub>                                                                                        | End-to-end resistance (between H and L terminals) | TPL0401A/B-10                                                                                       | 8     | 10    | 12   | kΩ     |
|                                                                                                           |                                                   | TPL0401C-50                                                                                         | 40    | 50    | 60   | kΩ     |
| V <sub>H</sub>                                                                                            | Terminal voltage range                            |                                                                                                     | 0     |       | VDD  | V      |
| R <sub>H</sub>                                                                                            | Terminal resistance                               |                                                                                                     |       | 35    | 100  | Ω      |
| R <sub>W</sub>                                                                                            | Wiper resistance                                  |                                                                                                     |       | 35    | 100  | Ω      |
| C <sub>H</sub>                                                                                            | Terminal capacitance                              |                                                                                                     |       | 10    |      | pF     |
| C <sub>W</sub>                                                                                            | Wiper capacitance                                 |                                                                                                     |       | 11    |      | pF     |
| I <sub>LKG</sub>                                                                                          | Terminal leakage current                          |                                                                                                     |       | 0.1   | 1    | μA     |
| TC <sub>R</sub>                                                                                           | Resistance temperature coefficient                | TPL0401A/B-10                                                                                       |       | 22    |      | ppm/°C |
|                                                                                                           |                                                   | TPL0401C-50                                                                                         |       | TBD   |      | ppm/°C |
| VOLTAGE DIVIDER MODE (TPL0401A, TPL0401B, V <sub>H</sub> = V <sub>DD</sub> , V <sub>W</sub> = Not Loaded) |                                                   |                                                                                                     |       |       |      |        |
| INL                                                                                                       | Integral non-linearity                            |                                                                                                     | −0.5  |       | 0.5  | LSB    |
| DNL                                                                                                       | Differential non-linearity                        |                                                                                                     | −0.25 |       | 0.25 | LSB    |
| ZS <sub>ERROR</sub>                                                                                       | Zero-scale error                                  |                                                                                                     | 0     | 0.75  | 1.5  | LSB    |
| FS <sub>ERROR</sub>                                                                                       | Full-scale error                                  |                                                                                                     | −1.5  | −0.75 | 0    | LSB    |
| T <sub>CV</sub>                                                                                           | Ratiometric temperature coefficient               | Wiper set at mid-scale                                                                              |       | 4     |      | ppm/°C |
| BW                                                                                                        | Bandwidth                                         | Wiper set at mid-scale, C <sub>LOAD</sub> = 10 pF                                                   |       | 2862  |      | kHz    |
| T <sub>SW</sub>                                                                                           | Wiper settling time                               |                                                                                                     |       | 0.152 |      | μS     |
| THD                                                                                                       | Total harmonic distortion                         | V <sub>H</sub> = 1 V <sub>RMS</sub> at 1 kHz, V <sub>L</sub> = V <sub>DD</sub> /2, Measurement at W |       |       | 0.03 | %      |
| RHEOSTAT MODE (TPL0401C)                                                                                  |                                                   |                                                                                                     |       |       |      |        |
| RINL                                                                                                      | Integral non-linearity                            |                                                                                                     |       |       | TBD  | LSB    |
| RDNL                                                                                                      | Differential non-linearity                        |                                                                                                     |       |       | TBD  | LSB    |
| R <sub>OFFSET</sub>                                                                                       | Offset                                            |                                                                                                     |       |       | TBD  | LSB    |
| RBW                                                                                                       | Bandwidth                                         | Code=0x00h, L Floating, Input applied to W, 10pF on H                                               |       |       | TBD  | kHz    |

## OPERATING SPECIFICATIONS

Typical values are specified at 25°C and V<sub>DD</sub>=3.3V<sup>(1)</sup>

| PARAMETER                                           |                                                                            | CONDITIONS                         | MIN                   | TYP                            | MAX                   | UNIT  |
|-----------------------------------------------------|----------------------------------------------------------------------------|------------------------------------|-----------------------|--------------------------------|-----------------------|-------|
| I <sub>DD</sub> (STBY)                              | V <sub>DD</sub> Standby current                                            | -40 to 85°C                        |                       |                                | 0.5                   | μA    |
|                                                     |                                                                            | -40 to 125°C                       |                       |                                | 1.5                   | μA    |
| I <sub>IN-DIG</sub>                                 | Digital Pins Leakage Current (SCL, SDA Inputs)                             |                                    | -1                    |                                | 1                     | μA    |
| <b>SERIAL INTERFACE SPECS (SDA, SCL)</b>            |                                                                            |                                    |                       |                                |                       |       |
| V <sub>IH</sub>                                     | Input high voltage                                                         |                                    | 0.7 × V <sub>DD</sub> |                                | 5.5                   | V     |
| V <sub>IL</sub>                                     | Input low voltage                                                          |                                    | 0                     |                                | 0.3 × V <sub>DD</sub> | V     |
| V <sub>OL</sub>                                     | Output low voltage                                                         | SDA Pin,<br>I <sub>OL</sub> = 4 mA |                       |                                | 0.4                   | V     |
| C <sub>IN</sub>                                     | Pin capacitance                                                            | SCL,<br>SDA Inputs                 |                       | 7                              |                       | pF    |
| <b>I<sup>2</sup>C INTERFACE TIMING REQUIREMENTS</b> |                                                                            |                                    |                       |                                |                       |       |
|                                                     |                                                                            | STANDARD MODE I <sup>2</sup> C BUS |                       | FAST MODE I <sup>2</sup> C BUS |                       | UNITS |
|                                                     |                                                                            | MIN                                | MAX                   | MIN                            | MAX                   |       |
| f <sub>SCL</sub>                                    | I <sup>2</sup> C Clock frequency                                           | 0                                  | 100                   | 0                              | 400                   | kHz   |
| t <sub>SCH</sub>                                    | I <sup>2</sup> C Clock high time                                           | 4                                  |                       | 0.6                            |                       | μs    |
| t <sub>SCL</sub>                                    | I <sup>2</sup> C Clock low time                                            | 4.7                                |                       | 1.3                            |                       | μs    |
| t <sub>sp</sub>                                     | I <sup>2</sup> C Spike time                                                | 0                                  | 50                    | 0                              | 50                    | ns    |
| t <sub>SDS</sub>                                    | I <sup>2</sup> C Serial data setup time                                    | 250                                |                       | 100                            |                       | ns    |
| t <sub>SDH</sub>                                    | I <sup>2</sup> C Serial data hold time                                     | 0                                  |                       | 0                              |                       | ns    |
| t <sub>ICR</sub>                                    | I <sup>2</sup> C Input rise time                                           |                                    | 1000                  | 20 + 0.1C <sub>b</sub>         | 300                   | ns    |
| t <sub>ICF</sub>                                    | I <sup>2</sup> C Input fall time                                           |                                    | 300                   | 20 + 0.1C <sub>b</sub>         | 300                   | ns    |
| t <sub>ICF</sub>                                    | I <sup>2</sup> C Output fall time, 10 pF to 400 pF bus                     |                                    | 300                   | 20 + 0.1C <sub>b</sub>         | 300                   | ns    |
| t <sub>BUF</sub>                                    | I <sup>2</sup> C Bus free time between stop and start                      | 4.7                                |                       | 1.3                            |                       | μs    |
| t <sub>STS</sub>                                    | I <sup>2</sup> C Start or repeater start condition setup time              | 4.7                                |                       | 1.3                            |                       | μs    |
| t <sub>STH</sub>                                    | I <sup>2</sup> C Start or repeater start condition hold time               | 4                                  |                       | 0.6                            |                       | μs    |
| t <sub>SPS</sub>                                    | I <sup>2</sup> C Stop condition setup time                                 | 4                                  |                       | 0.6                            |                       | μs    |
| t <sub>VD(DATA)</sub>                               | Valid data time, SCL low to SDA output valid                               |                                    | 1                     |                                | 1                     | μs    |
| t <sub>VD(DATA)</sub>                               | Valid data time of ACK condition, ACK signal from SCL low to SDA (out) low |                                    | 1                     |                                | 1                     | μs    |

