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# PS9309L, PS9309L2

R08DS0047EJ0100

Rev.1.00

Mar 28, 2014

LOW IF TOTEM POLE OUTPUT TYPE HIGH CMR, IPM DRIVER, 6-PIN SDIP PHOTOCOUPLER

## DESCRIPTION

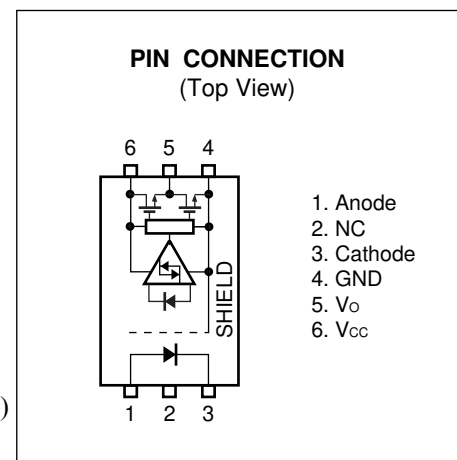
The PS9309L and PS9309L2 are optical coupled high-speed, totem pole output (active high output type) isolators containing a GaAlAs LED on the input side and a photodiode and a signal processing circuit on the output side on one chip.

The PS9309L and PS9309L2 are specified high CMR and pulse width distortion with operating temperature. It is suitable for IPM (Intelligent Power Module) drive.

The PS9309L is lead bending type (Gull-wing) for surface mounting. The PS9309L2 is lead bending type for long creepage distance (Gull-wing) for surface mount.

## FEATURES

- Totem pole output (Active High Output Type)
- Pulse width distortion ( $t_{PLH} - t_{PHL} = 80 \text{ ns MAX.}$ )
- High common mode transient immunity ( $CM_H, CM_L = \pm 15 \text{ kV}/\mu\text{s MIN.}$ )
- Half size of 8-pin DIP
- <R> • Long creepage distance (8 mm MIN.: PS9309L2)
- High isolation voltage ( $BV = 5\,000 \text{ Vr.m.s.}$ )
- Embossed tape product : PS9309L-E3, PS9309L2-E3: 2 000 pcs/reel
- Pb-Free product
- Safety standards
  - UL approved: No. E72422
  - CSA approved: No. CA 101391 (CA5A, CAN/CSA-C22.2 60065, 60950)
- <R> • SEMKO approved (EN 60065, EN 60950)
- <R> • DIN EN 60747-5-5 (VDE 0884-5) approved (Option)



## APPLICATIONS

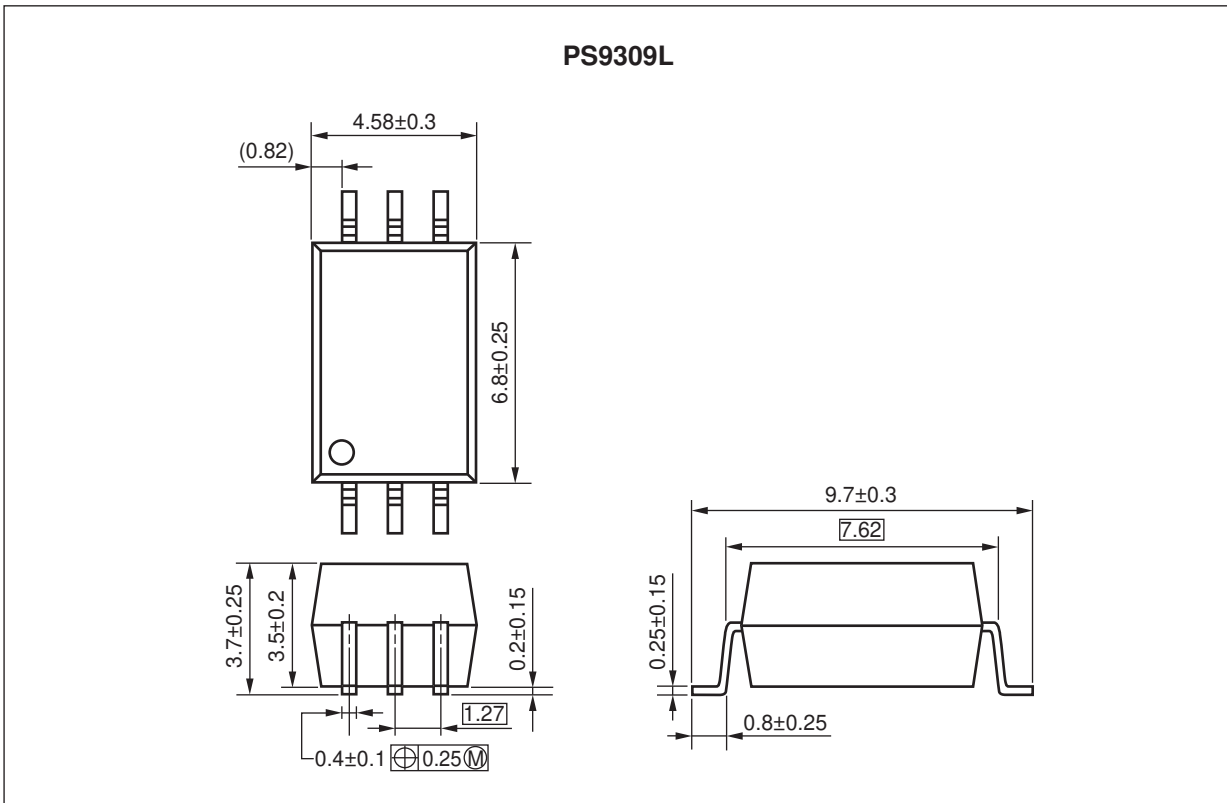
- IPM Driver
- General purpose inverter

The mark <R> shows major revised points.

