# PS9505,PS9505L1,PS9505L2,PS9505L3

–NEPOC Series–

2.5 A OUTPUT CURRENT, HIGH CMR, IGBT GATE DRIVE, 8-PIN DIP PHOTOCOUPLER

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## DESCRIPTION

The PS9505, PS9505L1, PS9505L2 and PS9505L3 are optically coupled isolators containing a GaAlAs LED on the input side and a photo diode, a signal processing circuit and a power output transistor on the output side on one chip.

The PS9505 Series is designed specifically for high common mode transient immunity (CMR), high output current and high switching speed.

The PS9505 Series is suitable for driving IGBTs and MOS FETs.

The PS9505 Series is in a plastic DIP (Dual In-line Package).

The PS9505L1 is lead bending type for long creepage distance.

The PS9505L2 is lead bending type for long creepage distance (Gull-wing) for surface mount.

The PS9505L3 is lead bending type (Gull-wing) for surface mounting.

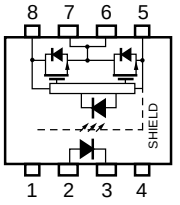
## FEATURES

- Long creepage distance (8 mm MIN.: PS9505L1, PS9505L2)
- Large peak output current (2.5 A MAX., 2.0 A MIN.)
- High speed switching ($t_{PLH}$, $t_{PHL}$ = 0.25 $\mu$s MAX.)
- UVLO (Under Voltage Lock Out) protection with hysteresis
- High common mode transient immunity ($CM_H$, $CM_L$ = ±25 kV/$\mu$s MIN.)
- Embossed tape product: PS9505L2-E3: 1 000 pcs/reel
  : PS9505L3-E3: 1 000 pcs/reel

## APPLICATIONS

- IGBT, Power MOS FET Gate Driver
- Industrial inverter
- IH (Induction Heating)