(1) Parameters with Min and Max limits are 100% tested at +25°C, unless otherwise specified. Temperature limits established by characterization and are not production tested

## TYPICAL CHARACTERISTICS

**INL vs  
TAP POSITION (Potentiometer Mode)**

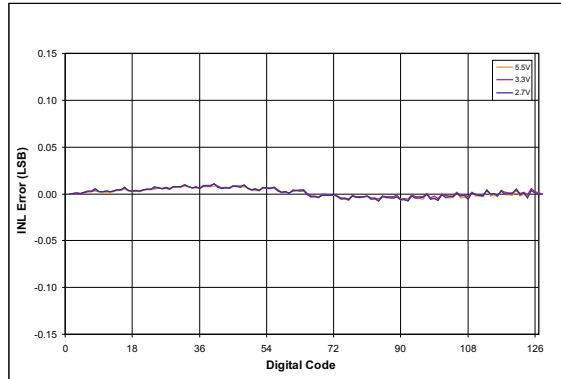


Figure 2.

**DNL vs  
TAP POSITION (Potentiometer Mode)**

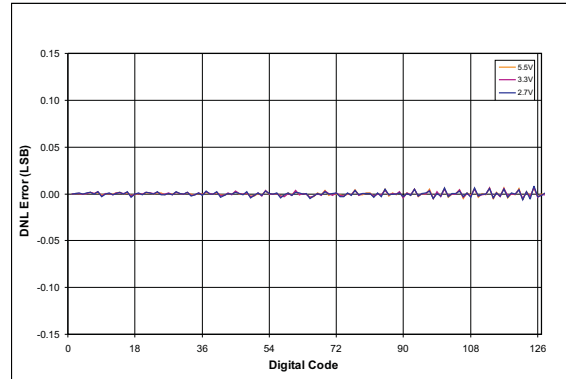


Figure 3.

**INL vs  
TAP POSITION (Rheostat Mode)**

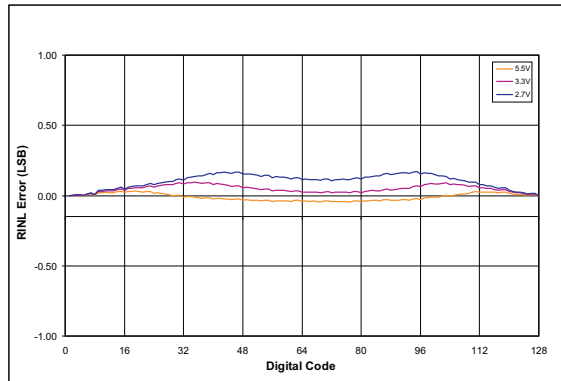


Figure 4.

**DNL vs  
TAP POSITION (Rheostat Mode)**

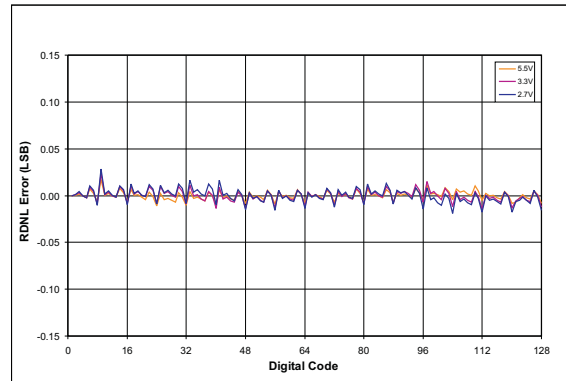


Figure 5.

**ZERO SCALE ERROR vs  
TEMPERATURE**

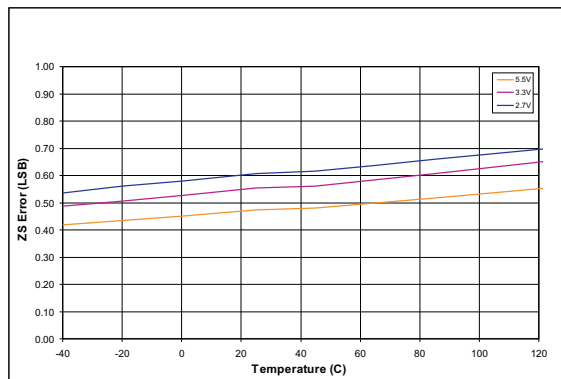


Figure 6.

