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Data Sheet

# PS9513, PS9513L1, PS9513L2, PS9513L3

1 Mbps, OPEN COLLECTOR OUTPUT, FOR INTELLIGENT POWER MODULE DRIVE

8-PIN DIP HIGH-SPEED PHOTOCOUPLER

R08DS0126EJ0203
Rev.2.03
Oct 29, 2018

## DESCRIPTION

The PS9513, PS9513L1, PS9513L2 and PS9513L3 are optically coupled isolators containing an AlGaAs LED on the input side and a photo diode and a signal processing circuit on the output side on one chip.

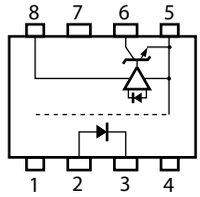
The PS9513 is designed specifically for high common mode transient immunity (CMR) and low pulse width distortion with operating temperature. It is suitable for IPM drive.

The PS9513L1 is lead bending type for long creepage distance.
The PS9513L2 is lead bending type for long creepage distance (Gull-wing) for surface mount.
The PS9513L3 is lead bending type (Gull-wing) for surface mounting.

## FEATURES

- Long creepage distance (8 mm MIN. : PS9513L1, PS9513L2)
- High common mode transient immunity ($CM_H$, $CM_L$ = ±15 kV/μs MIN)
- High-speed response ($t_{PHL}$ = 500 ns MAX., $t_{PLH}$ = 750 ns MAX.)
- Propagation Delay Difference ($t_{PLH} - t_{PHL}$ = 270 ns TYP.)
- Pulse width distortion ($|t_{PHL} - t_{PLH}|$ = 270 ns TYP.)
- Open collector output
- Ordering number of tape product : PS9513L2-E3 : 1 000 pcs/reel
  : PS9513L3-E3 : 1 000 pcs/reel
- Pb-Free product
- Safety standards
- - UL approved: UL1577, Double protection
- - CSA approved: CAN/CSA-C22.2 No.62368-1, Reinforced insulation
- - BSI approved: BS EN 62368-1, Reinforced insulation
- - SEMKO approved: EN 62368-1, IEC 62368-1, Reinforced insulation
- - NEMKO approved: EN 62368-1, Reinforced insulation
- - DEMKO approved: EN 62368-1, Reinforced insulation
- - FIMKO approved: EN 62368-1, Reinforced insulation
- - VDE approved: DIN EN 60747-5-5 (Option)

PIN CONNECTIONS
(Top View)




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

## APPLICATIONS

- IPM Driver
- General purpose inverter

Start of mass production
Jun-2006

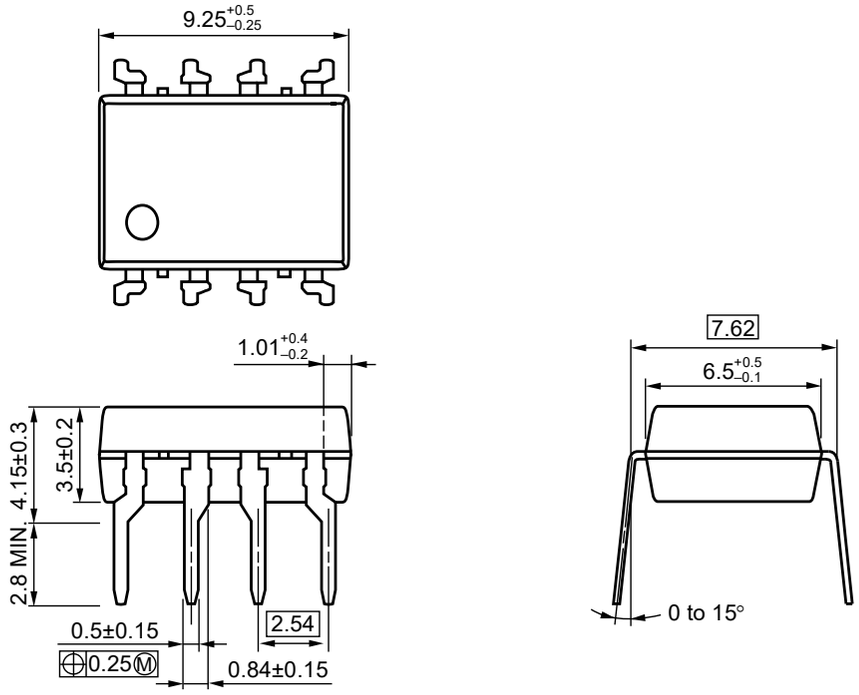
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## PACKAGE DIMENSIONS (UNIT: mm)