**PIN CONNECTION**
(Top View)

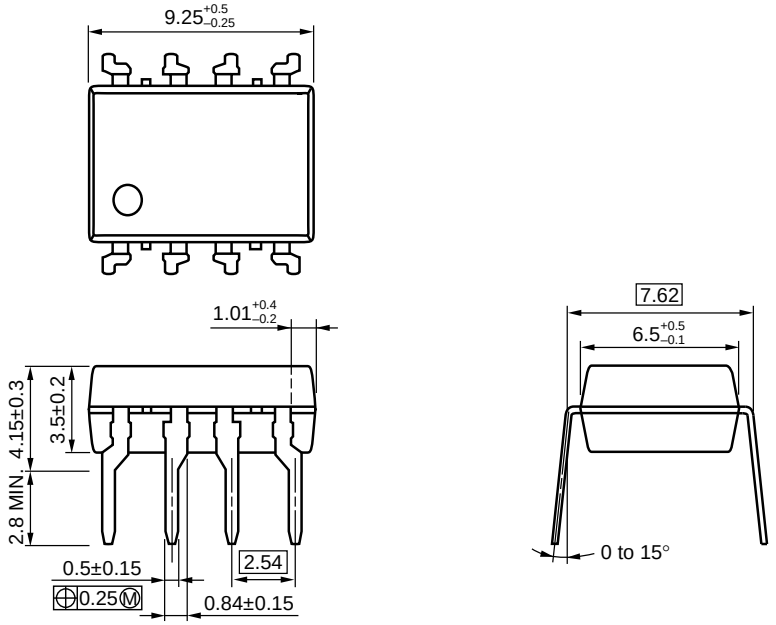



1. NC
2. Anode
3. Cathode
4. NC
5. $V_{EE}$
6. $V_O$
7. $V_O$
8. $V_{CC}$

## PACKAGE DIMENSIONS (UNIT: mm)

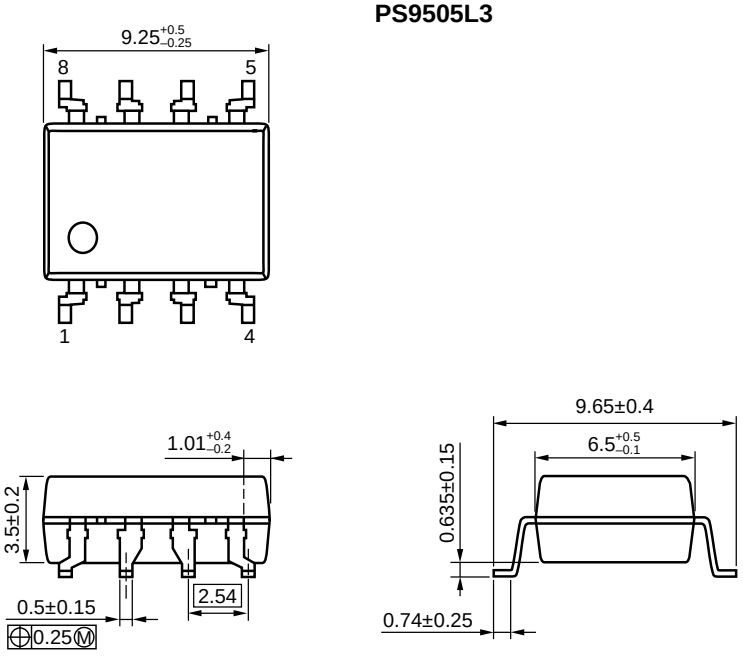
### DIP Type

**PS9505**



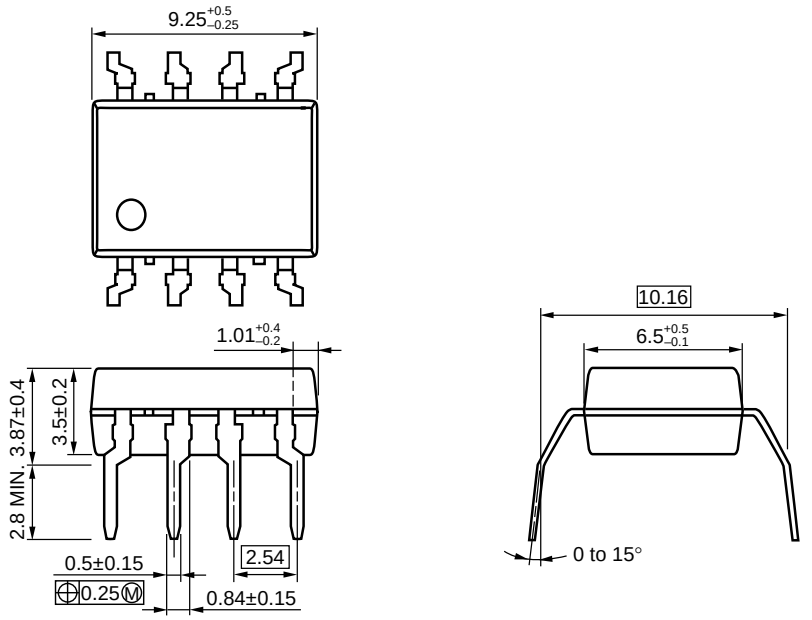

### Lead Bending Type (Gull-wing) For Surface Mount

**PS9505L3**



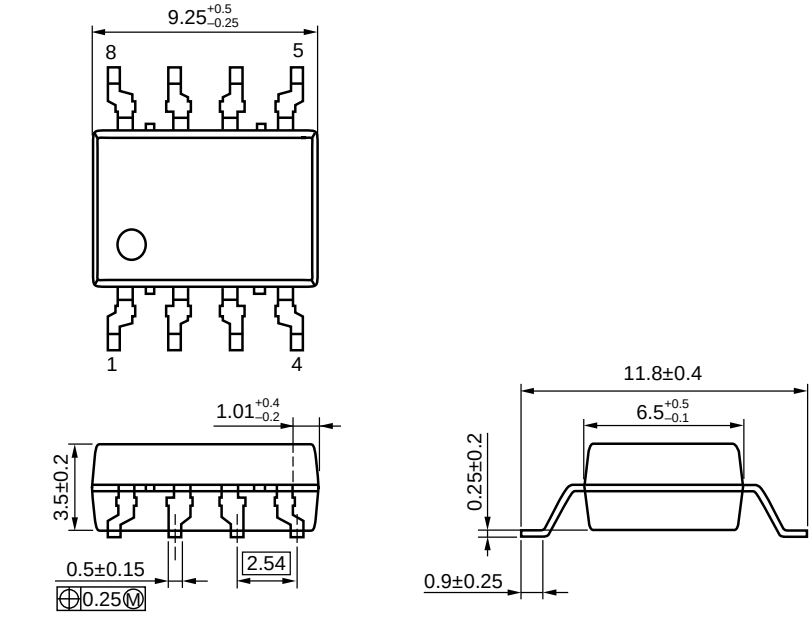
## Lead Bending Type For Long Creepage Distance