**FULL SCALE ERROR vs  
TEMPERATURE**

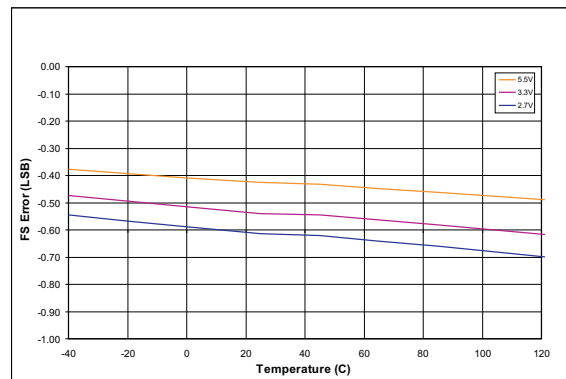


Figure 7.

## TYPICAL CHARACTERISTICS (continued)

**END-TO-END RTOTAL% CHANGE vs  
TEMPERATURE**

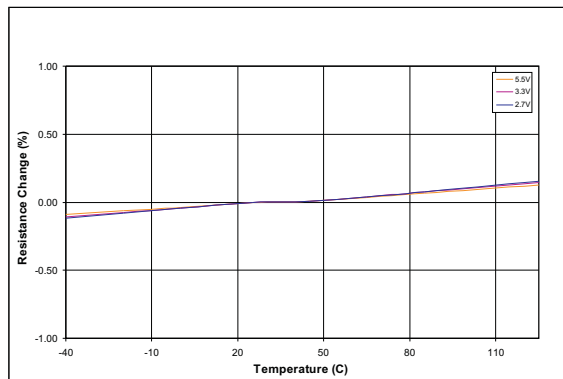


Figure 8.

**TEMPERATURE COEFFICIENT vs  
TAP POSITION (Potentiometer Mode)**

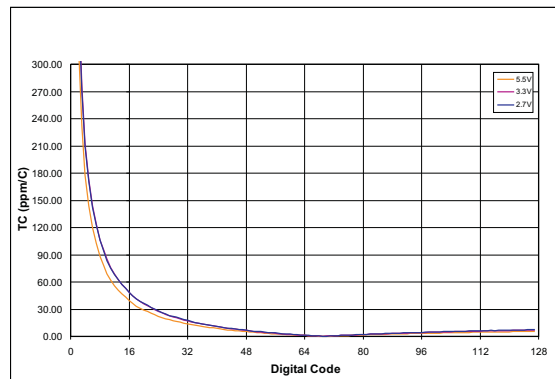


Figure 9.

**TEMPERATURE COEFFICIENT vs  
TAP POSITION (Rheostat Mode)**

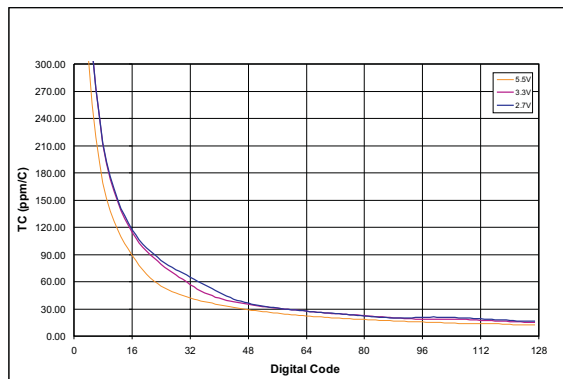


Figure 10.

**FREQUENCY RESPONSE**

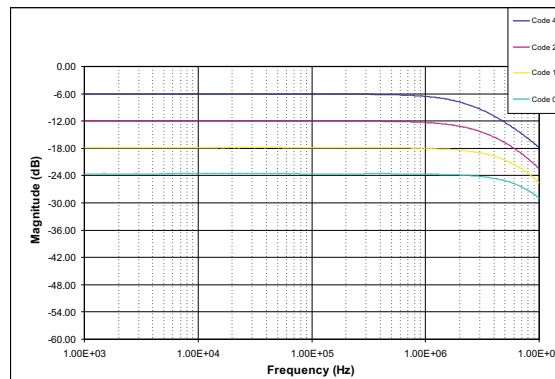


Figure 11.



## SLAVE ADDRESS

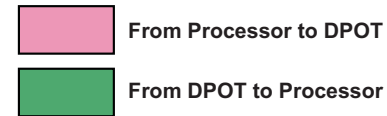
### TPL0401A, TPL0401C

| BIT 7<br>(MSB) | BIT 6 | BIT 5 | BIT 4 | BIT 3 | BIT 2 | BIT 1 | BIT 0<br>(LSB) |
|----------------|-------|-------|-------|-------|-------|-------|----------------|
| 0              | 1     | 0     | 1     | 1     | 1     | 0     | R/W            |

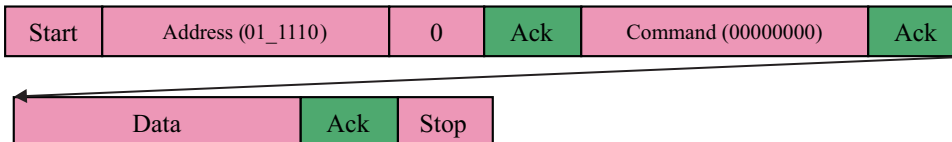
### TPL0401B

| BIT 7<br>(MSB) | BIT 6 | BIT 5 | BIT 4 | BIT 3 | BIT 2 | BIT 1 | BIT 0<br>(LSB) |
|----------------|-------|-------|-------|-------|-------|-------|----------------|
| 0              | 1     | 1     | 1     | 1     | 1     | 0     | R/W            |

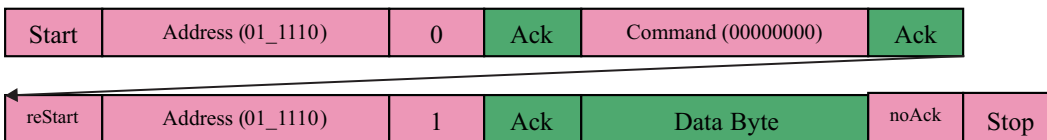
## WRITE AND READ PROTOCOL



### I<sup>2</sup>C Write to A Register



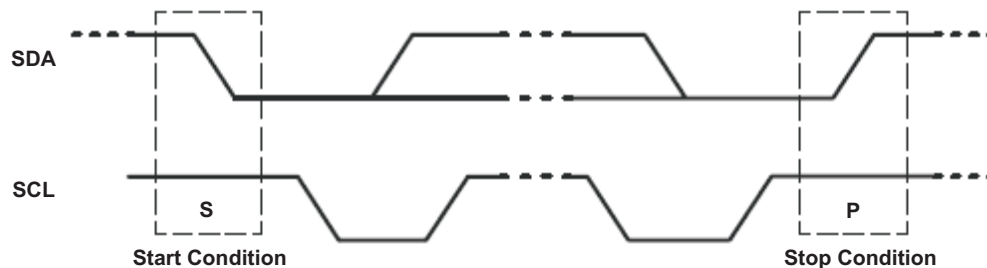
### I<sup>2</sup>C Read From A Register



## Standard I<sup>2</sup>C Interface Details

The bidirectional I<sup>2</sup>C bus consists of the serial clock (SCL) and serial data (SDA) lines. Both lines must be connected to a positive supply via a pullup resistor when connected to the output stages of a device. Data transfer may be initiated only when the bus is not busy.