DIP Type

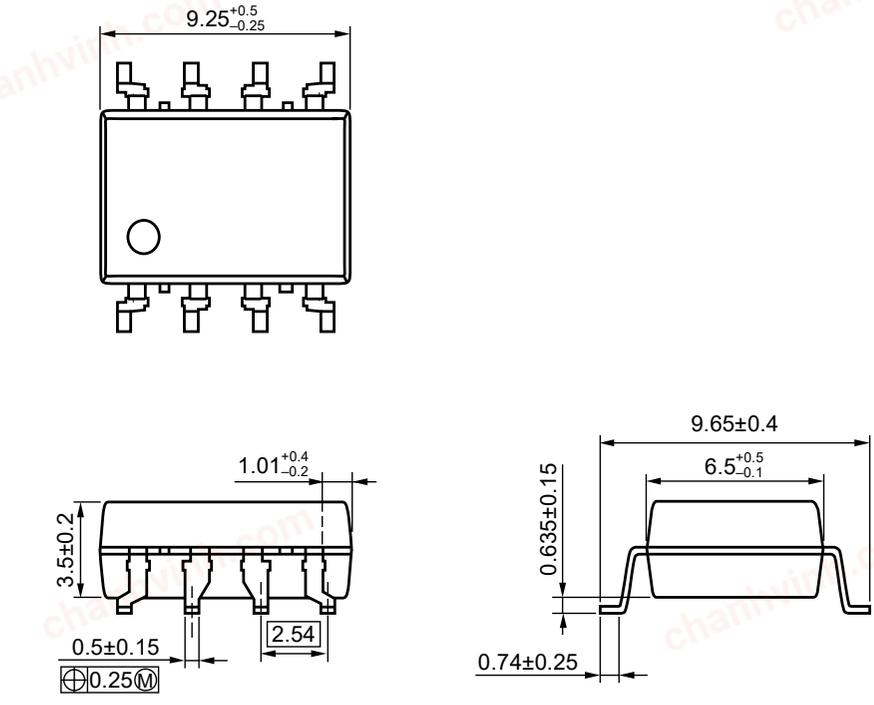
**PS9513**




Weight: 0.55g (typ.)