**PS9505L1**




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

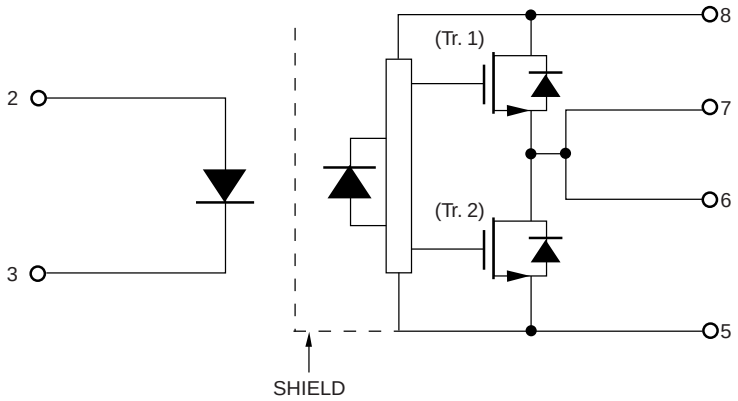
**PS9505L2**



## PHOTOCOUPLER CONSTRUCTION

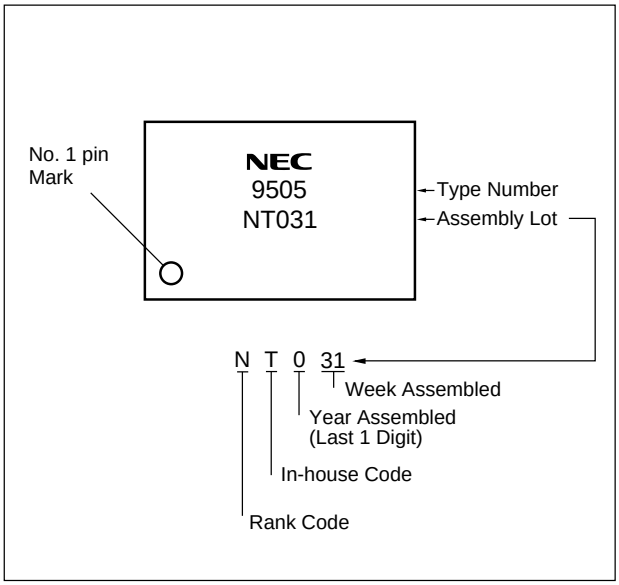
| Parameter | PS9505, PS9505L3 | PS9505L1, PS9505L2 |
|---|---|---|
| Air Distance (MIN.) | 7 mm | 8 mm |
| Outer Creepage Distance (MIN.) | 7 mm | 8 mm |
| Isolation Distance (MIN.) | 0.4 mm | 0.4 mm |

## FUNCTIONAL DIAGRAM




| Input | LED | Tr. 1 | Tr. 2 | Output |
|---|---|---|---|---|
| H | ON | ON | OFF | H |
| L | OFF | OFF | ON | L |

## MARKING EXAMPLE



## ABSOLUTE MAXIMUM RATINGS ($T_A$ = 25°C, unless otherwise specified)

| Parameter | | Symbol | Ratings | Unit |
|---|---|---|---|---|
| Diode | Forward Current | $I_F$ | 25 | mA |
| | Peak Transient Forward Current (Pulse Width < 1 μs) | $I_{F\ (TRAN)}$ | 1.0 | A |
| | Reverse Voltage | $V_R$ | 5 | V |
| Detector | High Level Peak Output Current *1 | $I_{OH\ (PEAK)}$ | 2.5 | A |
| | Low Level Peak Output Current *1 | $I_{OL\ (PEAK)}$ | 2.5 | A |
| | Supply Voltage | ($V_{CC}$ - $V_{EE}$) | 0 to 35 | V |
| | Output Voltage | $V_O$ | 0 to $V_{CC}$ | V |
| | Power Dissipation *2 | $P_C$ | 250 | mW |
| Isolation Voltage *3 | | BV | 5 000 | Vr.m.s. |
| Total Power Dissipation *4 | | $P_T$ | 300 | mW |
| Operating Frequency *5 | | f | 50 | kHz |
| Operating Ambient Temperature | | $T_A$ | –40 to +110 | °C |
| Storage Temperature | | $T_{stg}$ | –55 to +125 | °C |

***1** Maximum pulse width = 10 μs, Maximum duty cycle = 0.2%

***2** Reduced to 4.8 mW/°C at $T_A$ = 70°C or more.

***3** AC voltage for 1 minute at $T_A$ = 25°C, RH = 60% between input and output. Pins 1-4 shorted together, 5-8 shorted together.