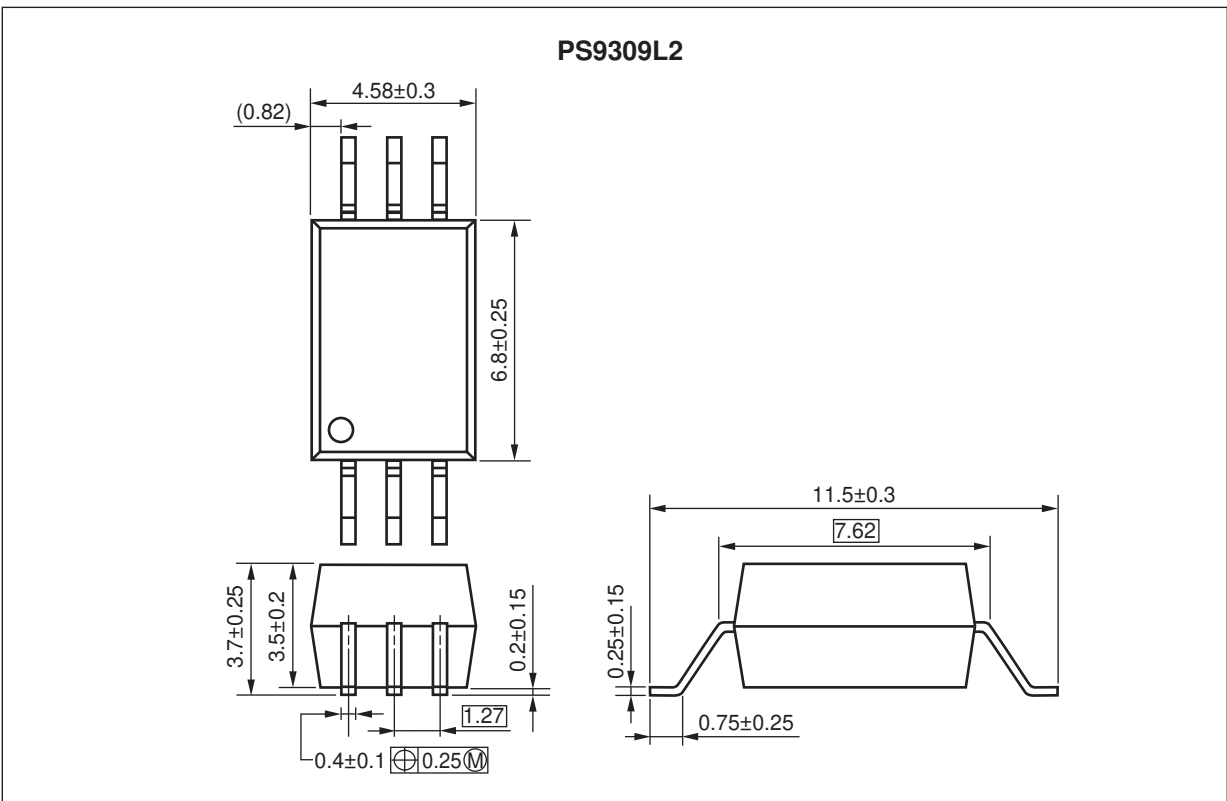
The revised points can be easily searched by copying an "<R>" in the PDF file and specifying it in the "Find what:" field.

**PACKAGE DIMENSIONS (UNIT: mm)**

**Lead Bending Type (Gull-wing) For Surface Mount**



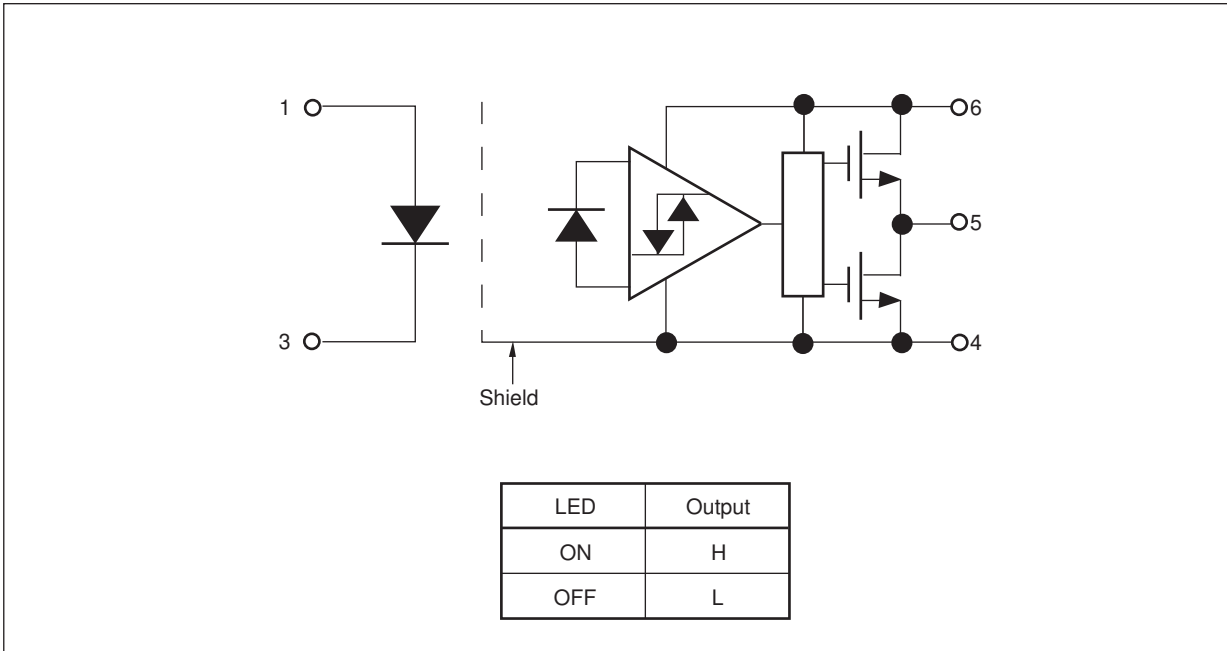
**Lead Bending Type (Gull-wing) For Long Creepage Distance (Surface Mount)**



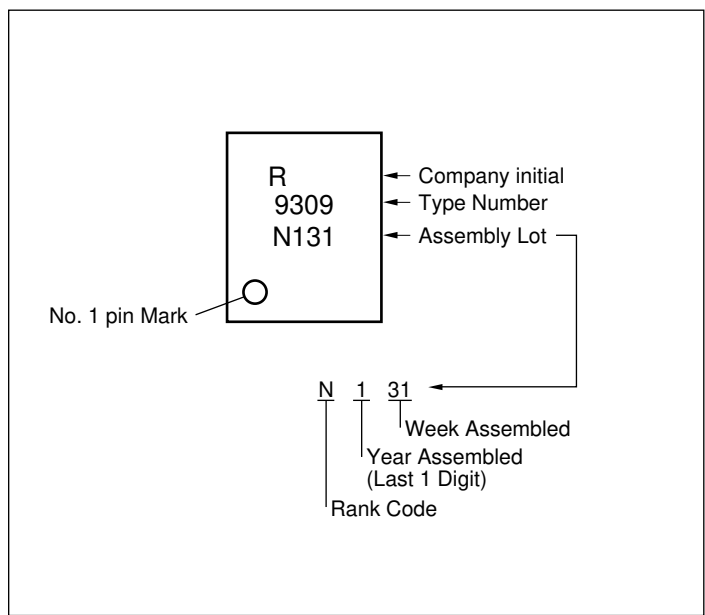
### PHOTOCOUPLER CONSTRUCTION

| Parameter                      | PS9309L | PS9309L2 |
|--------------------------------|---------|----------|
| Air Distance (MIN.)            | 7 mm    | 8 mm     |
| Outer Creepage Distance (MIN.) | 7 mm    | 8 mm     |
| Isolation Distance (MIN.)      | 0.4 mm  | 0.4 mm   |

### BLOCK DIAGRAM



### MARKING EXAMPLE



## &lt;R&gt; ORDERING INFORMATION

| Part Number   | Order Number     | Solder Plating Specification | Packing Style                | Safety Standard Approval                                       | Application Part Number <sup>*1</sup> |          |
|---------------|------------------|------------------------------|------------------------------|--|---------------------------------------|----------|
| PS9309L       | PS9309L-AX       | Pb-Free<br>(Ni/Pd/Au)        | 20 pcs (Tape 20 pcs cut)     | Standard products<br>(UL, CSA, SEMKO approved)                 | PS9309L                               |          |
| PS9309L-E3    | PS9309L-E3-AX    |                              | Embossed Tape 2 000 pcs/reel |  |                                       |          |
| PS9309L2      | PS9309L2-AX      |                              | 20 pcs (Tape 20 pcs cut)     |  | PS9309L2                              |          |
| PS9309L2-E3   | PS9309L2-E3-AX   |                              | Embossed Tape 2 000 pcs/reel |  |                                       |          |
| PS9309L-V     | PS9309L-V-AX     |                              | 20 pcs (Tape 20 pcs cut)     | UL, CSA, SEMKO<br>DIN EN 60747-5-5<br>(VDE 0884-5)<br>approved | PS9309L                               |          |
| PS9309L-V-E3  | PS9309L-V-E3-AX  |                              | Embossed Tape 2 000 pcs/reel |  |                                       |          |
| PS9309L2-V    | PS9309L2-V-AX    |                              | 20 pcs (Tape 20 pcs cut)     |  |                                       | PS9309L2 |
| PS9309L2-V-E3 | PS9309L2-V-E3-AX |                              | Embossed Tape 2 000 pcs/reel |  |                                       |          |

Note: \*1. For the application of the Safety Standard, following part number should be used.