Lead Bending Type (Gull-wing) For Surface Mount

**PS9513L3**

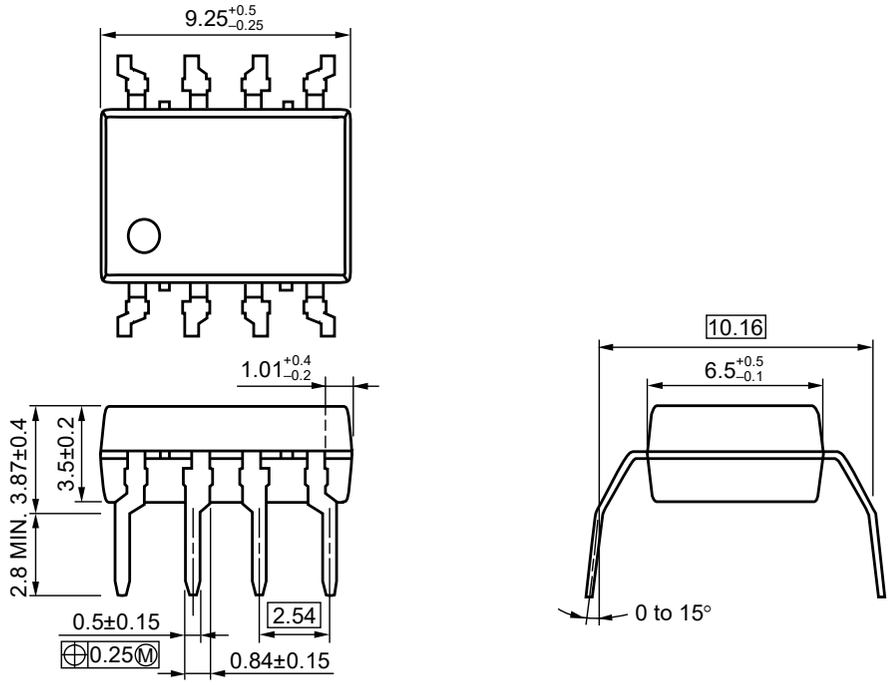


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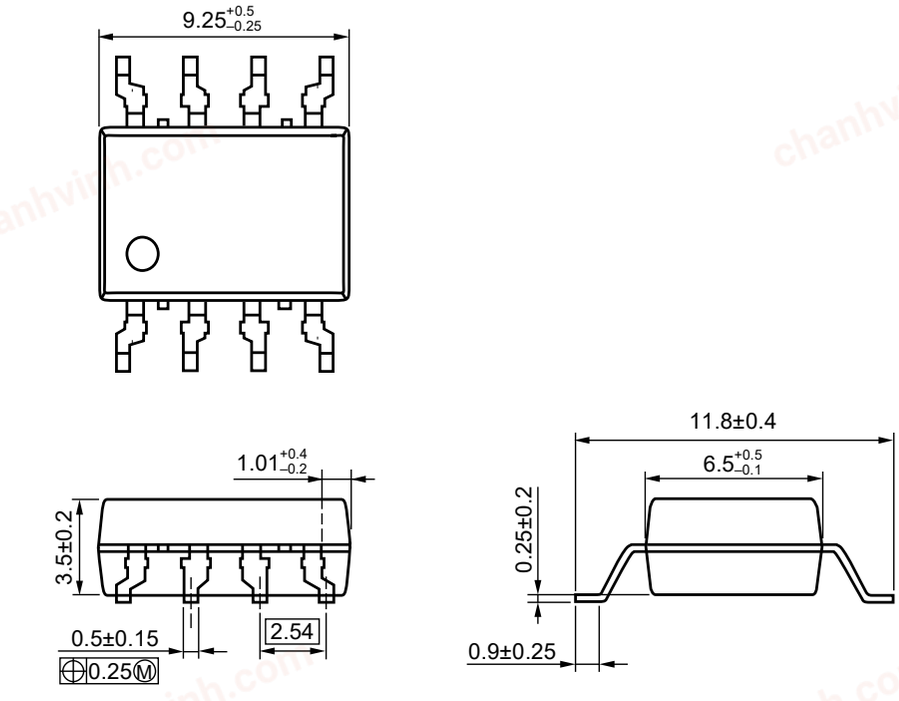
Lead Bending Type For Long Creepage Distance