I<sup>2</sup>C communication with this device is initiated by the master sending a start condition, a high-to-low transition on the SDA input/output while the SCL input is high (see Figure 13). After the start condition, the device address byte is sent, MSB first, including the data direction bit (R/W). This device does not respond to the general call address. After receiving the valid address byte, this device responds with an ACK, a low on the SDA input/output during the high of the ACK-related clock pulse.



**Figure 12. Definition of Start and Stop Conditions**

The data byte follows the address ACK. The R/W bit is kept low for transfer from the master to the slave. The data byte is followed by an ACK sent from this device. Data are output only if complete bytes are received and acknowledged. The output data is valid at time (tpv) after the low-to-high transition of SCL, during the clock cycle for the ACK.

On the I<sup>2</sup>C bus, only one data bit is transferred during each clock pulse. The data on the SDA line must remain stable during the high pulse of the clock period, as changes in the data line at this time are interpreted as control commands (start or stop) (see Figure 13).

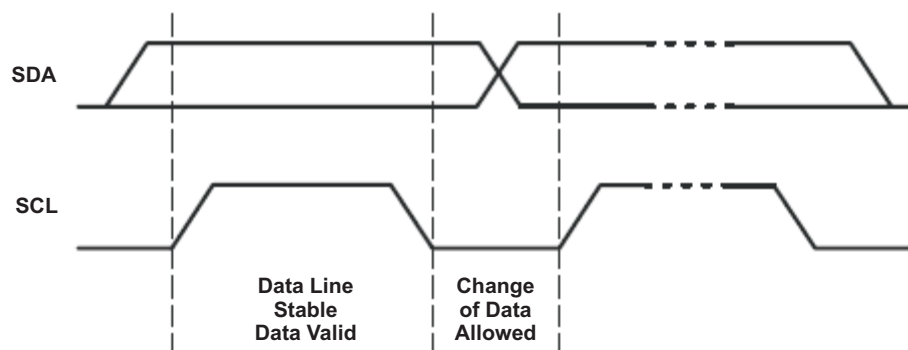


Figure 13. Bit Transfer

A stop condition, a low-to-high transition on the SDA input/output while the SCL input is high, is sent by the master (see Figure 13).

The number of data bytes transferred between the start and the stop conditions from transmitter to receiver is not limited. Each byte of eight bits is followed by one ACK bit. The transmitter must release the SDA line before the receiver can send an ACK bit.

A slave receiver that is addressed must generate an ACK after the reception of each byte. The device that acknowledges has to pull down the SDA line during the ACK clock pulse so that the SDA line is stable low during the high pulse of the ACK-related clock period (see Figure 14). Setup and hold times must be taken into account.

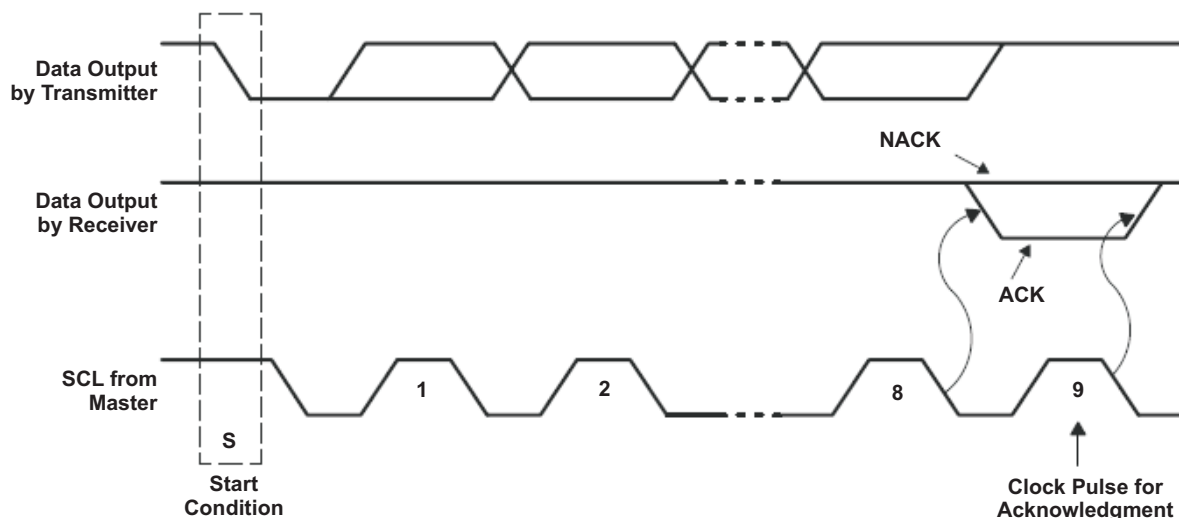
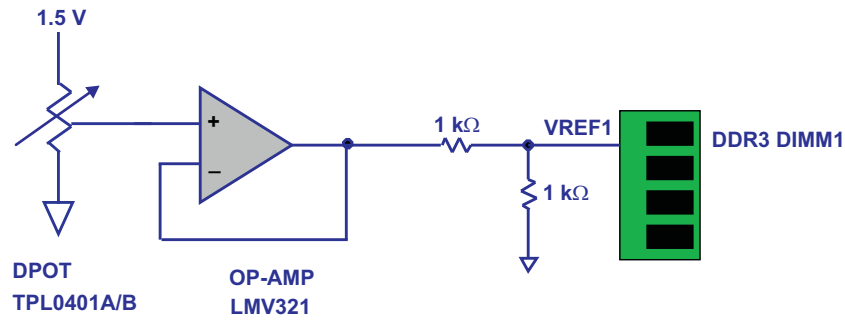


Figure 14. Acknowledgement on the I<sup>2</sup>C Bus

## TYPICAL APPLICATION



**Figure 15. DDR3 Voltage Reference Adjustment**

Below table shows Ideal values of resistance for a 10kΩ DPOT. The absolute values can vary significantly, but the ratio (Rh<sub>w</sub>/R<sub>wl</sub>) is extremely accurate.