**ABSOLUTE MAXIMUM RATINGS (T<sub>A</sub> = 25°C, unless otherwise specified)**

| Parameter                       |                                 | Symbol           | Ratings     | Unit    |
|---------------------------------|---------------------------------|------------------|-------------|---------|
| Diode                           | Forward Current* <sup>1</sup>   | I <sub>F</sub>   | 20          | mA      |
|                                 | Reverse Voltage                 | V <sub>R</sub>   | 5           | V       |
| Detector                        | Supply Voltage                  | V <sub>CC</sub>  | -0.5 to +25 | V       |
|                                 | Output Voltage                  | V <sub>O</sub>   | -0.5 to +25 | V       |
|                                 | Output Current                  | I <sub>O</sub>   | 25          | mA      |
|                                 | Power Dissipation* <sup>2</sup> | P <sub>C</sub>   | 210         | mW      |
| Isolation Voltage* <sup>3</sup> |                                 | BV               | 5 000       | Vr.m.s. |
| Operating Ambient Temperature   |                                 | T <sub>A</sub>   | -40 to +110 | °C      |
| Storage Temperature             |                                 | T <sub>stg</sub> | -55 to +125 | °C      |

Notes: \*1. Reduced to 0.32 mA/°C at T<sub>A</sub> = 70°C or more.

\*2. Reduced to 3.75 mW/°C at T<sub>A</sub> = 70°C or more

\*3. AC voltage for 1 minute at T<sub>A</sub> = 25°C, RH = 60% between input and output.

Pins 1-3 shorted together, 4-6 shorted together.

**RECOMMENDED OPERATING CONDITIONS**

| Parameter             | Symbol               | MIN. | TYP. | MAX. | Unit |
|-----------------------|----------------------|------|------|------|------|
| Supply Voltage        | V <sub>CC</sub>      | 4.5  | 15   | 20   | V    |
| Output Voltage        | V <sub>O</sub>       | 0    |      | 20   | V    |
| Forward Current (ON)  | I <sub>F (ON)</sub>  | 4    |      | 10   | mA   |
| Forward Voltage (OFF) | V <sub>F (OFF)</sub> | 0    |      | 0.8  | V    |

**ELECTRICAL CHARACTERISTICS****( $T_A = -40$  to  $+110^\circ\text{C}$ ,  $V_{CC} = 4.5$  to  $20$  V, unless otherwise specified)**

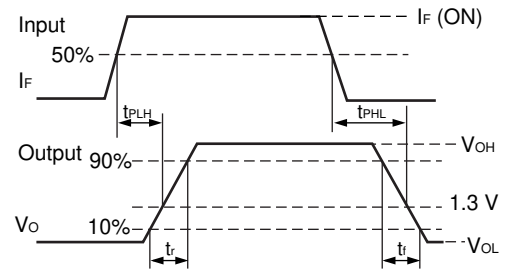
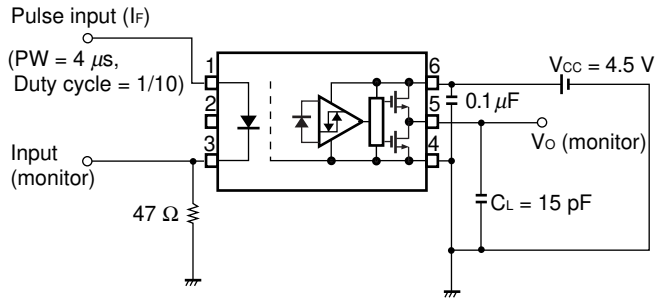
| Parameter   |   | Symbol                              | Conditions  | MIN.      | TYP.* <sup>1</sup> | MAX. | Unit              |
|---|---|-------------------------------------|---|-----------|--------------------|------|-------------------|
| Diode   | Forward Voltage   | $V_F$                               | $I_F = 10$ mA, $T_A = 25^\circ\text{C}$   | 1.3       | 1.55               | 1.8  | V                 |
|   | Reverse Current   | $I_R$                               | $V_R = 3$ V, $T_A = 25^\circ\text{C}$   |           |                    | 10   | $\mu\text{A}$     |
|   | Input Capacitance   | $C_t$                               | $V_F = 0$ V, $f = 1$ MHz,<br>$T_A = 25^\circ\text{C}$                           |           | 30                 |      | pF                |
| Detector  | High Level Output Voltage   | $V_{OH}$                            | $V_{CC} = 4.5$ V, $I_O = -2.6$ mA,<br>$I_F = 4$ mA                              | 2.7       | 3.2                |      | V                 |
|   |   |                                     | $V_{CC} = 20$ V, $I_O = -2.6$ mA,<br>$I_F = 4$ mA                               | 17.4      | 18.6               |      |                   |
|   | Low Level Output Voltage* <sup>2</sup>                                  | $V_{OL}$                            | $I_O = 3.5$ mA, $I_F = 0$ mA  |           | 0.25               | 0.6  | V                 |
|   | High Level Supply Current   | $I_{CCH}$                           | $V_{CC} = 4.5$ V, $I_F = 4$ mA  |           | 0.98               | 3    | mA                |
|   |   |                                     | $V_{CC} = 20$ V, $I_F = 4$ mA   |           | 1.32               | 3    |                   |
|   | Low Level Supply Current  | $I_{CCL}$                           | $V_{CC} = 4.5$ V, $I_F = 0$ mA  |           | 1.23               | 3    | mA                |
|   |   |                                     | $V_{CC} = 20$ V, $I_F = 0$ mA   |           | 1.53               | 3    |                   |
|   | High Level Output Short* <sup>3</sup><br>Circuit Current                | $I_{OSH}$                           | $V_{CC} = 4.5$ V, $V_O = \text{GND}$ ,<br>$I_F = 4$ mA                          | -7        | -45                |      | mA                |
| Low Level Output Short* <sup>3</sup><br>Circuit Current | $I_{OSL}$   | $V_{CC} = V_O = 4.5$ V, $V_F = 0$ V | 7   | 34        |                    | mA   |                   |
| Coupled   | Threshold Input Current   | $I_{FLH}$                           | $V_{CC} = 4.5$ V, $V_O > 2.7$ V,<br>$I_O = -2.6$ mA                             |           | 1.57               | 3    | mA                |
|   | Isolation Resistance  | $R_{I-O}$                           | $V_{I-O} = 1$ kV <sub>DC</sub> , RH = 60%,<br>$T_A = 25^\circ\text{C}$          | $10^{11}$ |                    |      | $\Omega$          |
|   | Isolation Capacitance   | $C_{I-O}$                           | $V = 0$ V, $f = 1$ MHz,<br>$T_A = 25^\circ\text{C}$                             |           | 0.6                |      | pF                |
|   | Propagation Delay Time<br>(H $\rightarrow$ L)* <sup>4</sup>             | $t_{PHL}$                           | $C_L = 15$ pF,<br>$I_F = 4 \rightarrow 0$ mA, $V_{THHL} = 1.3$ V                |           | 124                | 200  | ns                |
|   | Propagation Delay Time<br>(L $\rightarrow$ H)* <sup>4</sup>             | $t_{PLH}$                           | $C_L = 15$ pF,<br>$I_F = 0 \rightarrow 4$ mA, $V_{THLH} = 1.3$ V                |           | 113                | 200  | ns                |
|   | Pulse Width Distortion<br>(PWD)   | $ t_{PLH} - t_{PHL} $               | $C_L = 15$ pF,<br>$I_F = 4 \leftrightarrow 0$ mA                                |           | 11                 | 80   | ns                |
|   | Maximum Propagation<br>Delays (PDD)                                     |                                     |   |           |                    | 80   |                   |
|   | Rise Time (10-90%)* <sup>4</sup>  | $t_r$                               | $C_L = 15$ pF,<br>$I_F = 0 \rightarrow 4$ mA                                    |           | 24                 |      | ns                |
|   | Fall Time (90-10%)* <sup>4</sup>  | $t_f$                               | $C_L = 15$ pF,<br>$I_F = 4 \rightarrow 0$ mA                                    |           | 3.2                |      | ns                |
|   | Common Mode<br>Transient Immunity at High<br>Level Output* <sup>5</sup> | $CM_H$                              | $V_{CC} = 5$ V, $T_A = 25^\circ\text{C}$ ,<br>$I_F = 4$ mA, $ V_{CM}  = 1.0$ kV | 15        |                    |      | kV/ $\mu\text{s}$ |
|   | Common Mode<br>Transient Immunity at Low<br>Level Output* <sup>5</sup>  | $CM_L$                              | $V_{CC} = 5$ V, $T_A = 25^\circ\text{C}$ ,<br>$I_F = 0$ mA, $ V_{CM}  = 1.0$ kV | 15        |                    |      | kV/ $\mu\text{s}$ |

