# 256-TAPS DUAL CHANNEL DIGITAL POTENTIOMETER WITH NON-VOLATILE MEMORY

**Check for Samples: TPL0102**

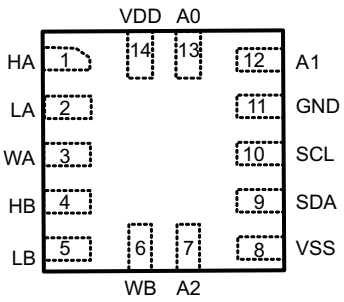
## FEATURES

- **Dual Channel, 256-Position Resolution**
- **Non-volatile Memory Stores Wiper Settings**
- **2mm x 2mm, 14-pin MicroQFN or 14-pin TSSOP Packages**
- **100 kΩ End-to-End Resistance (TPL0102-100)**
- **Fast Power-up Response Time to Wiper Setting: <100µs**
- **±0.5 LSB INL, ±0.25 LSB DNL (Voltage-Divider Mode)**
- **4 ppm/°C Ratiometric Temperature Coefficient**
- **I²C-compatible Serial Interface**
- **2.7 V to 5.5 V Single-Supply Operation**
- **±2.25 V to ±2.75 V Dual-Supply Operation**
- **Operating Temperature Range From -40°C to +85°C**
- **ESD Performance Tested Per JESD 22**
  - **2000-V Human Body Model (A114-B, Class II)**

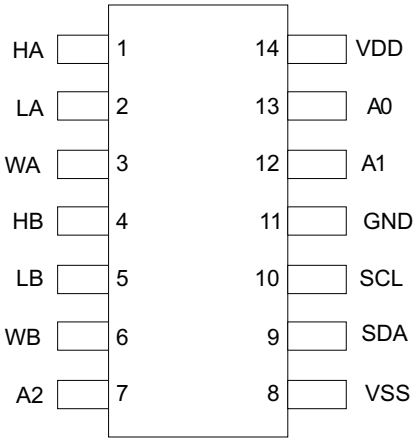
## APPLICATIONS

- **Adjustable Gain Amplifiers and Offset Trimming**
- **Adjustable Power Supplies**
- **Precision Calibration of Set Point Thresholds**
- **Sensor Trimming and Calibration**
- **Mechanical Potentiometer Replacement**

**MicroQFN - RUC PACKAGE**
**(TOP VIEW)**




**TSSOP - PW PACKAGE**
**(TOP VIEW)**




## DESCRIPTION

The TPL0102 is a two channel, linear-taper digital potentiometer with 256 wiper positions. Each potentiometer can be used as a three-terminal potentiometer or as a two-terminal rheostat. The TPL0102-100 has an end-to-end resistance of 100kΩ.

The TPL0102 has non-volatile memory (EEPROM) which can be used to store the wiper position. The internal registers of the TPL0102 can be accessed using the I²C interface.

The TPL0102 is available in a 14-pin MicroQFN and 14-pin TSSOP package with a specified temperature range of -40°C to +85°C.

## ORDERING INFORMATION

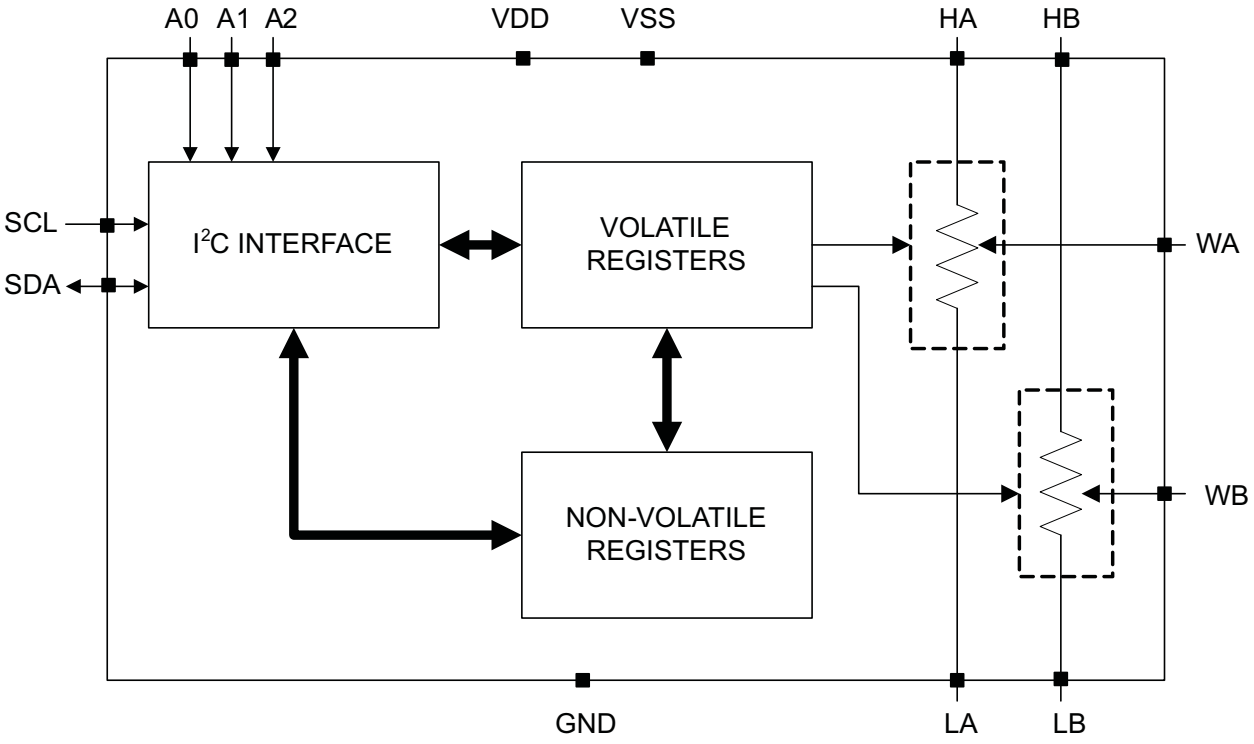
| $T_A$ | PACKAGE (1) (2) | | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|---|---|---|---|---|
| –40°C to 85°C | TSSOP – PW | Tape and reel | TPL0102-100PWR | EL-100 |
| | MicroQFN-RUC | | TPL0102-100RUCR | 6N |

(1) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.
(2) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI website at www.ti.com.

### Table 1. Summary of Features

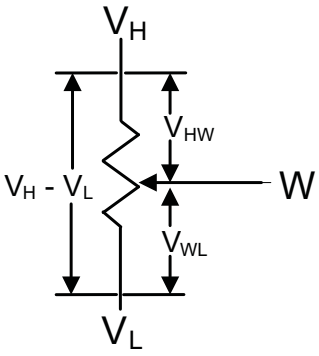
| Feature | TPL0102-100 |
|---|---|
| # of Potentiometers | 2 |
| Digital Interface | $I^2C$ |
| Steps | 256 |
| Wiper Memory | Non-Volatile |
| Taper | Linear |
| End-to-end Resistance | 100kΩ |
| End-to-end Resistance Tolerance | 20% |
| Wiper Resistance | 25 Ω (typ) |
| Smallest Package Size | MicroQFN (RUC): 4 $mm^2$ |

## FUNCTIONAL BLOCK DIAGRAM



## DIGITAL POTENTIOMETER CONFIGURATIONS

VOLTAGE DIVIDER MODE

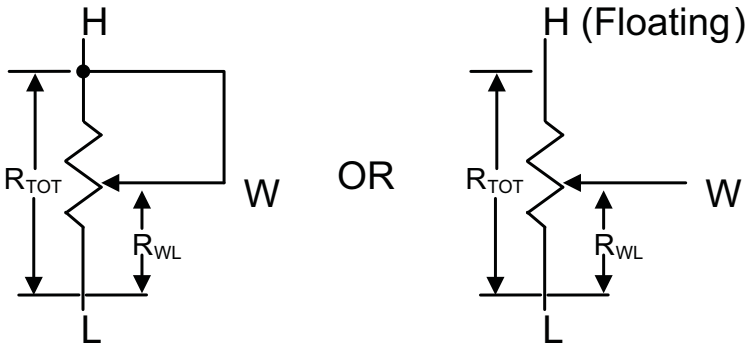



$V_{HW} = (V_H – V_L) \times (1 – (D/256))$

$V_{WL} = (V_H – V_L) \times D/256$

Where D = Decimal Value of Wiper Code

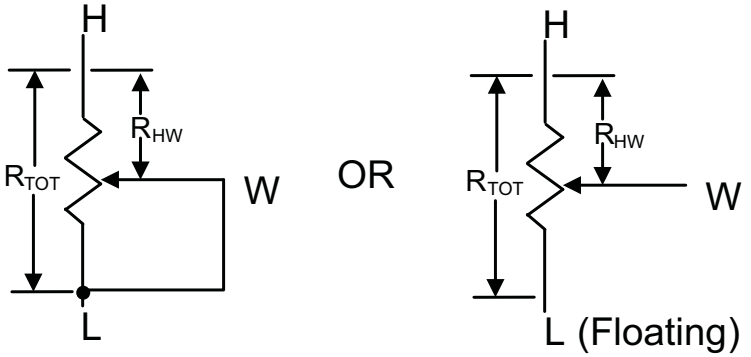
RHEOSTAT MODE A




$R_{WL} = R_{TOT} \times D/256$

Where D = Decimal Value of Wiper Code

RHEOSTAT MODE B




$R_{HW} = R_{TOT} \times (1 – (D/256))$

Where D = Decimal Value of Wiper Code

**Figure 1. DPOT Configurations**

**Table 2. PIN DESCRIPTION TABLE**

| 14 RUC/14 PW | PIN NAME | TYPE | DESCRIPTION |
|---|---|---|---|
| 1 | HA | I/O | High terminal of Potentiometer A |
| 2 | LA | I/O | Low terminal of Potentiometer A |
| 3 | WA | I/O | Wiper terminal of Potentiometer A |
| 4 | HB | I/O | High terminal of Potentiometer B |
| 5 | LB | I/O | Low terminal of Potentiometer B |
| 6 | WB | I/O | Wiper terminal of Potentiometer B |
| 7 | A2 | Input | Address Bit 2 |
| 8 | VSS | Power | Negative or GND Power Supply Pin |
| 9 | SDA | I/O | $I^2C$ Data I/O |
| 10 | SCL | Input | $I^2C$ Clock Input |
| 11 | GND | Ground | Ground |
| 12 | A1 | Input | Address Bit 1 |
| 13 | A0 | Input | Address Bit 0 |
| 14 | VDD | Power | Positive Power Supply Pin |