***4** Reduced to 5.4 mW/°C at $T_A$ = 70°C or more.

***5** $I_{OH\ (PEAK)} \leq$ 2.0 A (≤ 0.3 μs), $I_{OL\ (PEAK)} \leq$ 2.0 A (≤ 0.3 μs)

## RECOMMENDED OPERATING CONDITIONS

| Parameter | Symbol | MIN. | TYP. | MAX. | Unit |
|---|---|---|---|---|---|
| Supply Voltage | ($V_{CC}$ - $V_{EE}$) | 15 | | 30 | V |
| Forward Current (ON) | $I_{F\ (ON)}$ | 7 | 10 | 16 | mA |
| Forward Voltage (OFF) | $V_{F\ (OFF)}$ | –2 | | 0.8 | V |
| Operating Ambient Temperature | $T_A$ | –40 | | 110 | °C |

## ELECTRICAL CHARACTERISTICS ($T_A$ = –40 to +110°C, $V_{CC}$ = 15 to 30 V, $I_{F\ (ON)}$ = 7 to 16 mA, $V_{F\ (OFF)}$ = –2 to 0.8 V, $V_{EE}$ = GND, unless otherwise specified)

| Parameter | | Symbol | Conditions | MIN. | TYP.*1 | MAX. | Unit |
|---|---|---|---|---|---|---|---|
| Diode | Forward Voltage | $V_F$ | $I_F$ = 10 mA, $T_A$ = 25°C | 1.2 | 1.56 | 1.8 | V |
| | Reverse Current | $I_R$ | $V_R$ = 3 V, $T_A$ = 25°C | | | 10 | μA |
| | Input Capacitance | $C_{IN}$ | f = 1 MHz, $V_F$ = 0 V, $T_A$ = 25°C | | 30 | | pF |
| Detector | High Level Output Current | $I_{OH}$ | $V_O$ = ($V_{CC}$ – 4 V) *2 | 0.5 | 2.0 | | A |
| | | | $V_O$ = ($V_{CC}$ – 15 V) *3 | 2.0 | | | |
| | Low Level Output Current | $I_{OL}$ | $V_O$ = ($V_{EE}$ + 2.5 V) *2 | 0.5 | 2.0 | | A |
| | | | $V_O$ = ($V_{EE}$ + 15 V) *3 | 2.0 | | | |
| | High Level Output Voltage | $V_{OH}$ | $I_O$ = –100 mA *4 | $V_{CC}$ – 3.0 | $V_{CC}$ – 1.5 | | V |
| | Low Level Output Voltage | $V_{OL}$ | $I_O$ = 100 mA | | 0.1 | 0.5 | V |
| | High Level Supply Current | $I_{CCH}$ | $V_O$ = open, $I_F$ = 10 mA | | 2.0 | 3.0 | mA |
| | Low Level Supply Current | $I_{CCL}$ | $V_O$ = open, $V_F$ = 0 to +0.8 V | | 2.0 | 3.0 | mA |
| | UVLO Threshold | $V_{UVLO+}$ | $V_O$ > 5 V, $I_F$ = 10 mA | 10.8 | 12.3 | 13.4 | V |
| | | $V_{UVLO–}$ | | 9.5 | 11.0 | 12.5 | |
| | UVLO Hysteresis | $UVLO_{HYS}$ | $V_O$ > 5 V, $I_F$ = 10 mA | 0.4 | 1.3 | | V |
| Coupled | Threshold Input Current (L → H) | $I_{FLH}$ | $I_O$ = 0 mA, $V_O$ > 5 V | | 2.0 | 5.0 | mA |
| | Threshold Input Voltage (H → L) | $V_{FHL}$ | $I_O$ = 0 mA, $V_O$ < 5 V | 0.8 | | | V |

***1** Typical values at $T_A$ = 25°C.

***2** Maximum pulse width = 50 μs, Maximum duty cycle = 0.5%.

***3** Maximum pulse width = 10 μs, Maximum duty cycle = 0.2%

***4** $V_{OH}$ is measured with the DC load current in this testing (Maximum pulse width = 2 ms, Maximum duty cycle = 20%).