Notes: \*1. Typical values at  $T_A = 25^\circ\text{C}$ 

\*2. Because  $V_O$  of 2.4 V may be output when the LED current is not input and when output supply of  $V_{CC} = 4.5$  V or less, it is important to confirm the characteristics (operation with the power supply on and off) during design, before using this device.

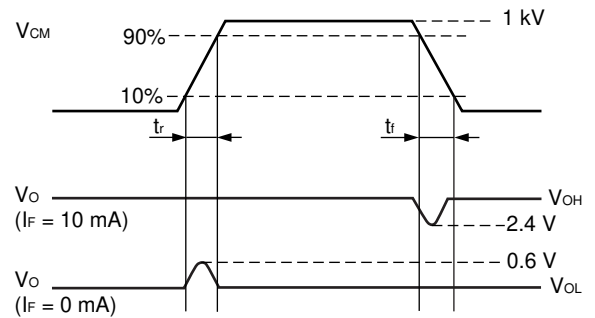
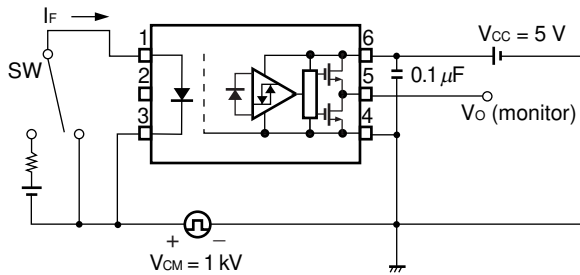
\*3. Duration of output short circuit time should not exceed 10 ms.