**Table 1. Resistance Values Table**

| Step | Binary | R <sub>wl</sub> (kΩ) | R <sub>hw</sub> (kΩ) | R <sub>hw</sub> /R <sub>wl</sub> |
|------|--------|----------------------|----------------------|----------------------------------|
| 0    | 0      | 0.00                 | 10.00                | 0.00                             |
| 1    | 1      | 0.08                 | 9.92                 | 0.01                             |
| 2    | 10     | 0.16                 | 9.84                 | 0.02                             |
| 3    | 11     | 0.23                 | 9.77                 | 0.02                             |
| 4    | 100    | 0.31                 | 9.69                 | 0.03                             |
| 5    | 101    | 0.39                 | 9.61                 | 0.04                             |
| 6    | 110    | 0.47                 | 9.53                 | 0.05                             |
| 7    | 111    | 0.55                 | 9.45                 | 0.06                             |
| 8    | 1000   | 0.63                 | 9.38                 | 0.07                             |
| 9    | 1001   | 0.70                 | 9.30                 | 0.08                             |
| 10   | 1010   | 0.78                 | 9.22                 | 0.08                             |
| 11   | 1011   | 0.86                 | 9.14                 | 0.09                             |
| 12   | 1100   | 0.94                 | 9.06                 | 0.10                             |
| 13   | 1101   | 1.02                 | 8.98                 | 0.11                             |
| 14   | 1110   | 1.09                 | 8.91                 | 0.12                             |
| 15   | 1111   | 1.17                 | 8.83                 | 0.13                             |
| 16   | 10000  | 1.25                 | 8.75                 | 0.14                             |
| 17   | 10001  | 1.33                 | 8.67                 | 0.15                             |
| 18   | 10010  | 1.41                 | 8.59                 | 0.16                             |
| 19   | 10011  | 1.48                 | 8.52                 | 0.17                             |
| 20   | 10100  | 1.56                 | 8.44                 | 0.19                             |
| 21   | 10101  | 1.64                 | 8.36                 | 0.20                             |
| 22   | 10110  | 1.72                 | 8.28                 | 0.21                             |
| 23   | 10111  | 1.80                 | 8.20                 | 0.22                             |
| 24   | 11000  | 1.88                 | 8.13                 | 0.23                             |
| 25   | 11001  | 1.95                 | 8.05                 | 0.24                             |
| 26   | 11010  | 2.03                 | 7.97                 | 0.25                             |
| 27   | 11011  | 2.11                 | 7.89                 | 0.27                             |
| 28   | 11100  | 2.19                 | 7.81                 | 0.28                             |
| 29   | 11101  | 2.27                 | 7.73                 | 0.29                             |
| 30   | 11110  | 2.34                 | 7.66                 | 0.31                             |
| 31   | 11111  | 2.42                 | 7.58                 | 0.32                             |

**Table 1. Resistance Values Table (continued)**

| Step | Binary  | Rwl (k $\Omega$ ) | Rhw (k $\Omega$ ) | Rhw/Rwl |
|------|---------|-------------------|-------------------|---------|
| 32   | 100000  | 2.50              | 7.50              | 0.33    |
| 33   | 100001  | 2.58              | 7.42              | 0.35    |
| 34   | 100010  | 2.66              | 7.34              | 0.36    |
| 35   | 100011  | 2.73              | 7.27              | 0.38    |
| 36   | 100100  | 2.81              | 7.19              | 0.39    |
| 37   | 100101  | 2.89              | 7.11              | 0.41    |
| 38   | 100110  | 2.97              | 7.03              | 0.42    |
| 39   | 100111  | 3.05              | 6.95              | 0.44    |
| 40   | 101000  | 3.13              | 6.88              | 0.45    |
| 41   | 101001  | 3.20              | 6.80              | 0.47    |
| 42   | 101010  | 3.28              | 6.72              | 0.49    |
| 43   | 101011  | 3.36              | 6.64              | 0.51    |
| 44   | 101100  | 3.44              | 6.56              | 0.52    |
| 45   | 101101  | 3.52              | 6.48              | 0.54    |
| 46   | 101110  | 3.59              | 6.41              | 0.56    |
| 47   | 101111  | 3.67              | 6.33              | 0.58    |
| 48   | 110000  | 3.75              | 6.25              | 0.60    |
| 49   | 110001  | 3.83              | 6.17              | 0.62    |
| 50   | 110010  | 3.91              | 6.09              | 0.64    |
| 51   | 110011  | 3.98              | 6.02              | 0.66    |
| 52   | 110100  | 4.06              | 5.94              | 0.68    |
| 53   | 110101  | 4.14              | 5.86              | 0.71    |
| 54   | 110110  | 4.22              | 5.78              | 0.73    |
| 55   | 110111  | 4.30              | 5.70              | 0.75    |
| 56   | 111000  | 4.38              | 5.63              | 0.78    |
| 57   | 111001  | 4.45              | 5.55              | 0.80    |
| 58   | 111010  | 4.53              | 5.47              | 0.83    |
| 59   | 111011  | 4.61              | 5.39              | 0.86    |
| 60   | 111100  | 4.69              | 5.31              | 0.88    |
| 61   | 111101  | 4.77              | 5.23              | 0.91    |
| 62   | 111110  | 4.84              | 5.16              | 0.94    |
| 63   | 111111  | 4.92              | 5.08              | 0.97    |
| 64   | 1000000 | 5.00              | 5.00              | 1.00    |
| 65   | 1000001 | 5.08              | 4.92              | 1.03    |
| 66   | 1000010 | 5.16              | 4.84              | 1.06    |
| 67   | 1000011 | 5.23              | 4.77              | 1.10    |
| 68   | 1000100 | 5.31              | 4.69              | 1.13    |
| 69   | 1000101 | 5.39              | 4.61              | 1.17    |
| 70   | 1000110 | 5.47              | 4.53              | 1.21    |
| 71   | 1000111 | 5.55              | 4.45              | 1.25    |
| 72   | 1001000 | 5.63              | 4.38              | 1.29    |
| 73   | 1001001 | 5.70              | 4.30              | 1.33    |
| 74   | 1001010 | 5.78              | 4.22              | 1.37    |
| 75   | 1001011 | 5.86              | 4.14              | 1.42    |
| 76   | 1001100 | 5.94              | 4.06              | 1.46    |
| 77   | 1001101 | 6.02              | 3.98              | 1.51    |
| 78   | 1001110 | 6.09              | 3.91              | 1.56    |