**PS9513L1**




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

**PS9513L2**



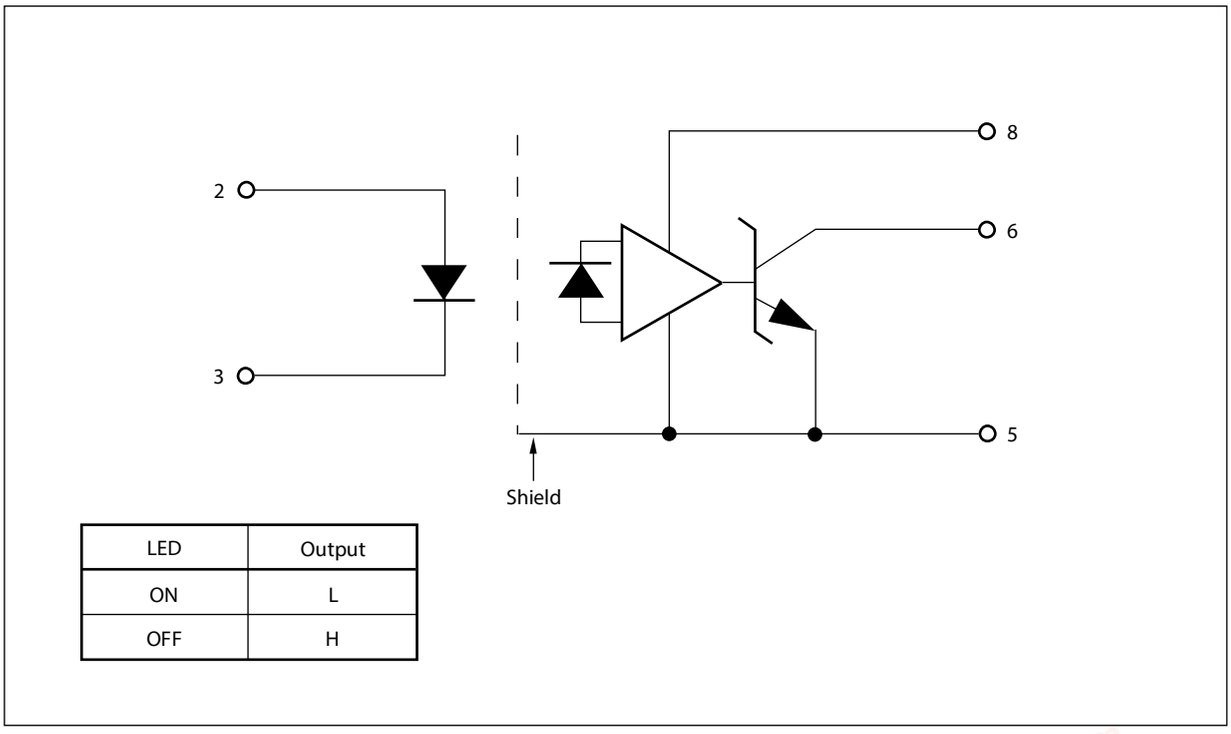
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## PHOTOCOUPLER CONSTRUCTION

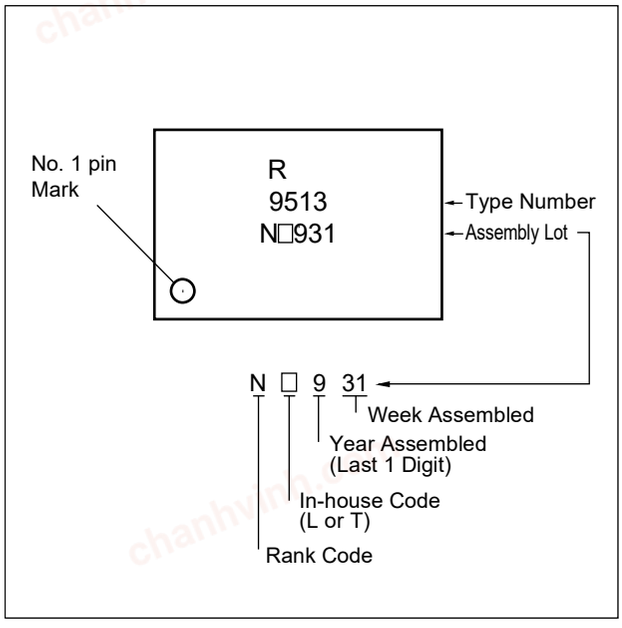
| Parameter | PS9513, PS9513L3 | PS9513L1, PS9513L2 |
|---|---|---|
| Air Distance (MIN.) | 7 mm | 8 mm |
| Creepage Distance (MIN.) | 7 mm | 8 mm |
| Isolation Distance (MIN.) | 0.4 mm | 0.4 mm |