\*4. Test circuit for propagation delay time



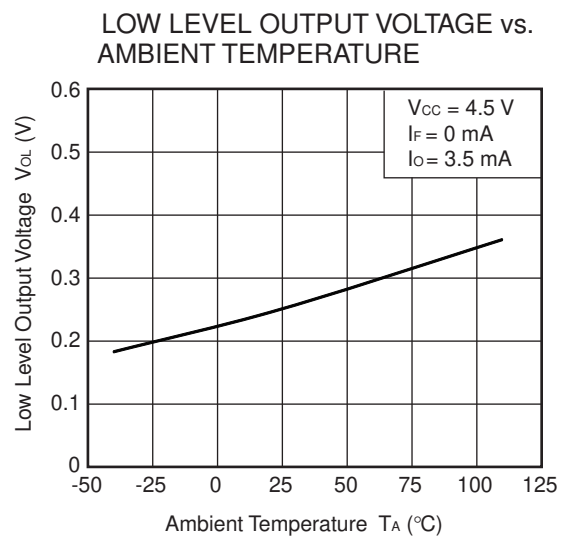
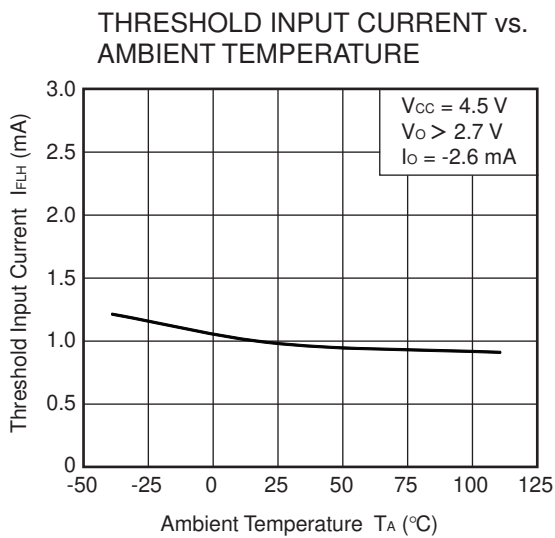
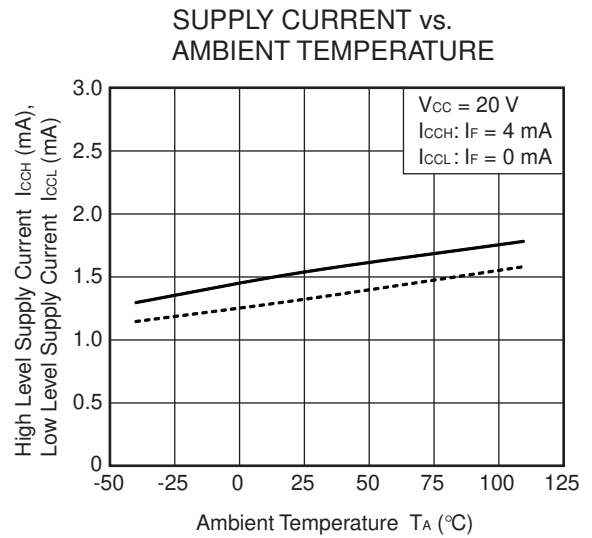
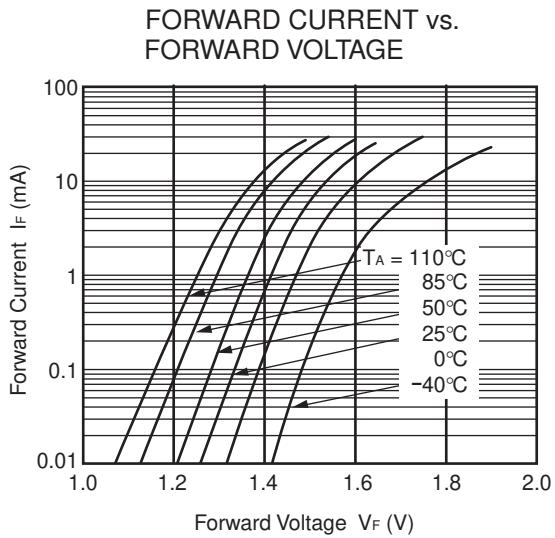
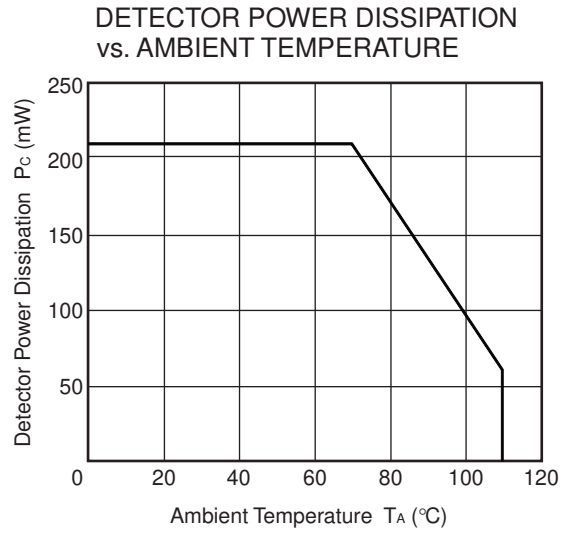
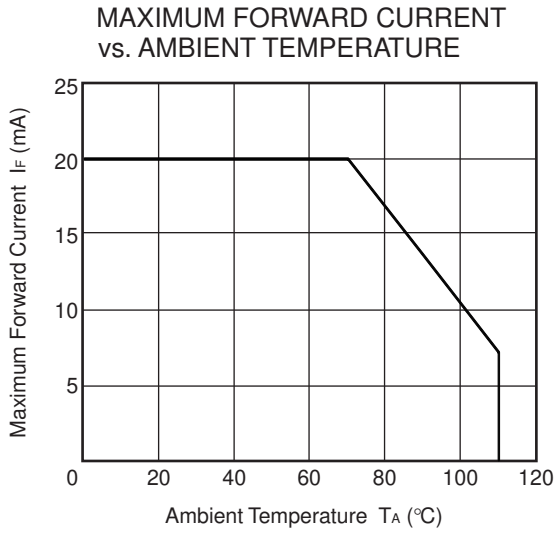
**Remark**  $C_L$  includes probe and stray wiring capacitance.

\*5. Test circuit for common mode transient immunity



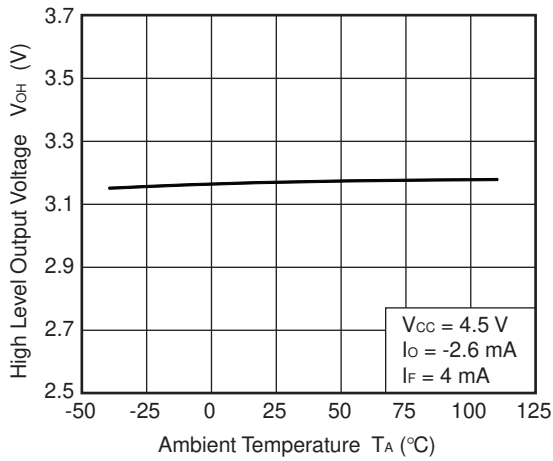
**Remark**  $C_L$  includes probe and stray wiring capacitance.

<R> TYPICAL CHARACTERISTICS ( $T_A = 25^\circ\text{C}$ , unless otherwise specified)

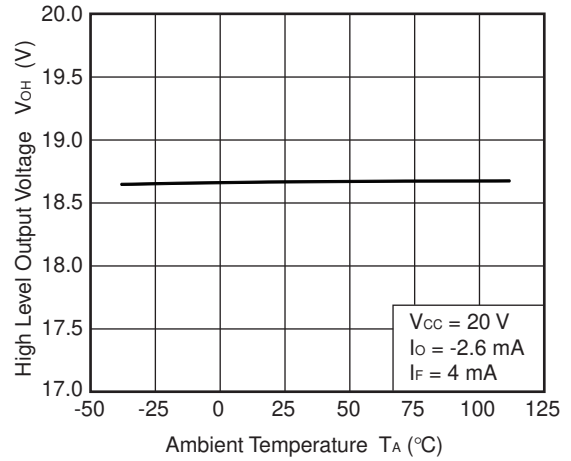


**Remark** The graphs indicate nominal characteristics.

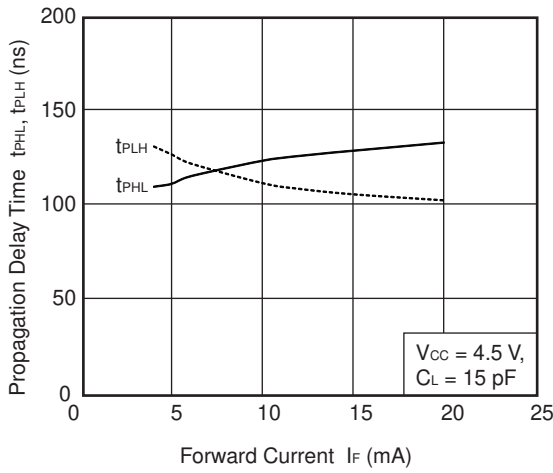
HIGH LEVEL OUTPUT VOLTAGE vs. AMBIENT TEMPERATURE



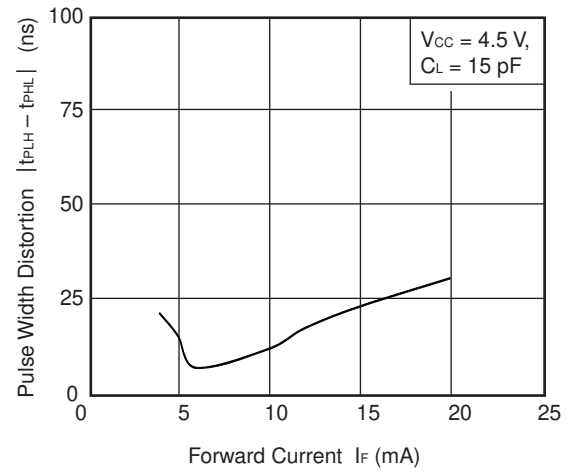
HIGH LEVEL OUTPUT VOLTAGE vs. AMBIENT TEMPERATURE