## SWITCHING CHARACTERISTICS ($T_A$ = –40 to +110°C, $V_{CC}$ = 15 to 30 V, $I_{F\ (ON)}$ = 7 to 16 mA, $V_{F\ (OFF)}$ = –2 to 0.8 V, $V_{EE}$ = GND, unless otherwise specified)

| Parameter | Symbol | Conditions | MIN. | TYP.*1 | MAX. | Unit |
|---|---|---|---|---|---|---|
| Propagation Delay Time (L → H) | $t_{PLH}$ | $R_g$ = 10 Ω, $C_g$ = 10 nF, f = 10 kHz, Duty Cycle = 50%*2, $I_F$ = 10 mA | | 0.18 | 0.25 | μs |
| Propagation Delay Time (H → L) | $t_{PHL}$ | | | 0.18 | 0.25 | μs |
| Pulse Width Distortion (PWD) | $\lvert t_{PHL}-t_{PLH}\rvert$ | | –0.1 | 0.02 | 0.1 | μs |
| Propagation Delay Time (Difference Between Any Two Products) | $t_{PHL}-t_{PLH}$ | | –0.1 | | 0.1 | μs |
| Rise Time | $t_r$ | | | 50 | | ns |
| Fall Time | $t_f$ | | | 50 | | ns |
| UVLO (Turn On Delay) | $t_{UVLO\ ON}$ | $V_O$ > 5 V, $I_F$ = 10 mA | | 0.8 | | μs |
| UVLO (Turn Off Delay) | $t_{UVLO\ OFF}$ | $V_O$ < 5 V, $I_F$ = 10 mA | | 0.6 | | μs |
| Common Mode Transient Immunity at High Level Output*3 | $\lvert CM_H\rvert$ | $T_A$ = 25°C, $I_F$ = 10 to 16 mA, $V_{CC}$ = 30 V, $V_{O\ (MIN.)}$ = 26 V, $V_{CM}$ = 1.5 kV | 25 | | | kV/μs |
| Common Mode Transient Immunity at Low Level Output*3 | $\lvert CM_L\rvert$ | $T_A$ = 25°C, $I_F$ = 0 mA, $V_{CC}$ = 30 V, $V_{O\ (MAX.)}$ = 1 V, $V_{CM}$ = 1.5 kV | 25 | | | kV/μs |