## RECOMMENDED OPERATING CONDITIONS

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

| | | MIN | MAX | UNIT |
|---|---|---|---|---|
| $V_{DD}$, $V_{SS}$ | Single Supply Operation ($V_{SS}$=0V) | 2.7 | 5.5 | V |
| | Dual Supply Operation | ±2.25 | ±2.75 | |
| $V_H$, $V_L$ | Terminal Voltage Range | $V_{SS}$ | $V_{DD}$ | V |
| $V_{IH}$ | Voltage Input High (SCL, SDA, A0, A1, A2) | 0.7 × $V_{DD}$ | 5.5 | V |
| $V_{IL}$ | Voltage Input Low (SCL, SDA, A0, A1, A2) | 0 | 0.3 × $V_{DD}$ | V |
| $I_W$ | Wiper Current | | ±2 | mA |
| $T_A$ | Ambient Temperature | –40 | 85 | °C |

## ABSOLUTE MAXIMUM RATINGS(1)(2)(3)

| | | | MIN | MAX | UNIT |
|---|---|---|---|---|---|
| $V_{DD}$ to GND | Supply voltage range | | –0.3 | 7 | V |
| $V_{SS}$ to GND | | | –7 | 0.3 | V |
| $V_{DD}$ to $V_{SS}$ | | | | 7 | V |
| $V_H$, $V_L$, $V_W$ | Voltage at resistor terminals | | $V_{SS}$ – 0.3 | $V_{DD}$ + 0.3 | V |
| $V_I$ | Digital input voltage range | | –0.3 | $V_{DD}$ + 0.3 | V |
| $I_H$, $I_L$, $I_W$ | Pulse Current | | | ±20 | mA |
| | Continuous Current | | | ±2 | mA |
| $\theta_{JA}$ | Package thermal impedance(4) | PW package | | 88 | °CW |
| | | RUC package | | 216.7 | |
| $T_{stg}$ | 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.

## ELECTRICAL CHARACTERISTICS

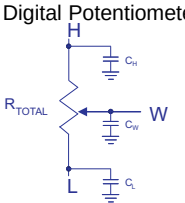
$V_{DD}$ = 2.7V to 5.5V, $V_{SS}$ = 0V, $V_H$= $V_{DD}$, $V_L$= GND, $T_A$ = –40°C to 85°C (unless otherwise noted). Typical values are at $V_{DD}$= 5V, $T_A$ = 25°C (unless otherwise noted).

| PARAMETER | | TEST CONDITIONS | | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| $R_{TOT}$ | End-to-end Resistance (Between H and L Terminals) | TPL0102-100 | | 80 | 100 | 120 | kΩ |
| $R_H$, $R_L$ | Terminal resistance | | | | 60 | 200 | Ω |
| $R_W$ | Wiper resistance | | | | 25 | 100 | Ω |
| $C_H$, $C_L$ (1)(2) | Terminal capacitance | | | | 22 | | pF |
| $C_W$ (1)(2) | Wiper capacitance | | | | 16 | | pF |
| $I_{LKG}$ | Terminal Leakage Current | $V_H$ = $V_{SS}$ to $V_{DD}$, $V_L$ = Floating OR $V_L$ = $V_{SS}$ to $V_{DD}$, $V_H$ = Floating | | | 0.1 | 1 | µA |
| $TC_R$ | Resistance temperature coefficient | Input Code = 0x80h | | | 92 | | ppm/°C |
| $R_{TOT,MATCH}$ | Channel-to-channel resistance match | | | | 0.1 | | % |
| **Voltage Divider Mode** | | | | | | | |
| INL (3)(4) | Integral non-linearity | | | –0.5 | | 0.5 | LSB |
| DNL (3)(5) | Differential non-linearity | | | –0.25 | | 0.25 | LSB |
| $ZS_{ERROR}$ (6)(7) | Zero-scale error | | | 0 | 0.1 | 2 | LSB |
| $FS_{ERROR}$ (6)(8) | Full-scale error | | | –2 | –0.1 | 0 | LSB |
| $V_{MATCH}$ (6)(9) | Channel-to-Channel matching | Wiper at the same tap position, same voltage at all H and same voltage at all L terminals | | –2 | | 2 | LSB |
| $TC_V$ | Ratiometric temperature coefficient | Wiper set at mid-scale | | | 4 | | ppm/°C |
| BW | Bandwidth | TPL0102-100 | Wiper set at mid-scale $C_{LOAD}$ = 10 pF | | 229 | | kHz |
| $T_{SW}$ | Wiper setting time | TPL0102-100 | | | 3.6 | | µS |
| THD | Total harmonic distortion | $V_H$ = 1 $V_{RMS}$ at 1 kHz, $V_L$ = ($V_{DD}$ – $V_{SS}$)/2, Measurement at W | TPL0102-100 | | 0.03 | | % |
| $X_{TALK}$ | Cross talk | $f_H$ = 1 kHz, $V_L$ = GND, Measurement at W | | | –82 | | dB |

(1) Terminal and Wiper Capacitance extracted from self admittance of three port network measurement

$$Y_{ii} = \frac{I_i}{V_i}\Big|_{V_k=0 \text{ for } k\neq i}$$

(2) Digital Potentiometer Macromodel




(3) LSB = ($V_{MEAS[code\ 255]}$ – $V_{MEAS[code\ 0]}$) / 255
(4) INL = (($V_{MEAS[code\ x]}$ – $V_{MEAS[code\ 0]}$) / LSB) - [code x]
(5) DNL = (($V_{MEAS[code\ x]}$ – $V_{MEAS[code\ x-1]}$) / LSB) – 1
(6) IDEAL_LSB = ($V_H$-$V_L$) / 256
(7) $ZS_{ERROR}$ = $V_{MEAS[code\ 0]}$ / IDEAL_LSB
(8) $FS_{ERROR}$ = [($V_{MEAS[code\ 255]}$ – ($V_H$-$V_L$)) / IDEAL_LSB] + 1
(9) $V_{MATCH}$ = ($V_{MEAS\_A[code\ x]}$ – $V_{MEAS\_B[code\ x]}$) / IDEAL_LSB

## ELECTRICAL CHARACTERISTICS (continued)

$V_{DD}$ = 2.7V to 5.5V, $V_{SS}$ = 0V, $V_H$= $V_{DD}$, $V_L$= GND, $T_A$ = –40°C to 85°C (unless otherwise noted). Typical values are at $V_{DD}$= 5V, $T_A$ = 25°C (unless otherwise noted).

| PARAMETER | | TEST CONDITIONS | | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|
| **RHEOSTAT MODE (Measurements between W and L with H not connected, or between W and H with L not connected)** | | | | | | | |
| RINL (10)(11) | Integral non-linearity | | | –1 | | 1 | LSB |
| RDNL (10)(12) | Differential non-linearity | | | –0.5 | | 0.5 | LSB |
| $R_{OFFSET}$ (13)(14) | Offset | | | 0 | 0.2 | 2 | LSB |
| $R_{MATCH}$ (13)(15) | Channel-to-Channel matching | | | –2 | | 2 | LSB |
| RBW | Bandwidth | Code = 0x00h,<br>L Floating,<br>Input applied to W, Measure at H,<br>$C_{LOAD}$ = 10 pF | TPL0102-100 | | 54 | | kHz |

(10) RLSB = ($R_{MEAS[code\ 255]}$ – $R_{MEAS[code\ 0]}$) / 255
(11) RINL =( ($R_{MEAS[code\ x]}$ – $R_{MEAS[code\ 0]}$) / RLSB) - [code x]
(12) RDNL =( ($R_{MEAS[code\ x]}$ – $R_{MEAS[code\ x-1]}$) / RLSB )– 1
(13) IDEAL_RLSB = $R_{TOT}$ / 256
(14) $R_{OFFSET}$ = $R_{MEAS[code\ 0]}$ / IDEAL_RLSB
(15) $R_{MATCH}$ = ($R_{MEAS\_A[code\ x]}$ – $R_{MEAS\_B[code\ x]}$) / IDEAL_RLSB

## OPERATING CHARACTERISTICS

$V_{DD}$ = 2.7V to 5.5V, $V_{SS}$ = 0V, $V_H$ = $V_{DD}$, $V_L$ = GND, $T_A$= –40°C to 85°C (unless otherwise noted). Typical values are at $V_{DD}$ = 5V, $T_A$ = 25°C (unless otherwise noted).