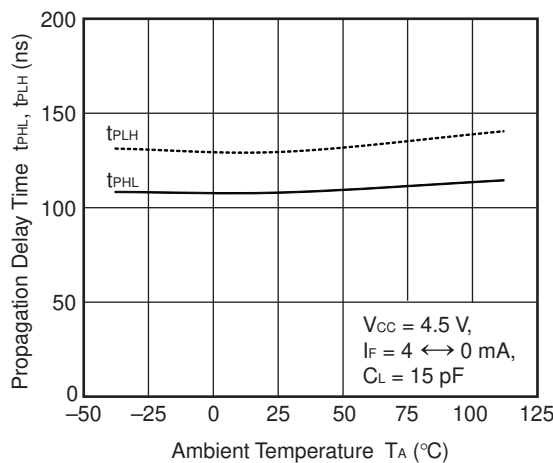
PROPAGATION DELAY TIME vs. FORWARD CURRENT



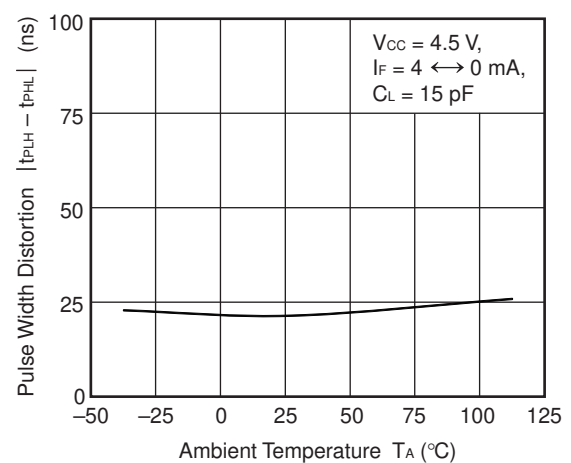
PULSE WIDTH DISTORTION vs. FORWARD CURRENT



PROPAGATION DELAY TIME vs. AMBIENT TEMPERATURE

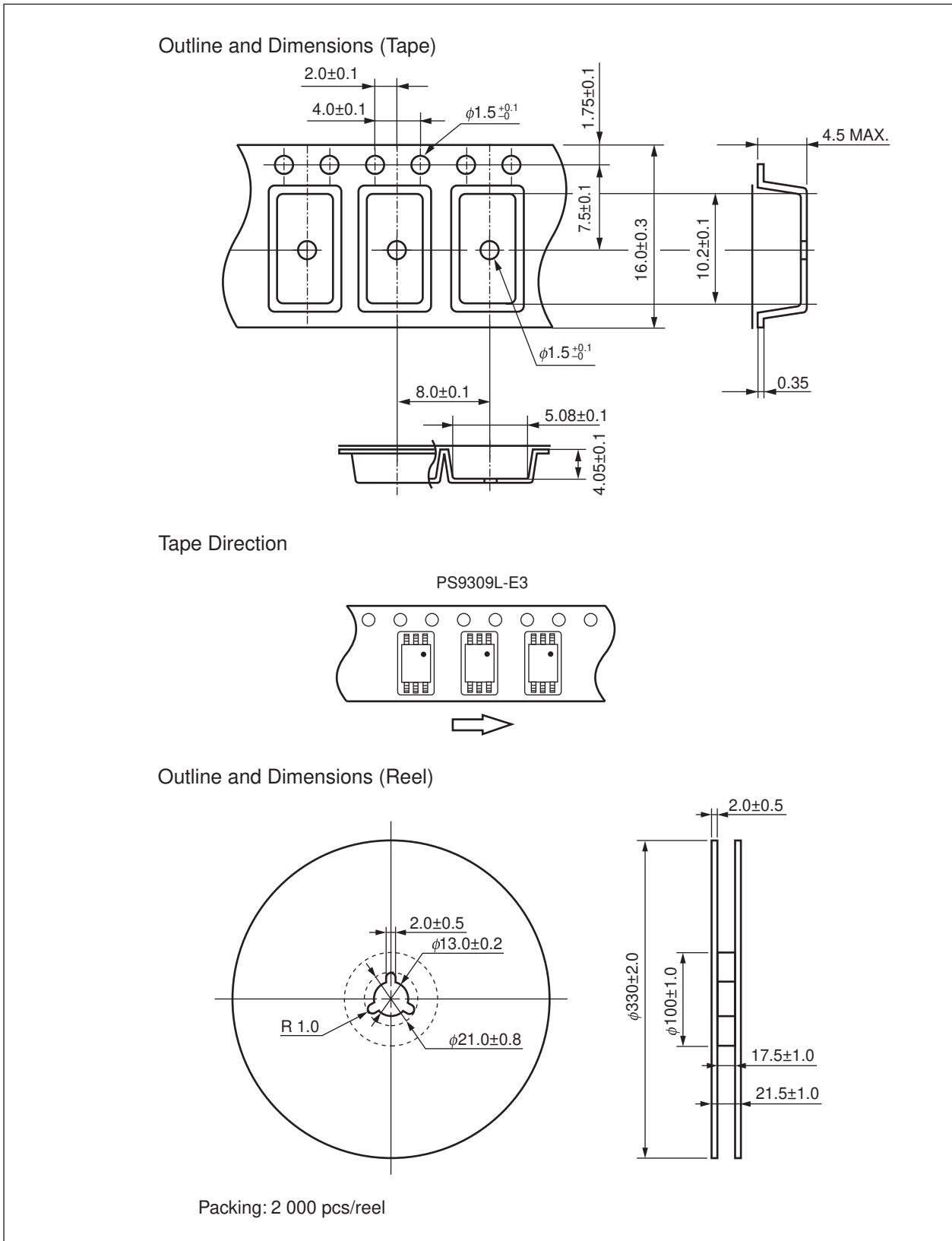


PULSE WIDTH DISTORTION vs. AMBIENT TEMPERATURE

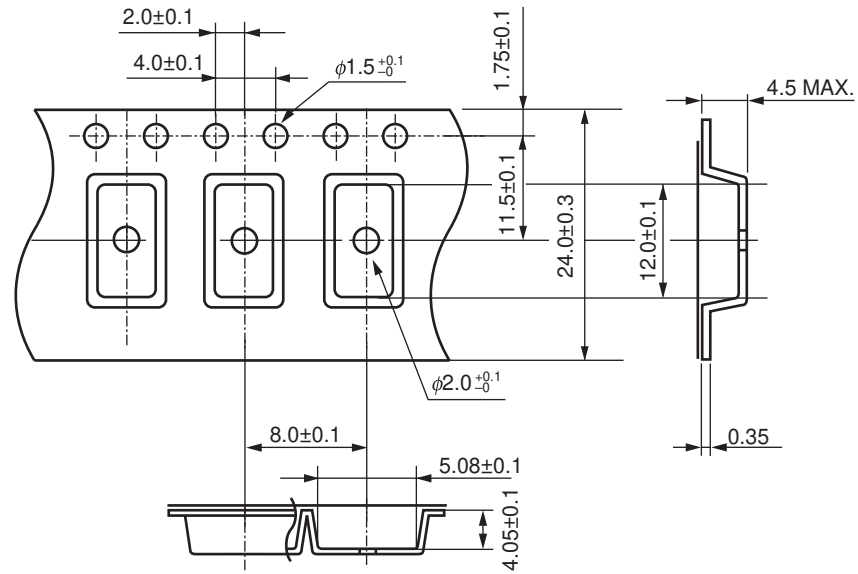


**Remark** The graphs indicate nominal characteristics.

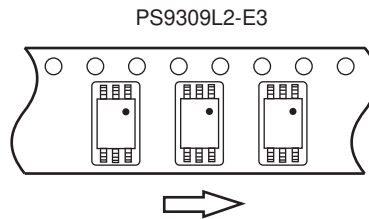
<R> TAPING SPECIFICATIONS (UNIT: mm)