**Table 1. Resistance Values Table (continued)**

| Step | Binary  | Rwl (kΩ) | Rhw (kΩ) | Rhw/Rwl |
|------|---------|----------|----------|---------|
| 79   | 1001111 | 6.17     | 3.83     | 1.61    |
| 80   | 1010000 | 6.25     | 3.75     | 1.67    |
| 81   | 1010001 | 6.33     | 3.67     | 1.72    |
| 82   | 1010010 | 6.41     | 3.59     | 1.78    |
| 83   | 1010011 | 6.48     | 3.52     | 1.84    |
| 84   | 1010100 | 6.56     | 3.44     | 1.91    |
| 85   | 1010101 | 6.64     | 3.36     | 1.98    |
| 86   | 1010110 | 6.72     | 3.28     | 2.05    |
| 87   | 1010111 | 6.80     | 3.20     | 2.12    |
| 88   | 1011000 | 6.88     | 3.13     | 2.20    |
| 89   | 1011001 | 6.95     | 3.05     | 2.28    |
| 90   | 1011010 | 7.03     | 2.97     | 2.37    |
| 91   | 1011011 | 7.11     | 2.89     | 2.46    |
| 92   | 1011100 | 7.19     | 2.81     | 2.56    |
| 93   | 1011101 | 7.27     | 2.73     | 2.66    |
| 94   | 1011110 | 7.34     | 2.66     | 2.76    |
| 95   | 1011111 | 7.42     | 2.58     | 2.88    |
| 96   | 1100000 | 7.50     | 2.50     | 3.00    |
| 97   | 1100001 | 7.58     | 2.42     | 3.13    |
| 98   | 1100010 | 7.66     | 2.34     | 3.27    |
| 99   | 1100011 | 7.73     | 2.27     | 3.41    |
| 100  | 1100100 | 7.81     | 2.19     | 3.57    |
| 101  | 1100101 | 7.89     | 2.11     | 3.74    |
| 102  | 1100110 | 7.97     | 2.03     | 3.92    |
| 103  | 1100111 | 8.05     | 1.95     | 4.12    |
| 104  | 1101000 | 8.13     | 1.88     | 4.33    |
| 105  | 1101001 | 8.20     | 1.80     | 4.57    |
| 106  | 1101010 | 8.28     | 1.72     | 4.82    |
| 107  | 1101011 | 8.36     | 1.64     | 5.10    |
| 108  | 1101100 | 8.44     | 1.56     | 5.40    |
| 109  | 1101101 | 8.52     | 1.48     | 5.74    |
| 110  | 1101110 | 8.59     | 1.41     | 6.11    |
| 111  | 1101111 | 8.67     | 1.33     | 6.53    |
| 112  | 1110000 | 8.75     | 1.25     | 7.00    |
| 113  | 1110001 | 8.83     | 1.17     | 7.53    |
| 114  | 1110010 | 8.91     | 1.09     | 8.14    |
| 115  | 1110011 | 8.98     | 1.02     | 8.85    |
| 116  | 1110100 | 9.06     | 0.94     | 9.67    |
| 117  | 1110101 | 9.14     | 0.86     | 10.64   |
| 118  | 1110110 | 9.22     | 0.78     | 11.80   |
| 119  | 1110111 | 9.30     | 0.70     | 13.22   |
| 120  | 1111000 | 9.38     | 0.63     | 15.00   |
| 121  | 1111001 | 9.45     | 0.55     | 17.29   |
| 122  | 1111010 | 9.53     | 0.47     | 20.33   |
| 123  | 1111011 | 9.61     | 0.39     | 24.60   |
| 124  | 1111100 | 9.69     | 0.31     | 31.00   |
| 125  | 1111101 | 9.77     | 0.23     | 41.67   |

**Table 1. Resistance Values Table (continued)**

| Step | Binary  | Rwl (k $\Omega$ ) | Rhw (k $\Omega$ ) | Rhw/Rwl |
|------|---------|-------------------|-------------------|---------|
| 126  | 1111110 | 9.84              | 0.16              | 63.00   |
| 127  | 1111111 | 9.92              | 0.08              | 127.00  |

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**Changes from Original (September 2011) to Revision A****Page**

|                                                 |                   |
|-------------------------------------------------|-------------------|
| • Added TPL0401C 器件到数据表。 .....                  | <a href="#">1</a> |
| • Added TPL0401C 封装。 .....                      | <a href="#">1</a> |
| • Added TPL0401C Functional Block Diagram. .... | <a href="#">2</a> |

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## PACKAGING INFORMATION

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>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                 |
|------------------|---------------|--------------|--------------------|------|----------------|-----------------|--------------------------------------|----------------------|--------------|-------------------------|-------------------------|
| TPLO401A-10DCKR  | ACTIVE        | SC70         | DCK                | 6    | 3000           | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 125   | (7TD, 7TV)              | <a href="#">Samples</a> |
| TPLO401B-10DCKR  | ACTIVE        | SC70         | DCK                | 6    | 3000           | RoHS & Green    | NIPDAU                               | Level-1-260C-UNLIM   | -40 to 125   | (7UD, 7UV)              | <a href="#">Samples</a> |

<sup>(1)</sup> 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.

<sup>(2)</sup> **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.

<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.