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $I_{DD(STBY)}$ | $V_{DD}$ standby current | $V_{DD}$ = 2.75 V, $V_{SS}$ = –2.75, $I^2C$ interface in standby mode | | 0.2 | 1 | µA |
| $I_{SS(STBY)}$ | $V_{SS}$ standby current | $V_{DD}$ = 2.75 V, $V_{SS}$ = –2.75, $I^2C$ interface in standby mode | –1 | –0.2 | | µA |
| $I_{DD(SHUTDOWN)}$ | $V_{DD}$ shutdown current | $V_{DD}$ = 2.75 V, $V_{SS}$ = –2.75, $I^2C$ interface in standby mode | | 0.2 | 1 | µA |
| $I_{SS(SHUTDOWN)}$ | $V_{SS}$ shutdown current | $V_{DD}$ = 2.75 V, $V_{SS}$ = –2.75, $I^2C$ interface in standby mode | –1 | –0.2 | | µA |
| $I_{DD}$ | $V_{DD}$ current during non-volatile write | $V_{DD}$ = 2.75 V, $V_{SS}$ = –2.75 | | 200 | µA | |
| $I_{SS}$ | $V_{SS}$ current during non-volatile write | $V_{DD}$ = 2.75 V, $V_{SS}$ = –2.75 | -200 | | | µA |
| $I_{LKG-DIG}$ | Digital pins leakage current (A0, A1, A2, SDA, and SCL) | | –1 | | 1 | µA |
| $V_{POR}$ | Power-on recall voltage | Minimum $V_{DD}$ at which memory recall occurs | | 2 | | V |
| **EEPROM Specification** | | | | | | |
| | EEPROM endurance | | | 100,000 | | Cycles |
| | EEPROM retention | $T_A$ = 85°C | | 100 | | Years |
| $t_{WC}$ | Non-volatile write cycle time | | | 20 | | ms |
| **Wiper Timing Characteristics** | | | | | | |
| $t_{WRT}$ | Wiper response time | SCL falling edge of last bit of wiper data byte to wiper new position | | 600 | | ns |
| $t_{SHUTDOWNREC}$ | Wiper position recall time from shut-down mode | SCL falling edge of last bit of ACR data byte to wiper stored position and H connection | | 800 | | ns |
| $t_D$ | Power-up delay | $V_{DD}$ above $V_{POR}$, to wiper initial value register recall completed, and $I^2C$ interface in standby mode | | 35 | 100 | µs |
| $C_{IN}$ | Pin capacitance | A0, A1, A2, SDA SCL pins | | 7 | | pF |

## OPERATING CHARACTERISTICS (continued)

$V_{DD}$ = 2.7V to 5.5V, $V_{SS}$ = 0V, $V_H$ = $V_{DD}$, $V_L$ = GND, $T_A$= –40°C to 85°C (unless otherwise noted). Typical values are at $V_{DD}$ = 5V, $T_A$ = 25°C (unless otherwise noted).

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| **I²C Interface Specifications** | | | | | | |
| $V_{IH}$ | Input high voltage | | 0.7 x $V_{DD}$ | | 5.5 | V |
| $V_{IL}$ | Input low voltage | | 0 | | 0.3 x $V_{DD}$ | V |
| $V_{OL}$ | Output low voltage | SDA pin, $I_{OL}$ = 4 mA | | | 0.4 | V |
| $C_{IN}$ | Pin capacitance | A0, A1, A2, SDA SCL pins | | 7 | | pF |

## TIMING REQUIREMENTS

$V_{DD}$ = 2.7V to 5.5V, $V_{SS}$ = 0V, $V_H$ = $V_{DD}$, $V_L$ = GND, $T_A$ = –40°C to 85°C (unless otherwise noted). Typical values are at $V_{DD}$ = 5V, $T_A$ = 25°C (unless otherwise noted).

| | | STANDARD MODE I²C BUS | | FAST MODE I²C BUS | | UNIT |
|---|---|---|---|---|---|---|
| | | MIN | MAX | MIN | MAX | |
| **I²C Interface Timing Requirements** | | | | | | |
| $f_{SCL}$ | I²C clock frequency | 0 | 100 | 0 | 400 | kHz |
| $t_{SCH}$ | I²C clock high time | 4 | | 0.6 | | µs |
| $t_{SCL}$ | I²C clock low time | 4.7 | | 1.3 | | µs |
| tsp | I²C spike time | 0 | 50 | 0 | 50 | ns |
| $t_{SDS}$ | I²C serial data setup time | 250 | | 100 | | ns |
| $t_{SDH}$ | I²C serial data hold time | 0 | | 0 | | ns |
| $t_{ICR}$ | I²C input rise time | | 1000 | 20 + 0.1$C_b$ (1) | 300 | ns |
| $t_{ICF}$ | I²C input fall time | | 300 | 20 + 0.1$C_b$ (1) | 300 | ns |
| $t_{ICF}$ | I²C output fall time, 10 pF to 400 pF bus | | 300 | 20 + 0.1$C_b$ (1) | 300 | ns |
| $t_{BUF}$ | I²C bus free time between stop and start | 4.7 | | 1.3 | | µs |
| $t_{STS}$ | I²C start or repeater start conditions setup time | 4.7 | | 1.3 | | µs |
| $t_{STH}$ | I²C start or repeater start condition hold time | 4 | | 0.6 | | µs |
| $t_{SPS}$ | I²C stop condition setup time | 4 | | 0.6 | | µs |
| $t_{VD(DATA)}$ | Valid data time, SCL low to SDA output valid | | 1 | | 1 | µs |
| $t_{VD(DATA)}$ | Valid data time of ACK condition, ACK signal from SCL low to SDA (out) low | | 1 | | 1 | µs |

(1) $C_b$ = total capacitance of one bus line in pF

# REGISTER DESCRIPTION

## Slave Address

| Bit 7 (MSB) | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 2 | Bit 0 (LSB) |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 1 | 0 | A2 | A1 | A0 | R/W |

## TPL0102 Register Map

| REGISTER ADDRESS (HEX) | NON-VOLATILE | VOLATILE |
|---|---|---|
| 0 | IVRA | WRA |
| 1 | IVRB | WRB |
| 2 | General purpose | N/A |
| 3 | General purpose | N/A |
| 4 | General purpose | N/A |
| 5 | General purpose | N/A |
| 6 | General purpose | N/A |
| 7 | General purpose | N/A |
| 8 | General purpose | N/A |
| 9 | General purpose | N/A |
| A | General purpose | N/A |
| B | General purpose | N/A |
| C | General purpose | N/A |
| E | General purpose | N/A |
| D | General purpose | N/A |
| F | Reserved | |
| 10 | N/A | ACR |

## IVRA (Initial Value Register for Potentiometer A)

- Register Address: 00H
- Factory Programmed Value: 80H
- Type: Non-volatile Write/Read

| NAME | SIZE (BITS) | DESCRIPTION |
|---|---|---|
| IVRA | 8 | Non-volatile register to store wiper position for potentiometer A |

## WRA (Wiper Resistance Register for Potentiometer A)

- Register Address: 00H
- Reset Value: Same as IVRA
- Type: Volatile Write/Read

| NAME | SIZE (BITS) | DESCRIPTION |
|---|---|---|
| WRA | 8 | Volatile register to change wiper position for potentiometer A |

## IVRB (Initial Value Register for Potentiometer B)

- Register Address: 01H
- Factory Programmed Value: 80H
- Type: Non-volatile Write/Read

| NAME | SIZE (BITS) | DESCRIPTION |
|---|---|---|
| IVRB | 8 | Non-volatile register to store wiper position for potentiometer B |

## WRB (Wiper Resistance Register for Potentiometer B)

- Register Address: 01H
- Reset Value: Same as IVRB
- Type: Volatile Write/Read

| NAME | SIZE (BITS) | DESCRIPTION |
|---|---|---|
| WRB | 8 | Volatile register to change wiper position for potentiometer B |

## ACR (Access Control Register)

- Register Address: 00H
- Reset Value: 40H
- Type: Non-volatile Write/Read

| NAME | SIZE (BITS) | DESCRIPTION | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| IVRA | 8 | Non-volatile register to store wiper position for potentiometer A | | | | | | | |
| ACR | 8 | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
| | | VOL | $\overline{\text{SHDN}}$ | WIP | 0 | 0 | 0 | 0 | 0 |
| Default Value | | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |

| NAME | SIZE (BITS) | DESCRIPTION |
|---|---|---|
| VOL | 1 | 0: Non-volatile registers (IVRA, IVRB) are accessible. Value written to IVRi register is also written to the corresponding WRi. |
| | | 1: Only Volatile Registers (WRi) are accessible. |
| $\overline{\text{SHDN}}$ | 1 | 0: Shut-down mode is enabled. Potentiometers are in shut-down mode. (see Figure 2) |
| | | 1: Shut-down mode is disabled |
| WIP (Read-only bit) | 1 | 0: Non-volatile write operation is not in progress |
| | | 1: Non-volatile write operation is in progress (it is not possible to write to the WRi or ACR while WIP = 1) |

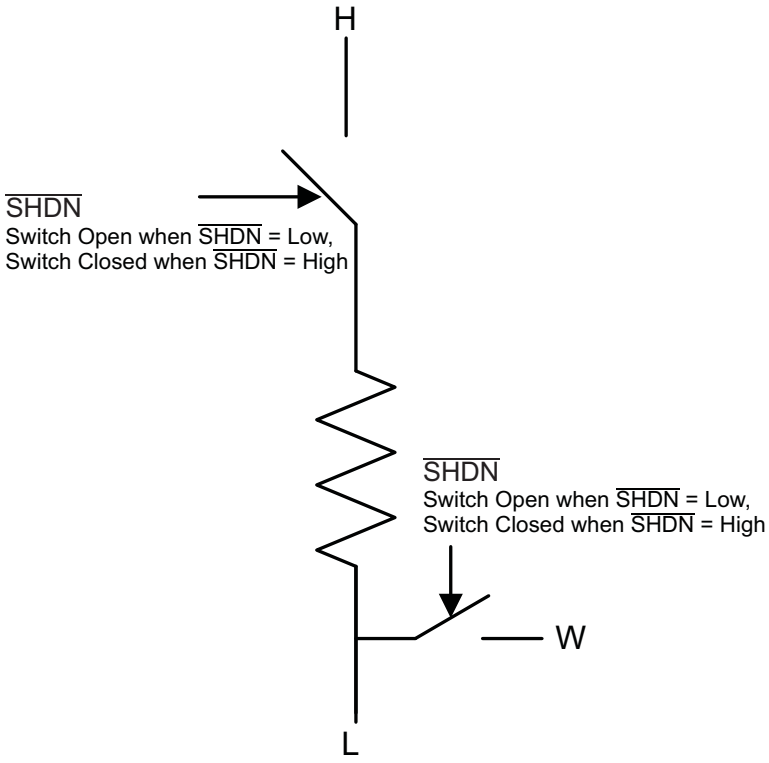



**Figure 2. Potentiometer in Shut-Down Mode**

## PRINCIPLES OF OPERATION

The TPL0102 is a two channel, linear-taper digital potentiometer with 256 wiper positions. Each potentiometer can be used as a three-terminal potentiometer or as a two-terminal rheostat. The TPL0102-100 has an end-to-end resistance of 100kΩ.