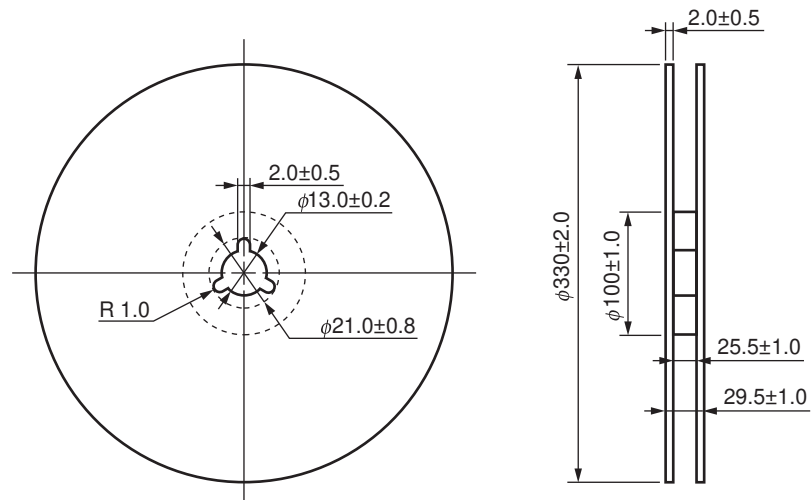
Outline and Dimensions (Tape)



Tape Direction

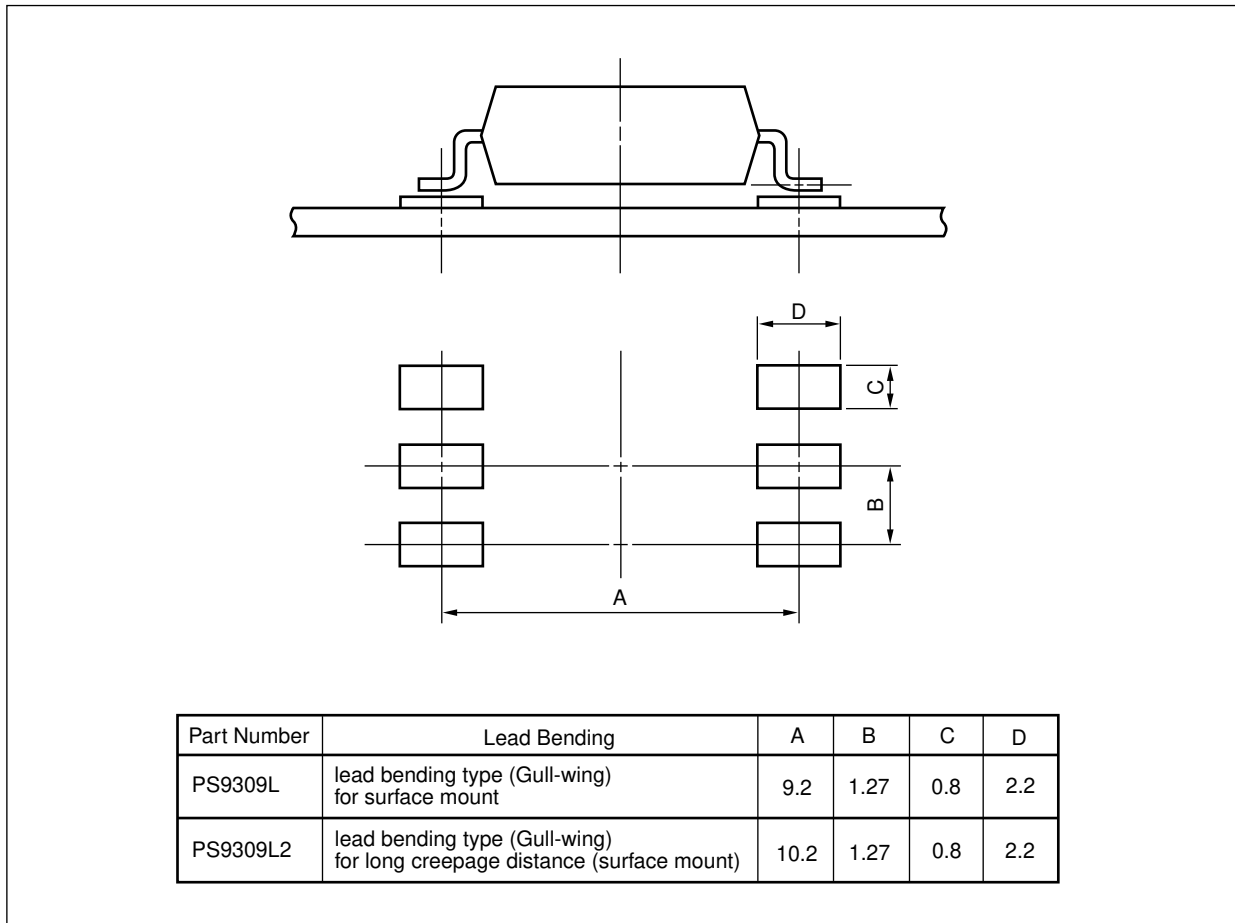


Outline and Dimensions (Reel)



Packing: 2 000 pcs/reel

**RECOMMENDED MOUNT PAD DIMENSIONS (UNIT: mm)**



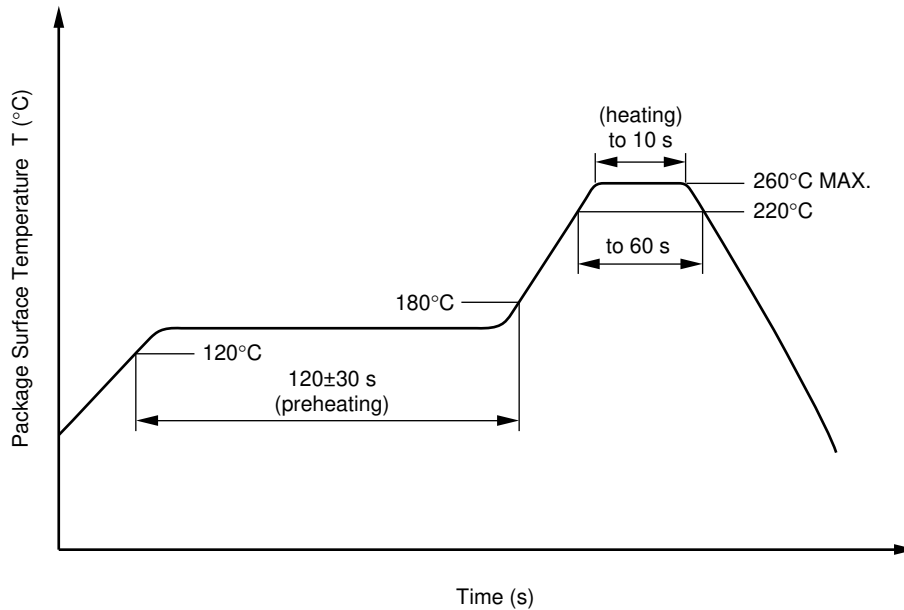
<R> **NOTES ON HANDLING (UNIT: mm)**

## 1. Recommended soldering conditions

## (1) Infrared reflow soldering

- Peak reflow temperature 260°C or below (package surface temperature)
- Time of peak reflow temperature 10 seconds or less
- Time of temperature higher than 220°C 60 seconds or less
- Time to preheat temperature from 120 to 180°C 120 ± 30 s
- Number of reflows Three
- Flux Rosin flux containing small amount of chlorine (The flux with a maximum chlorine content of 0.2 Wt% is recommended.)