***1** Typical values at $T_A$ = 25°C.

***2** This load condition is equivalent to the IGBT load at 1 200 V/75 A.

***3** Connect pin 1 and pin 4 to the LED common.

## TEST CIRCUIT

**Fig. 1 $I_{OH}$ Test Circuit**

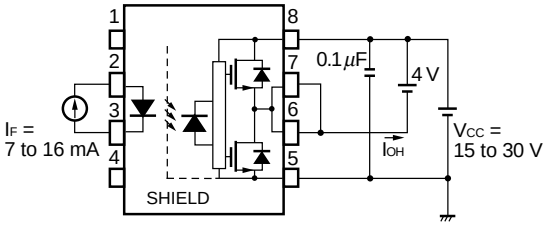



**Fig. 2 $I_{OL}$ Test Circuit**

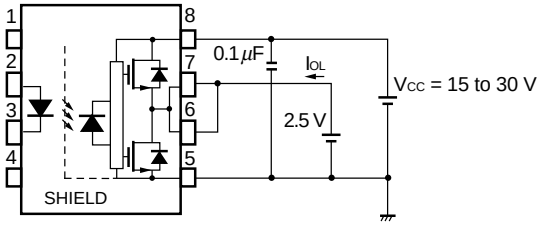



**Fig. 3 $V_{OH}$ Test Circuit**

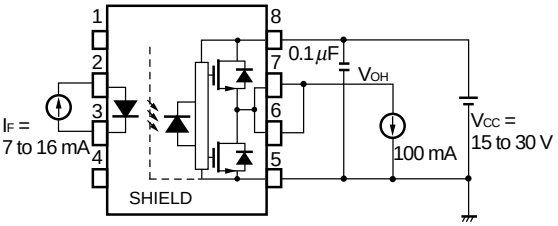



**Fig. 4 $V_{OL}$ Test Circuit**

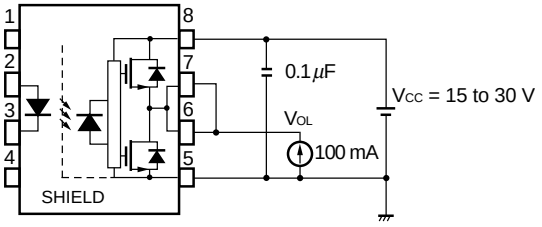



**Fig. 5 $I_{FLH}$ Test Circuit**

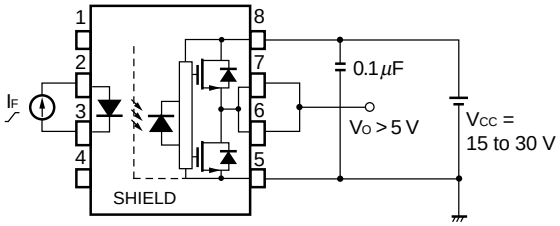



**Fig. 6 UVLO Test Circuit**

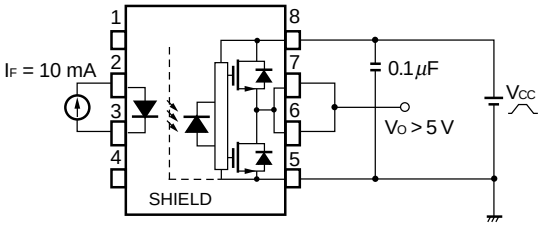


**Fig. 7 $t_{PLH}$, $t_{PHL}$, $t_r$, $t_f$ Test Circuit and Wave Forms**

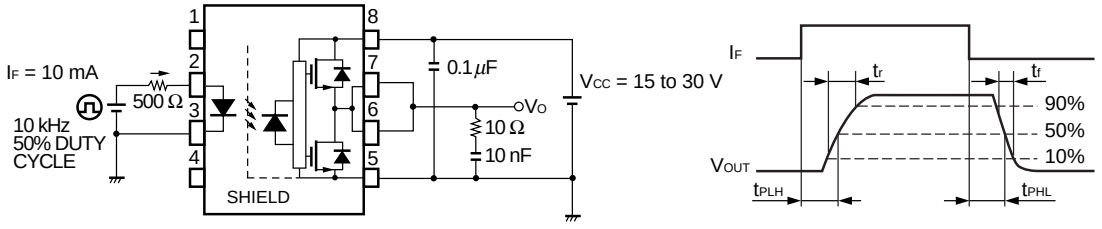
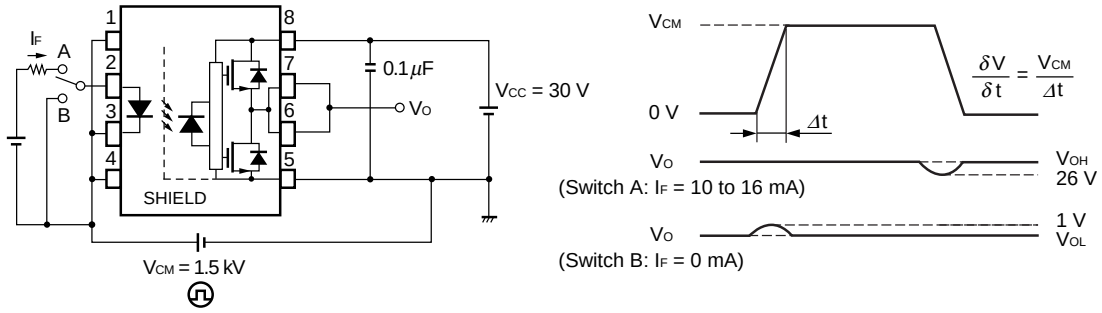