The TPL0102 has non-volatile memory (EEPROM) which can be used to store the wiper position. When the device is powered down, the last value stored in the IVR register will be maintained in the non-volatile memory. When power is restored, the contents of the IVR register are recalled and loaded into the corresponding WR register to set the wipers to the initial position. The internal registers of the TPL0102 can be accessed using the $I^2C$ interface.

The position of the wiper terminal is controlled by the value in the WR 8-bit register. When the WR contains all zeroes, the wiper terminal W is closest to its L (Low) terminal. As the value of the WR increases from all zeroes to all ones (255 decimal), the wiper moves monotonically from the position closest to L to the position closest to H. At the same time, the resistance between W and L increases monotonically, whereas the resistance between W and H decreases monotonically.

### Potentiometer Pin Description

#### HA,HB,LA,LB

The high (HA, HB) and low (LA, LB) terminals of the TPL0102 are equivalent to the fixed terminals of a mechanical potentiometer. The H and L terminals do not have any polarity restrictions, i.e. H can be at a higher voltage than L, or L can be at a higher voltage than H. The WA and WB terminals are the wipers and equivalent to the movable terminal of a mechanical potentiometer. The position of the wiper is set using the WR register. With the WR register set to 255 decimal, the wiper is closest to the H terminal, and with the WR register set to 0, the wiper is closest to the L terminal.

#### SDA, SCL

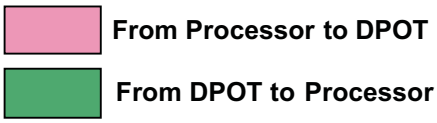
SDA is a bi-directional serial data input/output pin for $I^2C$ communication. SDA is an open drain output and requires an external pull-up resistor.

SCL is the serial clock input for $I^2C$ communication. SCL requires an external pull-up resistor.

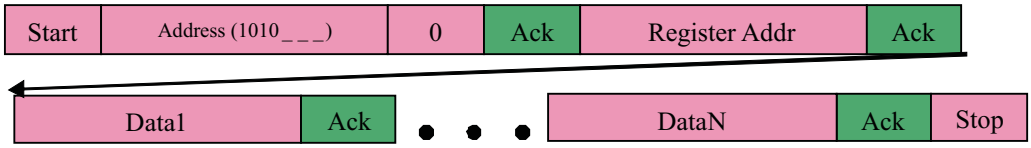
#### A0, A1, A2

These inputs are used to set the last three bits of the $I^2C$ address of the device. By using different values for A0, A1, A2, up to eight TPL0102 devices can be used on the same $I^2C$ bus.

**Figure 3. I²C Interface**




**I²C Write to A Register**




**I²C Read From A Register**

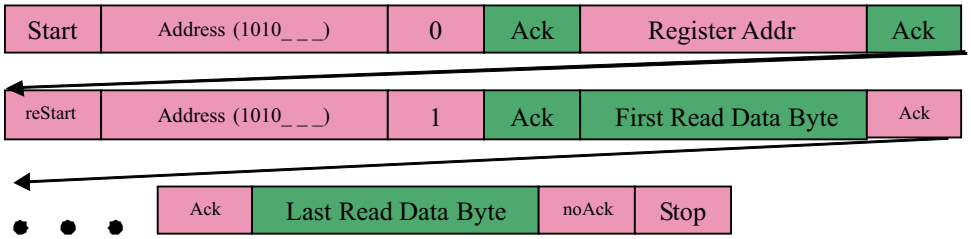
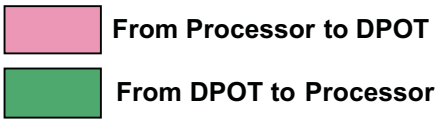
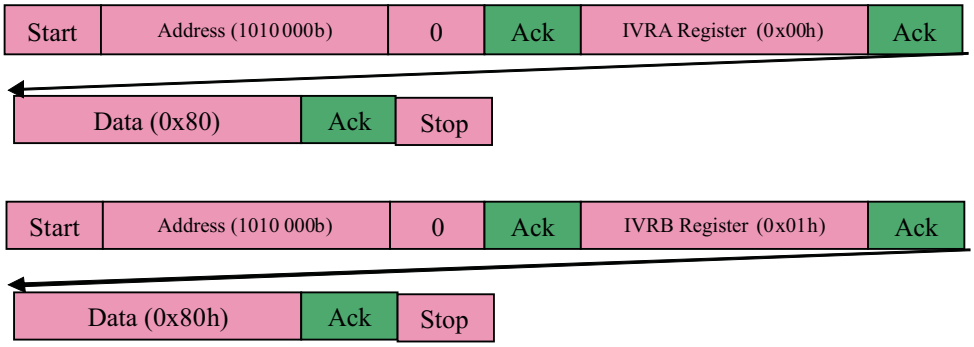



**Figure 4. I²C Interface**

Following is a sample sequence to set wipers of both potentiometers at mid-scale. Assume A0, A1, and A2 are zero and device has just been powered up.




**Method 1: First Write 0x80 to IVRA and then write 0x80 to IVRB Register**




**Method 2: Perform a multi byte write to IVRA and IVRB Register**

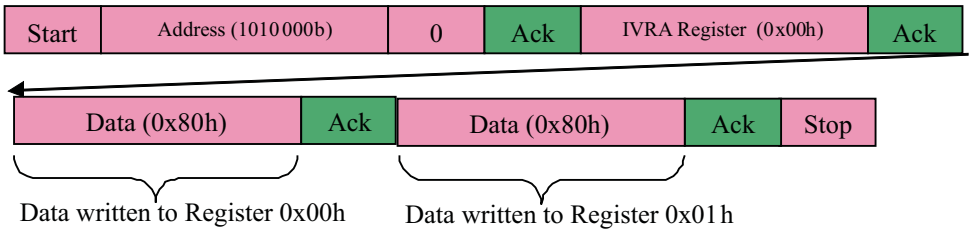



**Figure 5. $I^2C$ Interface Example**

## Standard I²C Interface Details

The bidirectional I²C 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.

I²C 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 6). 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

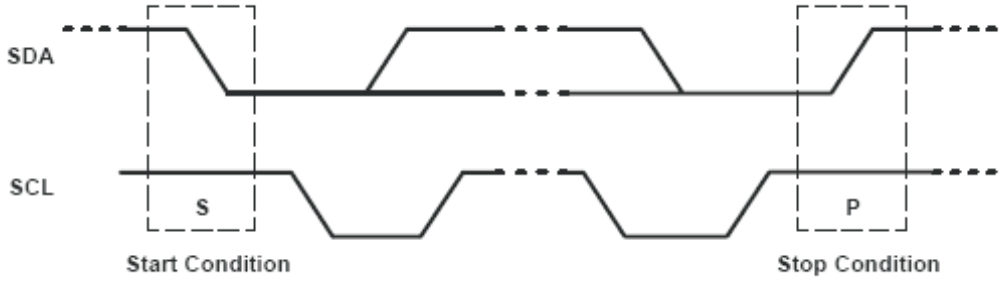



**Figure 6. Definition of Start and Stop Conditions**

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 I²C 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 7).

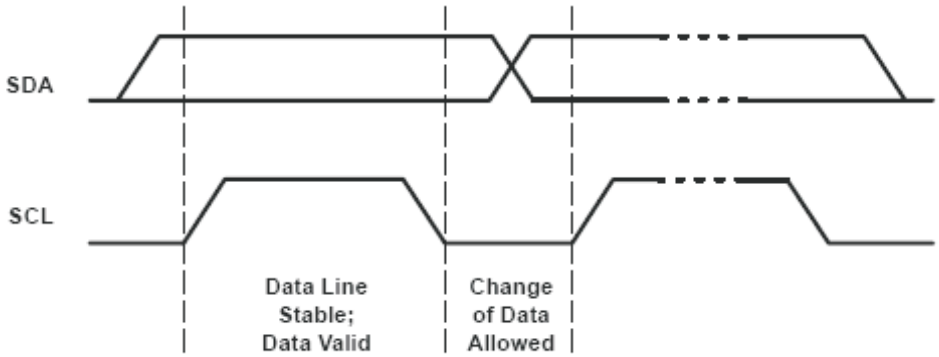



**Figure 7. Bit Transfer**

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 6).

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 8). Setup and hold times must be taken into account.