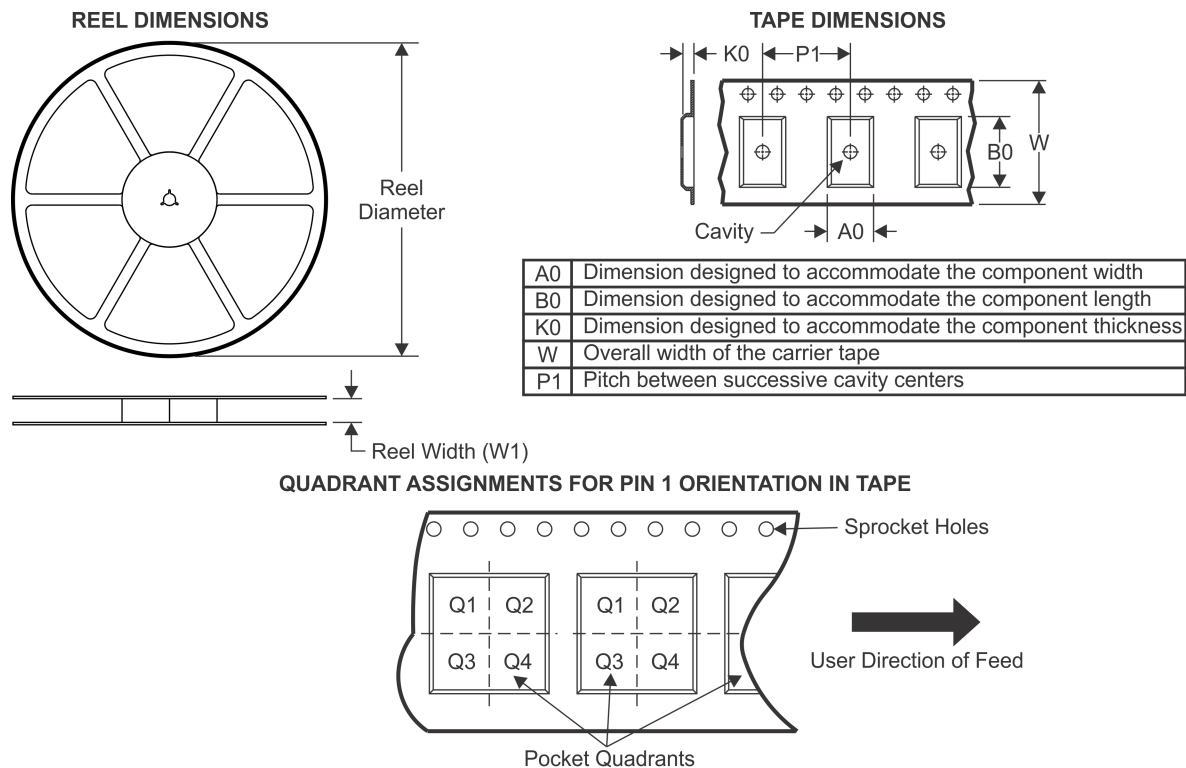
<sup>(6)</sup> Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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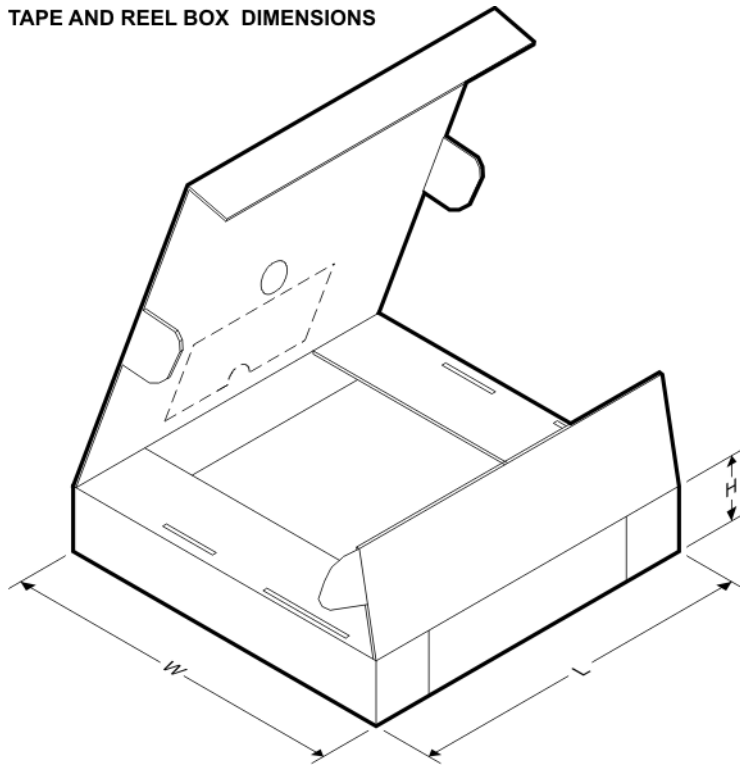


**TAPE AND REEL INFORMATION**


\*All dimensions are nominal

| Device          | Package Type | Package Drawing | Pins | SPQ  | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|-----------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TPL0401A-10DCKR | SC70         | DCK             | 6    | 3000 | 180.0              | 8.4                | 2.41    | 2.41    | 1.2     | 4.0     | 8.0    | Q3            |
| TPL0401B-10DCKR | SC70         | DCK             | 6    | 3000 | 180.0              | 8.4                | 2.41    | 2.41    | 1.2     | 4.0     | 8.0    | Q3            |