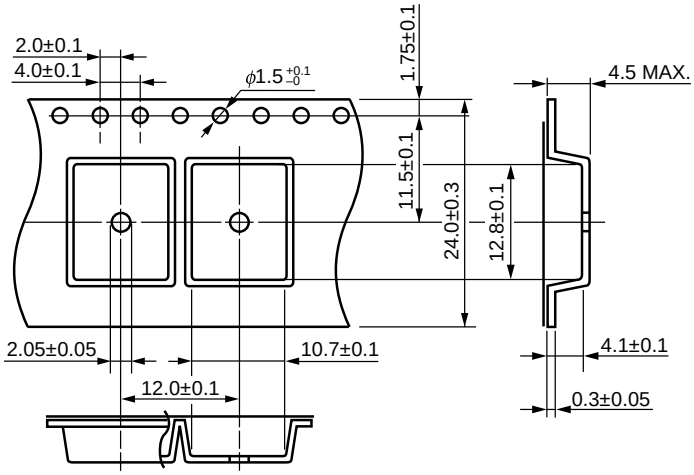

**Fig. 8 CMR Test Circuit and Wave Forms**



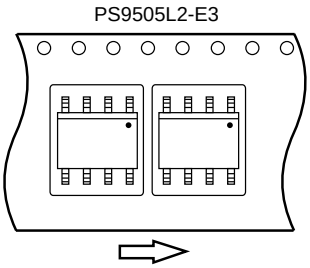

**Remark** CMR Test : Connect pin 1 and pin 4 to the LED common.

## TAPING SPECIFICATIONS (UNIT: mm)

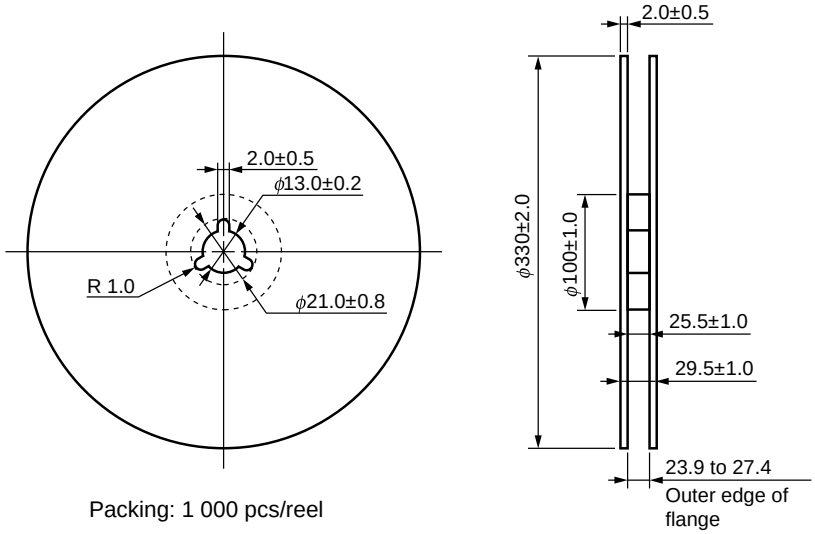
Outline and Dimensions (Tape)




Tape Direction

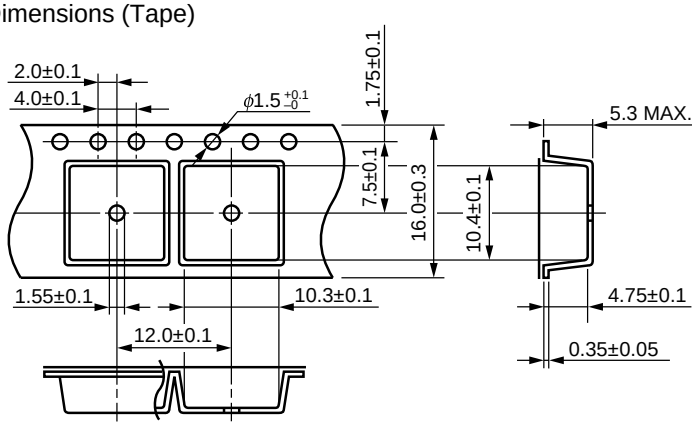



Outline and Dimensions (Reel)