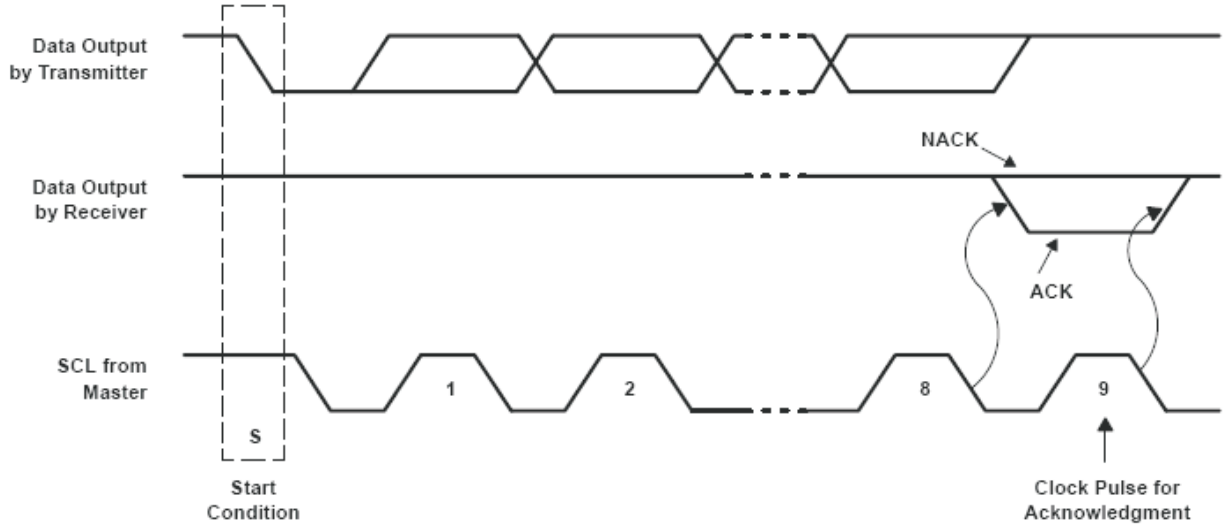
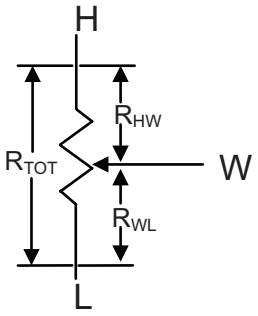



**Figure 8. Acknowledgment on the $I^2C$ Bus**

## IDEAL RESISTANCE VALUES




$R_{WL} = R_{TOT} \times D/256$

$R_{HW} = R_{TOT} \times (1 - (D/256))$

Where D = Decimal Value of Wiper Code

Below table shows the ideal values for DPOT with end-to End resistance of 100kΩ. The absolute values of resistance can vary significantly but the Ratio (Rhw/Rwl) is extremely accurate.

| Step | Binary | $R_{HW}$ (kΩ) | $R_{WL}$ (kΩ) | $R_{HW}/R_{WL}$ |
|---|---|---|---|---|
| 0 | 0 | 0.00 | 100.00 | 0.00 |
| 1 | 1 | 0.39 | 99.61 | 0.00 |
| 2 | 10 | 0.78 | 99.22 | 0.01 |
| 3 | 11 | 1.17 | 98.83 | 0.01 |
| 4 | 100 | 1.56 | 98.44 | 0.02 |
| 5 | 101 | 1.95 | 98.05 | 0.02 |
| 6 | 110 | 2.34 | 97.66 | 0.02 |
| 7 | 111 | 2.73 | 97.27 | 0.03 |
| 8 | 1000 | 3.13 | 96.88 | 0.03 |
| 9 | 1001 | 3.52 | 96.48 | 0.04 |
| 10 | 1010 | 3.91 | 96.09 | 0.04 |
| 11 | 1011 | 4.30 | 95.70 | 0.04 |
| 12 | 1100 | 4.69 | 95.31 | 0.05 |
| 13 | 1101 | 5.08 | 94.92 | 0.05 |
| 14 | 1110 | 5.47 | 94.53 | 0.06 |
| 15 | 1111 | 5.86 | 94.14 | 0.06 |

| Step | Binary | $R_{HW}$ (kΩ) | $R_{WL}$ (kΩ) | $R_{HW}/R_{WL}$ |
|---|---|---|---|---|
| 16 | 10000 | 6.25 | 93.75 | 0.07 |
| 17 | 10001 | 6.64 | 93.36 | 0.07 |
| 18 | 10010 | 7.03 | 92.97 | 0.08 |
| 19 | 10011 | 7.42 | 92.58 | 0.08 |
| 20 | 10100 | 7.81 | 92.19 | 0.08 |
| 21 | 10101 | 8.20 | 91.80 | 0.09 |
| 22 | 10110 | 8.59 | 91.41 | 0.09 |
| 23 | 10111 | 8.98 | 91.02 | 0.10 |
| 24 | 11000 | 9.38 | 90.63 | 0.10 |
| 25 | 11001 | 9.77 | 90.23 | 0.11 |
| 26 | 11010 | 10.16 | 89.84 | 0.11 |
| 27 | 11011 | 10.55 | 89.45 | 0.12 |
| 28 | 11100 | 10.94 | 89.06 | 0.12 |
| 29 | 11101 | 11.33 | 88.67 | 0.13 |
| 30 | 11110 | 11.72 | 88.28 | 0.13 |
| 31 | 11111 | 12.11 | 87.89 | 0.14 |
| 32 | 100000 | 12.50 | 87.50 | 0.14 |
| 33 | 100001 | 12.89 | 87.11 | 0.15 |
| 34 | 100010 | 13.28 | 86.72 | 0.15 |
| 35 | 100011 | 13.67 | 86.33 | 0.16 |
| 36 | 100100 | 14.06 | 85.94 | 0.16 |
| 37 | 100101 | 14.45 | 85.55 | 0.17 |
| 38 | 100110 | 14.84 | 85.16 | 0.17 |
| 39 | 100111 | 15.23 | 84.77 | 0.18 |
| 40 | 101000 | 15.63 | 84.38 | 0.19 |
| 41 | 101001 | 16.02 | 83.98 | 0.19 |
| 42 | 101010 | 16.41 | 83.59 | 0.20 |
| 43 | 101011 | 16.80 | 83.20 | 0.20 |
| 44 | 101100 | 17.19 | 82.81 | 0.21 |
| 45 | 101101 | 17.58 | 82.42 | 0.21 |
| 46 | 101110 | 17.97 | 82.03 | 0.22 |
| 47 | 101111 | 18.36 | 81.64 | 0.22 |
| 48 | 110000 | 18.75 | 81.25 | 0.23 |
| 49 | 110001 | 19.14 | 80.86 | 0.24 |
| 50 | 110010 | 19.53 | 80.47 | 0.24 |
| 51 | 110011 | 19.92 | 80.08 | 0.25 |
| 52 | 110100 | 20.31 | 79.69 | 0.25 |
| 53 | 110101 | 20.70 | 79.30 | 0.26 |
| 54 | 110110 | 21.09 | 78.91 | 0.27 |
| 55 | 110111 | 21.48 | 78.52 | 0.27 |
| 56 | 111000 | 21.88 | 78.13 | 0.28 |
| 57 | 111001 | 22.27 | 77.73 | 0.29 |
| 58 | 111010 | 22.66 | 77.34 | 0.29 |
| 59 | 111011 | 23.05 | 76.95 | 0.30 |
| 60 | 111100 | 23.44 | 76.56 | 0.31 |
| 61 | 111101 | 23.83 | 76.17 | 0.31 |
| 62 | 111110 | 24.22 | 75.78 | 0.32 |
| 63 | 111111 | 24.61 | 75.39 | 0.33 |
| 64 | 1000000 | 25.00 | 75.00 | 0.33 |

| Step | Binary | $R_{HW}$ (kΩ) | $R_{WL}$ (kΩ) | $R_{HW}/R_{WL}$ |
|---|---|---|---|---|
| 65 | 1000001 | 25.39 | 74.61 | 0.34 |
| 66 | 1000010 | 25.78 | 74.22 | 0.35 |
| 67 | 1000011 | 26.17 | 73.83 | 0.35 |
| 68 | 1000100 | 26.56 | 73.44 | 0.36 |
| 69 | 1000101 | 26.95 | 73.05 | 0.37 |
| 70 | 1000110 | 27.34 | 72.66 | 0.38 |
| 71 | 1000111 | 27.73 | 72.27 | 0.38 |
| 72 | 1001000 | 28.13 | 71.88 | 0.39 |
| 73 | 1001001 | 28.52 | 71.48 | 0.40 |
| 74 | 1001010 | 28.91 | 71.09 | 0.41 |
| 75 | 1001011 | 29.30 | 70.70 | 0.41 |
| 76 | 1001100 | 29.69 | 70.31 | 0.42 |
| 77 | 1001101 | 30.08 | 69.92 | 0.43 |
| 78 | 1001110 | 30.47 | 69.53 | 0.44 |
| 79 | 1001111 | 30.86 | 69.14 | 0.45 |
| 80 | 1010000 | 31.25 | 68.75 | 0.45 |
| 81 | 1010001 | 31.64 | 68.36 | 0.46 |
| 82 | 1010010 | 32.03 | 67.97 | 0.47 |
| 83 | 1010011 | 32.42 | 67.58 | 0.48 |
| 84 | 1010100 | 32.81 | 67.19 | 0.49 |
| 85 | 1010101 | 33.20 | 66.80 | 0.50 |
| 86 | 1010110 | 33.59 | 66.41 | 0.51 |
| 87 | 1010111 | 33.98 | 66.02 | 0.51 |
| 88 | 1011000 | 34.38 | 65.63 | 0.52 |
| 89 | 1011001 | 34.77 | 65.23 | 0.53 |
| 90 | 1011010 | 35.16 | 64.84 | 0.54 |
| 91 | 1011011 | 35.55 | 64.45 | 0.55 |
| 92 | 1011100 | 35.94 | 64.06 | 0.56 |
| 93 | 1011101 | 36.33 | 63.67 | 0.57 |
| 94 | 1011110 | 36.72 | 63.28 | 0.58 |
| 95 | 1011111 | 37.11 | 62.89 | 0.59 |
| 96 | 1100000 | 37.50 | 62.50 | 0.60 |
| 97 | 1100001 | 37.89 | 62.11 | 0.61 |
| 98 | 1100010 | 38.28 | 61.72 | 0.62 |
| 99 | 1100011 | 38.67 | 61.33 | 0.63 |
| 100 | 1100100 | 39.06 | 60.94 | 0.64 |
| 101 | 1100101 | 39.45 | 60.55 | 0.65 |
| 102 | 1100110 | 39.84 | 60.16 | 0.66 |
| 103 | 1100111 | 40.23 | 59.77 | 0.67 |
| 104 | 1101000 | 40.63 | 59.38 | 0.68 |
| 105 | 1101001 | 41.02 | 58.98 | 0.70 |
| 106 | 1101010 | 41.41 | 58.59 | 0.71 |
| 107 | 1101011 | 41.80 | 58.20 | 0.72 |
| 108 | 1101100 | 42.19 | 57.81 | 0.73 |
| 109 | 1101101 | 42.58 | 57.42 | 0.74 |
| 110 | 1101110 | 42.97 | 57.03 | 0.75 |
| 111 | 1101111 | 43.36 | 56.64 | 0.77 |
| 112 | 1110000 | 43.75 | 56.25 | 0.78 |
| 113 | 1110001 | 44.14 | 55.86 | 0.79 |