Recommended Temperature Profile of Infrared Reflow



## (2) Wave soldering

- Temperature 260°C or below (molten solder temperature)
- Time 10 seconds or less
- Preheating conditions 120°C or below (package surface temperature)
- Number of times One (Allowed to be dipped in solder including plastic mold portion.)
- Flux Rosin flux containing small amount of chlorine (The flux with a maximum chlorine content of 0.2 Wt% is recommended.)

## (3) Soldering by Soldering Iron

- Peak Temperature (lead part temperature) 350°C or below
- Time (each pins) 3 seconds or less
- Flux Rosin flux containing small amount of chlorine (The flux with a maximum chlorine content of 0.2 Wt% is recommended.)

(a) Soldering of leads should be made at the point 1.5 to 2.0 mm from the root of the lead

## (4) Cautions

- Fluxes Avoid removing the residual flux with freon-based and chlorine-based cleaning solvent.

## 2. Cautions regarding noise

Be aware that when voltage is applied suddenly between the photocoupler's input and output at startup, the output transistor may enter the on state, even if the voltage is within the absolute maximum ratings.

## USAGE CAUTIONS

1. This product is weak for static electricity by designed with high-speed integrated circuit so protect against static electricity when handling.
2. By-pass capacitor of more than 0.1  $\mu$ F is used between  $V_{CC}$  and GND near device. Also, ensure that the distance between the leads of the photocoupler and capacitor is no more than 10 mm.
3. Pin 2 (which is an NC<sup>\*1</sup> pin) can either be connected directly to the GND pin on the LED side or left open. Unconnected pins should not be used as a bypass for signals or for any other similar purpose because this may degrade the internal noise environment of the device.  
Note: \*1. NC: Non-Connection (No Connection).
4. Avoid storage at a high temperature and high humidity.

## &lt;R&gt; SPECIFICATION OF VDE MARKS LICENSE DOCUMENT

| Parameter   | Symbol               | Spec.                  | Unit                 |
|---|----------------------|------------------------|----------------------|
| Climatic test class (IEC 60068-1/DIN EN 60068-1)  |                      | 40/110/21              |                      |
| Dielectric strength<br>maximum operating isolation voltage  | $U_{IORM}$           | 1 130                  | $V_{peak}$           |
| Test voltage (partial discharge test, procedure a for type test and random test)<br>$U_{pr} = 1.6 \times U_{IORM.}, P_d < 5 \text{ pC}$                                       | $U_{pr}$             | 1 808                  | $V_{peak}$           |
| Test voltage (partial discharge test, procedure b for all devices)<br>$U_{pr} = 1.875 \times U_{IORM.}, P_d < 5 \text{ pC}$   | $U_{pr}$             | 2 119                  | $V_{peak}$           |
| Highest permissible overvoltage   | $U_{TR}$             | 8 000                  | $V_{peak}$           |
| Degree of pollution (DIN EN 60664-1 VDE0110 Part 1)   |                      | 2                      |                      |
| Comparative tracking index (IEC 60112/DIN EN 60112 (VDE 0303 Part 11))  | CTI                  | 175                    |                      |
| Material group (DIN EN 60664-1 VDE0110 Part 1)  |                      | III a                  |                      |
| Storage temperature range   | $T_{stg}$            | -55 to +125            | °C                   |
| Operating temperature range   | $T_A$                | -40 to +110            | °C                   |
| Isolation resistance, minimum value<br>$V_{IO} = 500 \text{ V dc at } T_A = 25^\circ\text{C}$<br>$V_{IO} = 500 \text{ V dc at } T_A \text{ MAX. at least } 100^\circ\text{C}$ | Ris MIN.<br>Ris MIN. | $10^{12}$<br>$10^{11}$ | $\Omega$<br>$\Omega$ |
| Safety maximum ratings (maximum permissible in case of fault, see thermal derating curve)   |                      |                        |                      |
| Package temperature   | $T_{si}$             | 175                    | °C                   |
| Current (input current $I_F$ , $P_{si} = 0$ )   | $I_{si}$             | 400                    | mA                   |
| Power (output or total power dissipation)   | $P_{si}$             | 700                    | mW                   |
| Isolation resistance<br>$V_{IO} = 500 \text{ V dc at } T_A = T_{si}$  | Ris MIN.             | $10^9$                 | $\Omega$             |

|                |               |  |
|----------------|---------------|--|
| <b>Caution</b> | GaAs Products | <p>This product uses gallium arsenide (GaAs). GaAs vapor and powder are hazardous to human health if inhaled or ingested, so please observe the following points.</p> <ul style="list-style-type: none"><li>• Follow related laws and ordinances when disposing of the product. If there are no applicable laws and/or ordinances, dispose of the product as recommended below.<ol style="list-style-type: none"><li>1. Commission a disposal company able to (with a license to) collect, transport and dispose of materials that contain arsenic and other such industrial waste materials.</li><li>2. Exclude the product from general industrial waste and household garbage, and ensure that the product is controlled (as industrial waste subject to special control) up until final disposal.</li></ol></li><li>• Do not burn, destroy, cut, crush, or chemically dissolve the product.</li><li>• Do not lick the product or in any way allow it to enter the mouth.</li></ul> |
|----------------|---------------|--|

**Revision History****PS9309L, PS9309L2 Data Sheet**

| <b>Rev.</b> | <b>Date</b>  | <b>Description</b> |  |
|-------------|--------------|--------------------|--|
|             |              | <b>Page</b>        | <b>Summary</b>   |
| 0.01        | Feb 14, 2012 | –                  | First edition issued   |
| 1.00        | Mar 28, 2014 | p.1                | Modification of <b>FEATURES</b>                                    |
|             |              | p.4                | Modification of <b>ORDERING INFORMATION</b>                        |
|             |              | p.8 to 9           | Addition of <b>TYPICAL CHARACTERISTICS</b>                         |
|             |              | p.10 to 11         | Modification of <b>TAPING SPECIFICATIONS</b>                       |
|             |              | p.13               | Addition of <b>NOTES ON HANDLING</b>                               |
|             |              | p.15               | Modification of <b>SPECIFICATION OF VDE MARKS LICENCE DOCUMENT</b> |

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