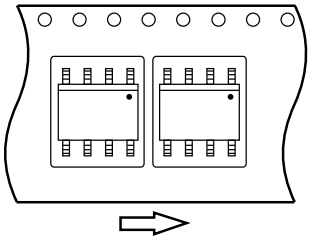

Packing: 1 000 pcs/reel

## Outline and Dimensions (Tape)

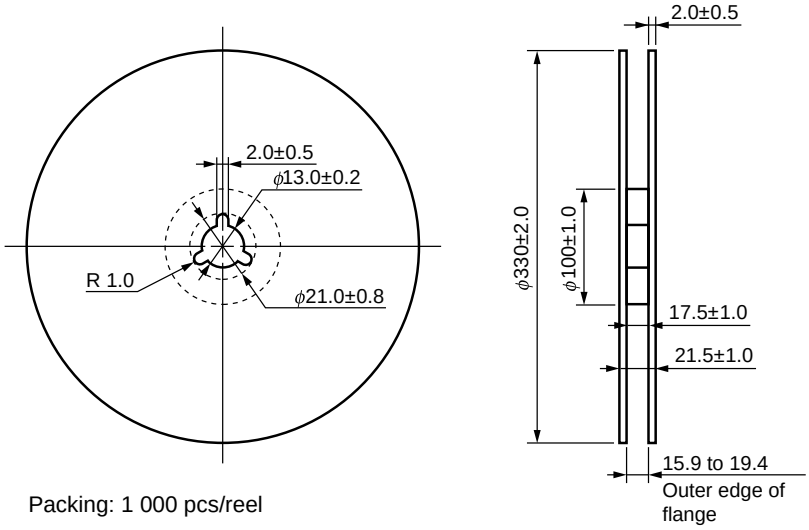



## Tape Direction

PS9505L3-E3

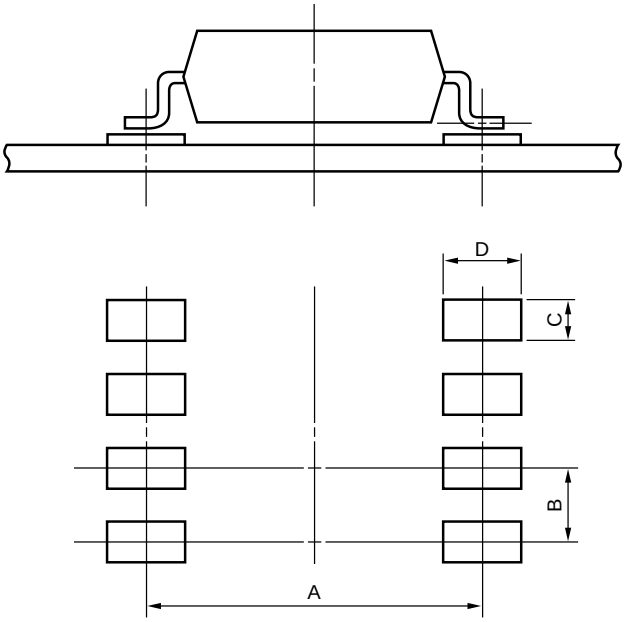


## Outline and Dimensions (Reel)




Packing: 1 000 pcs/reel

## RECOMMENDED MOUNT PAD DIMENSIONS (UNIT: mm)




| Part Number | Lead Bending | A | B | C | D |
|---|---|---|---|---|---|
| PS9505L2 | lead bending type (Gull-wing) for long creepage distance (surface mount) | 10.2 | 2.54 | 1.7 | 2.2 |
| PS9505L3 | lead bending type (Gull-wing) for surface mount | 8.2 | 2.54 | 1.7 | 2.2 |

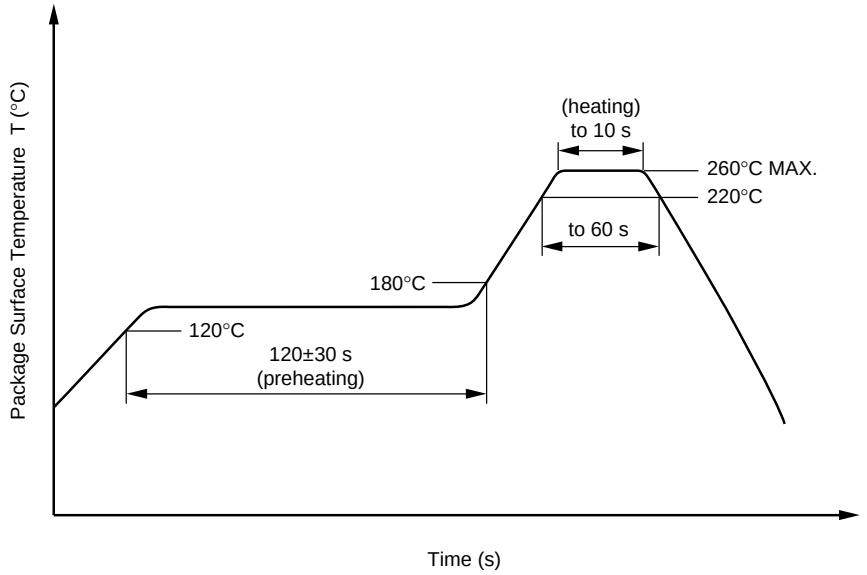
## NOTES ON HANDLING

### 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

(b) Please be sure that the temperature of the package would not be heated over 100°C

**(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. Board designing
   (1) 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.
   (2) In older to avoid malfunctions and characteristics degradation, IGBT collector or emitter traces should not be closed to the LED input.
   (3) Pins 1, 4 (which is an NC[*1] 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.
   ***1** NC: Non-Connection (No Connection)
3. Make sure the rise/fall time of the forward current is 0.5 $\mu$s or less.
4. In order to avoid malfunctions, make sure the rise/fall slope of the supply voltage is 3 V/$\mu$s or less.
5. Avoid storage at a high temperature and high humidity.

| | |
|---|---|
| **Caution** GaAs Products | This product uses gallium arsenide (GaAs).<br>GaAs vapor and powder are hazardous to human health if inhaled or ingested, so please observe the following points.<br>• 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.<br>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.<br>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.<br>• Do not burn, destroy, cut, crush, or chemically dissolve the product.<br>• Do not lick the product or in any way allow it to enter the mouth. |

| Revision History | PS9505,PS9505L1,PS9505L2,PS9505L3 Preliminary Data Sheet |
|---|---|

| Rev. | Date | Description | |
|---|---|---|---|
| | | Page | Summary |
| 0.01 | May 12, 2010 | – | First Edition issued |
| | | | |