| Step | Binary | $R_{HW}$ (kΩ) | $R_{WL}$ (kΩ) | $R_{HW}/R_{WL}$ |
|---|---|---|---|---|
| 114 | 1110010 | 44.53 | 55.47 | 0.80 |
| 115 | 1110011 | 44.92 | 55.08 | 0.82 |
| 116 | 1110100 | 45.31 | 54.69 | 0.83 |
| 117 | 1110101 | 45.70 | 54.30 | 0.84 |
| 118 | 1110110 | 46.09 | 53.91 | 0.86 |
| 119 | 1110111 | 46.48 | 53.52 | 0.87 |
| 120 | 1111000 | 46.88 | 53.13 | 0.88 |
| 121 | 1111001 | 47.27 | 52.73 | 0.90 |
| 122 | 1111010 | 47.66 | 52.34 | 0.91 |
| 123 | 1111011 | 48.05 | 51.95 | 0.92 |
| 124 | 1111100 | 48.44 | 51.56 | 0.94 |
| 125 | 1111101 | 48.83 | 51.17 | 0.95 |
| 126 | 1111110 | 49.22 | 50.78 | 0.97 |
| 127 | 1111111 | 49.61 | 50.39 | 0.98 |
| 128 | 10000000 | 50.00 | 50.00 | 1.00 |
| 129 | 10000001 | 50.39 | 49.61 | 1.02 |
| 130 | 10000010 | 50.78 | 49.22 | 1.03 |
| 131 | 10000011 | 51.17 | 48.83 | 1.05 |
| 132 | 10000100 | 51.56 | 48.44 | 1.06 |
| 133 | 10000101 | 51.95 | 48.05 | 1.08 |
| 134 | 10000110 | 52.34 | 47.66 | 1.10 |
| 135 | 10000111 | 52.73 | 47.27 | 1.12 |
| 136 | 10001000 | 53.13 | 46.88 | 1.13 |
| 137 | 10001001 | 53.52 | 46.48 | 1.15 |
| 138 | 10001010 | 53.91 | 46.09 | 1.17 |
| 139 | 10001011 | 54.30 | 45.70 | 1.19 |
| 140 | 10001100 | 54.69 | 45.31 | 1.21 |
| 141 | 10001101 | 55.08 | 44.92 | 1.23 |
| 142 | 10001110 | 55.47 | 44.53 | 1.25 |
| 143 | 10001111 | 55.86 | 44.14 | 1.27 |
| 144 | 10010000 | 56.25 | 43.75 | 1.29 |
| 145 | 10010001 | 56.64 | 43.36 | 1.31 |
| 146 | 10010010 | 57.03 | 42.97 | 1.33 |
| 147 | 10010011 | 57.42 | 42.58 | 1.35 |
| 148 | 10010100 | 57.81 | 42.19 | 1.37 |
| 149 | 10010101 | 58.20 | 41.80 | 1.39 |
| 150 | 10010110 | 58.59 | 41.41 | 1.42 |
| 151 | 10010111 | 58.98 | 41.02 | 1.44 |
| 152 | 10011000 | 59.38 | 40.63 | 1.46 |
| 153 | 10011001 | 59.77 | 40.23 | 1.49 |
| 154 | 10011010 | 60.16 | 39.84 | 1.51 |
| 155 | 10011011 | 60.55 | 39.45 | 1.53 |
| 156 | 10011100 | 60.94 | 39.06 | 1.56 |
| 157 | 10011101 | 61.33 | 38.67 | 1.59 |
| 158 | 10011110 | 61.72 | 38.28 | 1.61 |
| 159 | 10011111 | 62.11 | 37.89 | 1.64 |
| 160 | 10100000 | 62.50 | 37.50 | 1.67 |
| 161 | 10100001 | 62.89 | 37.11 | 1.69 |
| 162 | 10100010 | 63.28 | 36.72 | 1.72 |

| Step | Binary | $R_{HW}$ (kΩ) | $R_{WL}$ (kΩ) | $R_{HW}/R_{WL}$ |
|---|---|---|---|---|
| 163 | 10100011 | 63.67 | 36.33 | 1.75 |
| 164 | 10100100 | 64.06 | 35.94 | 1.78 |
| 165 | 10100101 | 64.45 | 35.55 | 1.81 |
| 166 | 10100110 | 64.84 | 35.16 | 1.84 |
| 167 | 10100111 | 65.23 | 34.77 | 1.88 |
| 168 | 10101000 | 65.63 | 34.38 | 1.91 |
| 169 | 10101001 | 66.02 | 33.98 | 1.94 |
| 170 | 10101010 | 66.41 | 33.59 | 1.98 |
| 171 | 10101011 | 66.80 | 33.20 | 2.01 |
| 172 | 10101100 | 67.19 | 32.81 | 2.05 |
| 173 | 10101101 | 67.58 | 32.42 | 2.08 |
| 174 | 10101110 | 67.97 | 32.03 | 2.12 |
| 175 | 10101111 | 68.36 | 31.64 | 2.16 |
| 176 | 10110000 | 68.75 | 31.25 | 2.20 |
| 177 | 10110001 | 69.14 | 30.86 | 2.24 |
| 178 | 10110010 | 69.53 | 30.47 | 2.28 |
| 179 | 10110011 | 69.92 | 30.08 | 2.32 |
| 180 | 10110100 | 70.31 | 29.69 | 2.37 |
| 181 | 10110101 | 70.70 | 29.30 | 2.41 |
| 182 | 10110110 | 71.09 | 28.91 | 2.46 |
| 183 | 10110111 | 71.48 | 28.52 | 2.51 |
| 184 | 10111000 | 71.88 | 28.13 | 2.56 |
| 185 | 10111001 | 72.27 | 27.73 | 2.61 |
| 186 | 10111010 | 72.66 | 27.34 | 2.66 |
| 187 | 10111011 | 73.05 | 26.95 | 2.71 |
| 188 | 10111100 | 73.44 | 26.56 | 2.76 |
| 189 | 10111101 | 73.83 | 26.17 | 2.82 |
| 190 | 10111110 | 74.22 | 25.78 | 2.88 |
| 191 | 10111111 | 74.61 | 25.39 | 2.94 |
| 192 | 11000000 | 75.00 | 25.00 | 3.00 |
| 193 | 11000001 | 75.39 | 24.61 | 3.06 |
| 194 | 11000010 | 75.78 | 24.22 | 3.13 |
| 195 | 11000011 | 76.17 | 23.83 | 3.20 |
| 196 | 11000100 | 76.56 | 23.44 | 3.27 |
| 197 | 11000101 | 76.95 | 23.05 | 3.34 |
| 198 | 11000110 | 77.34 | 22.66 | 3.41 |
| 199 | 11000111 | 77.73 | 22.27 | 3.49 |
| 200 | 11001000 | 78.13 | 21.88 | 3.57 |
| 201 | 11001001 | 78.52 | 21.48 | 3.65 |
| 202 | 11001010 | 78.91 | 21.09 | 3.74 |
| 203 | 11001011 | 79.30 | 20.70 | 3.83 |
| 204 | 11001100 | 79.69 | 20.31 | 3.92 |
| 205 | 11001101 | 80.08 | 19.92 | 4.02 |
| 206 | 11001110 | 80.47 | 19.53 | 4.12 |
| 207 | 11001111 | 80.86 | 19.14 | 4.22 |
| 208 | 11010000 | 81.25 | 18.75 | 4.33 |
| 209 | 11010001 | 81.64 | 18.36 | 4.45 |
| 210 | 11010010 | 82.03 | 17.97 | 4.57 |
| 211 | 11010011 | 82.42 | 17.58 | 4.69 |

| Step | Binary | $R_{HW}$ (kΩ) | $R_{WL}$ (kΩ) | $R_{HW}/R_{WL}$ |
|---|---|---|---|---|
| 212 | 11010100 | 82.81 | 17.19 | 4.82 |
| 213 | 11010101 | 83.20 | 16.80 | 4.95 |
| 214 | 11010110 | 83.59 | 16.41 | 5.10 |
| 215 | 11010111 | 83.98 | 16.02 | 5.24 |
| 216 | 11011000 | 84.38 | 15.63 | 5.40 |
| 217 | 11011001 | 84.77 | 15.23 | 5.56 |
| 218 | 11011010 | 85.16 | 14.84 | 5.74 |
| 219 | 11011011 | 85.55 | 14.45 | 5.92 |
| 220 | 11011100 | 85.94 | 14.06 | 6.11 |
| 221 | 11011101 | 86.33 | 13.67 | 6.31 |
| 222 | 11011110 | 86.72 | 13.28 | 6.53 |
| 223 | 11011111 | 87.11 | 12.89 | 6.76 |
| 224 | 11100000 | 87.50 | 12.50 | 7.00 |
| 225 | 11100001 | 87.89 | 12.11 | 7.26 |
| 226 | 11100010 | 88.28 | 11.72 | 7.53 |
| 227 | 11100011 | 88.67 | 11.33 | 7.83 |
| 228 | 11100100 | 89.06 | 10.94 | 8.14 |
| 229 | 11100101 | 89.45 | 10.55 | 8.48 |
| 230 | 11100110 | 89.84 | 10.16 | 8.85 |
| 231 | 11100111 | 90.23 | 9.77 | 9.24 |
| 232 | 11101000 | 90.63 | 9.38 | 9.67 |
| 233 | 11101001 | 91.02 | 8.98 | 10.13 |
| 234 | 11101010 | 91.41 | 8.59 | 10.64 |
| 235 | 11101011 | 91.80 | 8.20 | 11.19 |
| 236 | 11101100 | 92.19 | 7.81 | 11.80 |
| 237 | 11101101 | 92.58 | 7.42 | 12.47 |
| 238 | 11101110 | 92.97 | 7.03 | 13.22 |
| 239 | 11101111 | 93.36 | 6.64 | 14.06 |
| 240 | 11110000 | 93.75 | 6.25 | 15.00 |
| 241 | 11110001 | 94.14 | 5.86 | 16.07 |
| 242 | 11110010 | 94.53 | 5.47 | 17.29 |
| 243 | 11110011 | 94.92 | 5.08 | 18.69 |
| 244 | 11110100 | 95.31 | 4.69 | 20.33 |
| 245 | 11110101 | 95.70 | 4.30 | 22.27 |
| 246 | 11110110 | 96.09 | 3.91 | 24.60 |
| 247 | 11110111 | 96.48 | 3.52 | 27.44 |
| 248 | 11111000 | 96.88 | 3.13 | 31.00 |
| 249 | 11111001 | 97.27 | 2.73 | 35.57 |
| 250 | 11111010 | 97.66 | 2.34 | 41.67 |
| 251 | 11111011 | 98.05 | 1.95 | 50.20 |
| 252 | 11111100 | 98.44 | 1.56 | 63.00 |
| 253 | 11111101 | 98.83 | 1.17 | 84.33 |
| 254 | 11111110 | 99.22 | 0.78 | 127.00 |
| 255 | 11111111 | 99.61 | 0.3 | 255.00 |