## TAPE AND REEL BOX DIMENSIONS

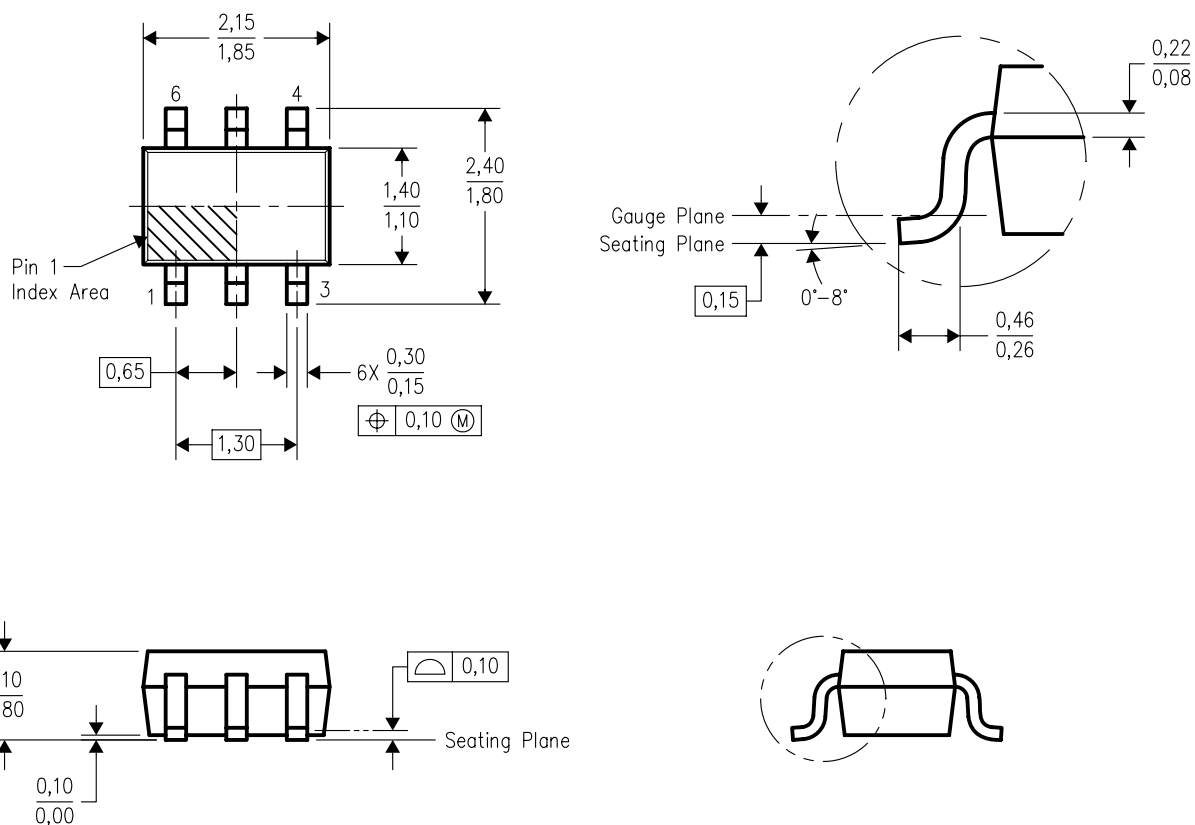


\*All dimensions are nominal

| Device          | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|-----------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TPL0401A-10DCKR | SC70         | DCK             | 6    | 3000 | 202.0       | 201.0      | 28.0        |
| TPL0401B-10DCKR | SC70         | DCK             | 6    | 3000 | 202.0       | 201.0      | 28.0        |

## DCK (R-PDSO-G6)

## PLASTIC SMALL-OUTLINE PACKAGE

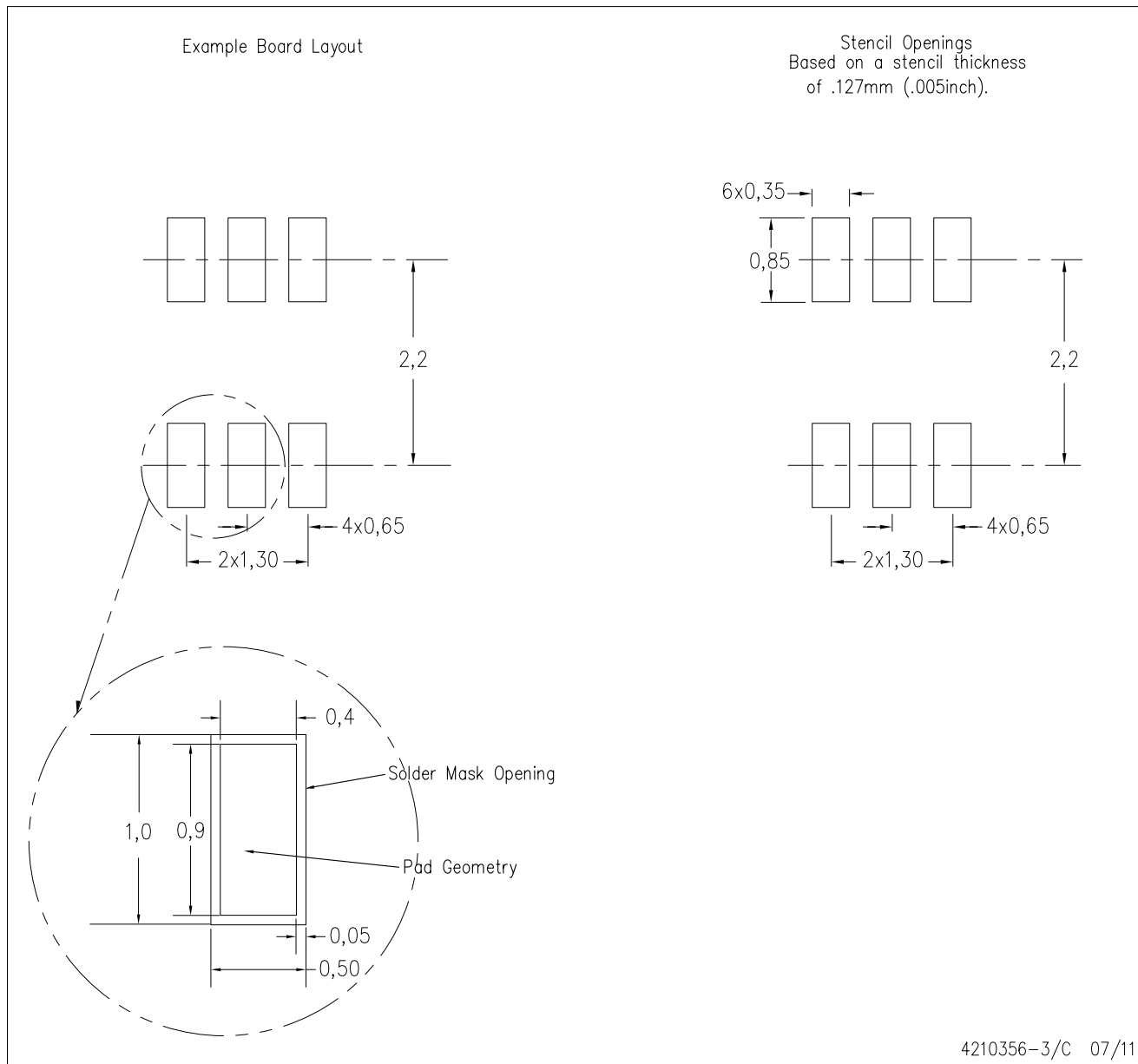


4093553-4/G 01/2007

- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
  - 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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