## REVISION HISTORY

| Changes from Revision A (March 2011) to Revision B | Page |
|---|---|
| • Added RECOMMENDED OPERATING CONDITONS table. | 5 |
| • Added IDEAL RESISTANCE VALUES section. | 16 |

## PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/ Ball Finish | MSL Peak Temp (3) | Samples (Requires Login) |
|---|---|---|---|---|---|---|---|---|---|
| TPL0102-100PWR | ACTIVE | TSSOP | PW | 14 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |
| TPL0102-100RUCR | ACTIVE | QFN | RUC | 14 | 3000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | |

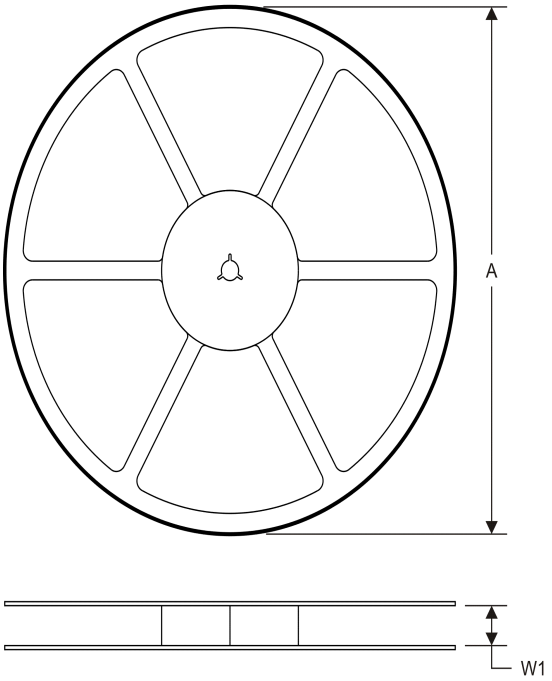
(1) The marketing status values are defined as follows:
**ACTIVE:** Product device recommended for new designs.
**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
**NRND:** Not recommended for new designs. Device is in production to support existing 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) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
**TBD:** The Pb-Free/Green conversion plan has not been defined.
**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

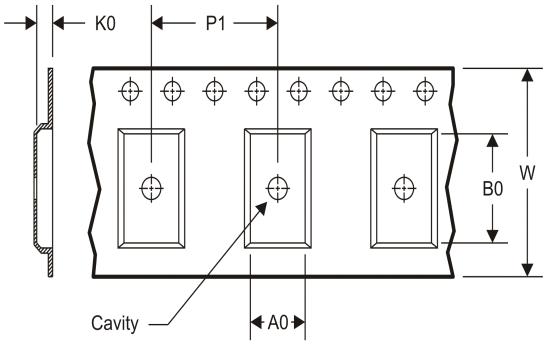
(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

## TAPE AND REEL INFORMATION

**REEL DIMENSIONS**




**TAPE DIMENSIONS**



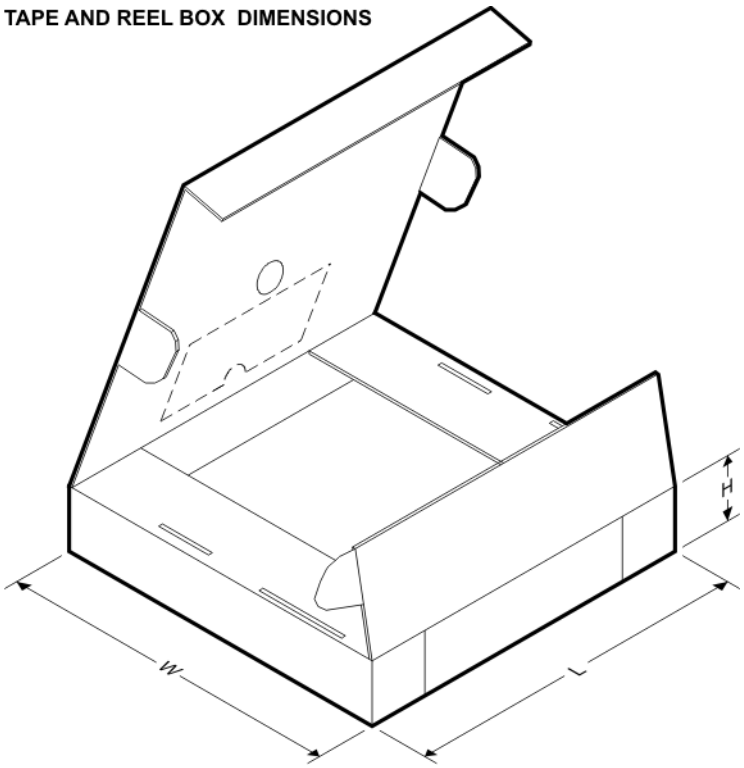

| | |
|---|---|
| A0 | Dimension designed to accommodate the component width |
| B0 | Dimension designed to accommodate the component length |
| K0 | Dimension designed to accommodate the component thickness |
| W | Overall width of the carrier tape |
| P1 | Pitch between successive cavity centers |

**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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TPL0102-100PWR | TSSOP | PW | 14 | 2000 | 330.0 | 12.4 | 6.9 | 5.6 | 1.6 | 8.0 | 12.0 | Q1 |
| TPL0102-100RUCR | QFN | RUC | 14 | 3000 | 180.0 | 8.4 | 2.3 | 2.3 | 0.55 | 4.0 | 8.0 | Q2 |

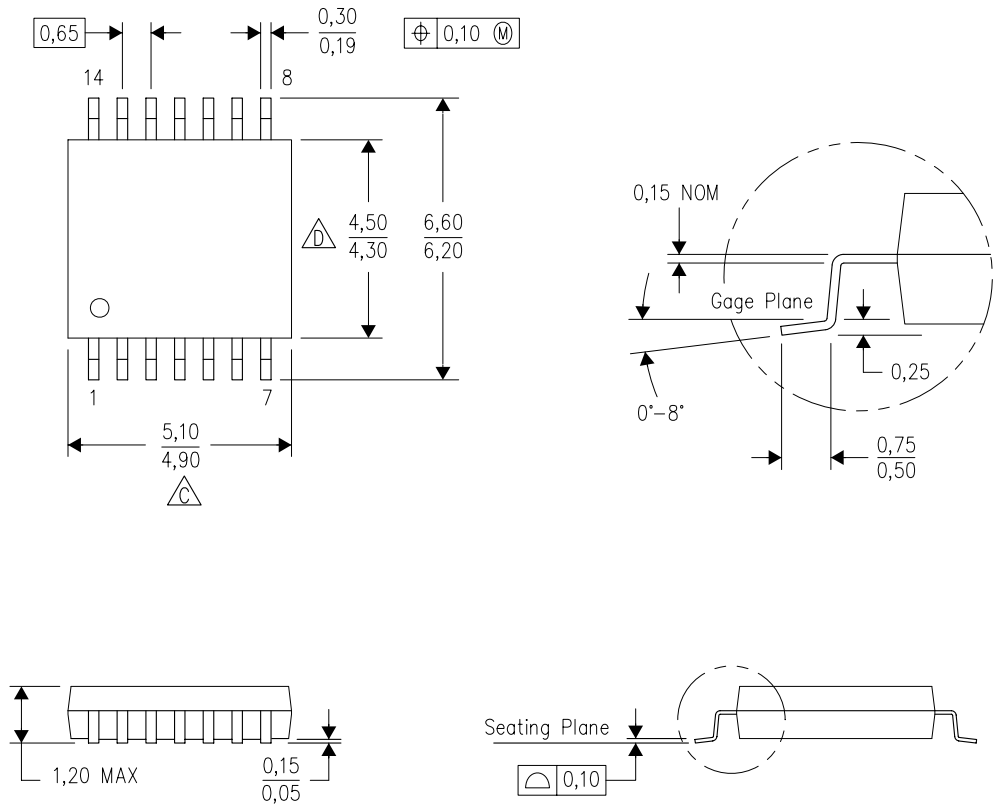
TAPE AND REEL BOX DIMENSIONS




*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---|---|---|---|---|---|---|---|
| TPL0102-100PWR | TSSOP | PW | 14 | 2000 | 367.0 | 367.0 | 35.0 |
| TPL0102-100RUCR | QFN | RUC | 14 | 3000 | 202.0 | 201.0 | 28.0 |

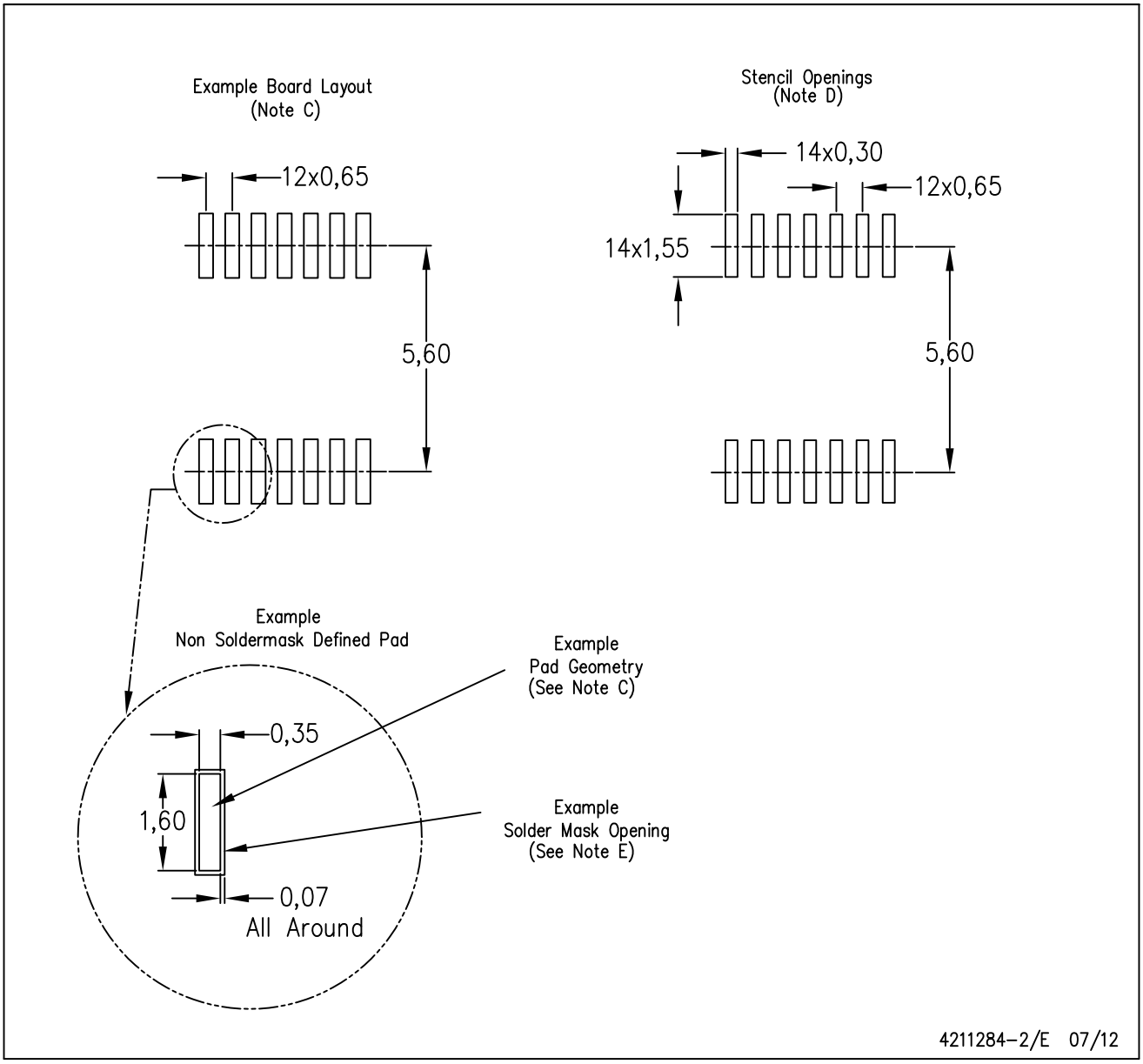
PW (R–PDSO–G14) PLASTIC SMALL OUTLINE




4040064–3/G 02/11

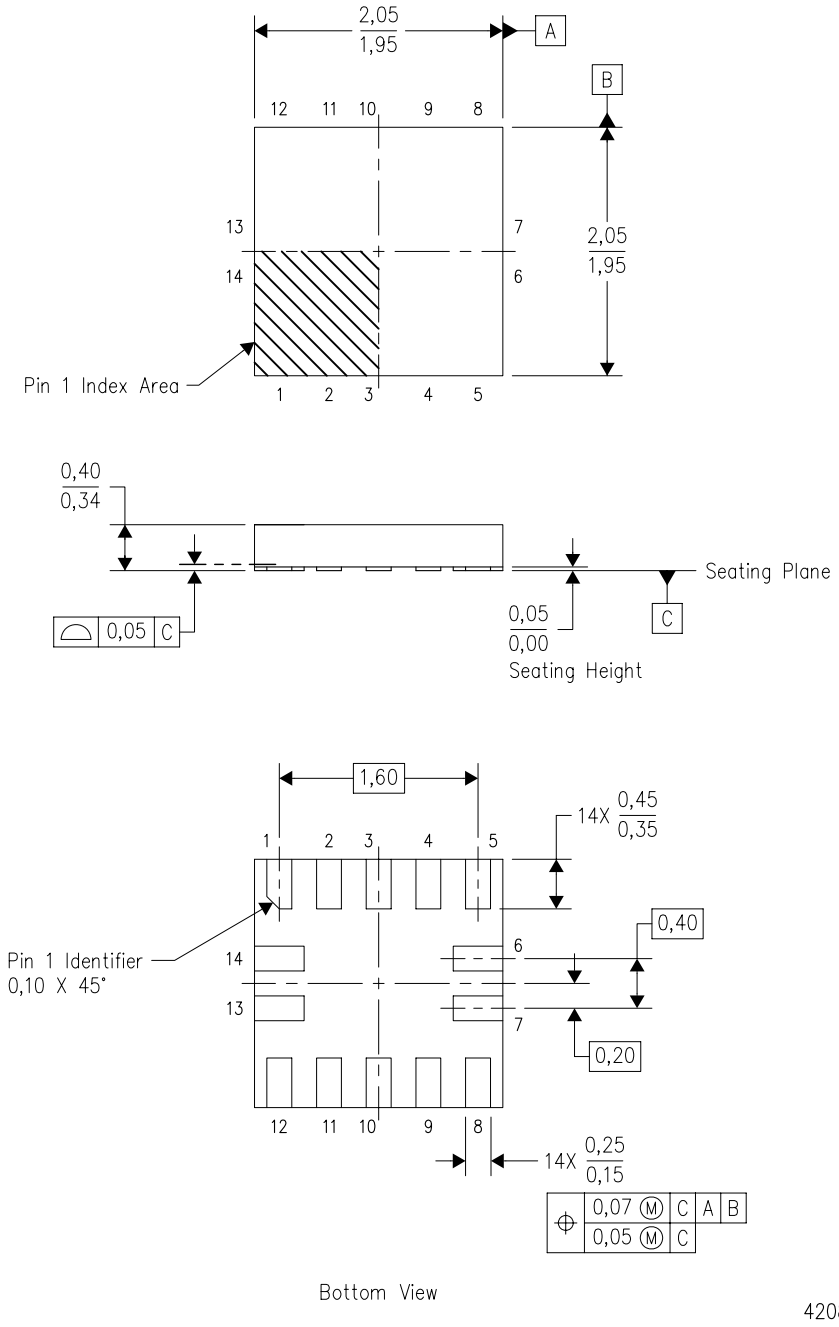
NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0,15 each side.
D. Body width does not include interlead flash. Interlead flash shall not exceed 0,25 each side.
E. Falls within JEDEC MO–153

PW (R–PDSO–G14) PLASTIC SMALL OUTLINE




NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC–7351 is recommended for alternate designs.
D. 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.
E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

RUC (S–PX2QFN–N14) PLASTIC QUAD FLATPACK NO–LEAD

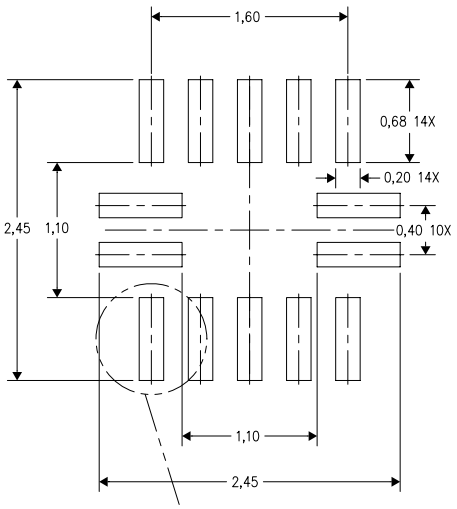



4208447/C 08/2008

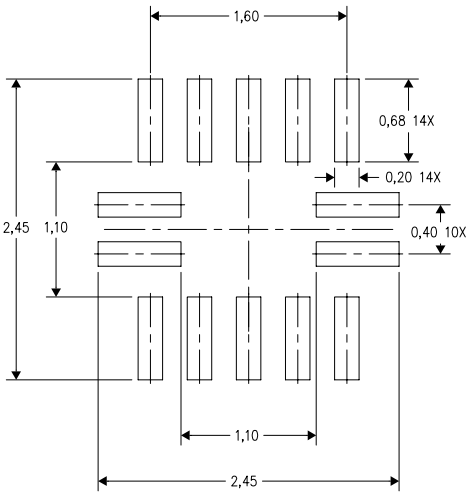
NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. QFN (Quad Flatpack No–lead) package configuration.
D. This package complies to JEDEC MO–288 variation X2GFE.

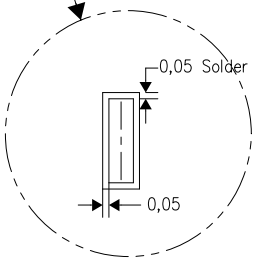
RUC (S–PX2QFN–N14) PLASTIC QUAD FLATPACK NO–LEAD

Example Board Layout




Example Stencil Design
(Note E)




Note D

4211124/A 06/10

NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Publication IPC–7351 is recommended for alternate designs.
D. Customers should contact their board fabrication site for minimum solder mask web tolerances between signal pads.
E. Maximum stencil thickness 0,127 mm (5 mils). All linear dimensions are in millimeters.
F. 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 stencil design considerations.
G. Side aperture dimensions over–print land for acceptable area ratio > 0.66. Customer may reduce side aperture dimensions if stencil manufacturing process allows for sufficient release at smaller opening.

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