## FUNCTIONAL DIAGRAM




| LED | Output |
|---|---|
| ON | L |
| OFF | H |

## MARKING EXAMPLE



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## ORDERING INFORMATION

| Part Number | Order Number | Solder Plating Specification | Packing Style | Safety Standard Approval | Application Part Number*1 |
|---|---|---|---|---|---|
| PS9513 | PS9513-AX | Pb-Free (Ni/Pd/Au) | Magazine case 50 pcs | Standard products (UL, CSA, BSI, SEMKO, NEMKO, DEMKO, FIMKO approved) | PS9513 |
| PS9513L1 | PS9513L1-AX | | | | PS9513L1 |
| PS9513L2 | PS9513L2-AX | | | | PS9513L2 |
| PS9513L3 | PS9513L3-AX | | | | PS9513L3 |
| PS9513L2-E3 | PS9513L2-E3-AX | | Embossed Tape 1 000 pcs/reel | | PS9513L2 |
| PS9513L3-E3 | PS9513L3-E3-AX | | | | PS9513L3 |
| PS9513-V | PS9513-V-AX | | Magazine case 50 pcs | UL, CSA, BSI, SEMKO, NEMKO, DEMKO, FIMKO, DIN EN 60747-5-5 approved | PS9513 |
| PS9513L1-V | PS9513L1-V-AX | | | | PS9513L1 |
| PS9513L2-V | PS9513L2-V-AX | | | | PS9513L2 |
| PS9513L3-V | PS9513L3-V-AX | | | | PS9513L3 |
| PS9513L2-V-E3 | PS9513L2-V-E3-AX | | Embossed Tape 1 000 pcs/reel | | PS9513L2 |
| PS9513L3-V-E3 | PS9513L3-V-E3-AX | | | | PS9513L3 |

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

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

| Parameter | | Symbol | Ratings | Unit |
|---|---|---|---|---|
| Diode | Forward Current *1 | $I_F$ | 25 | mA |
| | Reverse Voltage | $V_R$ | 5.0 | V |
| Detector | Supply Voltage | $V_{CC}$ | –0.5 to +25 | V |
| | Output Voltage | $V_O$ | –0.5 to +25 | V |
| | Output Current | $I_O$ | 15 | mA |
| | Power Dissipation *2 | $P_C$ | 100 | mW |
| Isolation Voltage *3 | | BV | 5 000 | Vr.m.s. |
| Operating Ambient Temperature | | $T_A$ | –40 to +100 | °C |
| Storage Temperature | | $T_{stg}$ | –55 to +125 | °C |

Notes*: 1. Reduced to 0.33 mA/°C at $T_A$ = 70°C or more.
2. Reduced to 2.0 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.

## RECOMMENDED OPERATING CONDITIONS

| Parameter | Symbol | MIN. | TYP. | MAX. | Unit |
|---|---|---|---|---|---|
| Forward Current | $I_F$ | 10 | | 20 | mA |
| Output Voltage | $V_O$ | 0 | | 20 | V |
| Supply Voltage | $V_{CC}$ | 4.5 | 15 | 20 | V |
| Input Voltage | $V_F$ | 0 | | 0.8 | V |

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## ELECTRICAL CHARACTERISTICS ($T_A$ = –40 to +100°C, $V_{CC}$ = 15 V, unless otherwise specified)

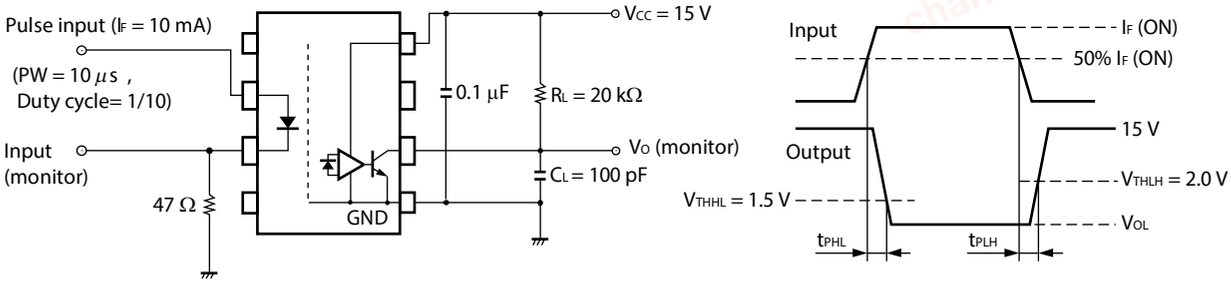
| Parameter | | Symbol | Conditions | MIN. | TYP.*1 | MAX. | Unit |
|---|---|---|---|---|---|---|---|
| Diode | Forward Voltage | $V_F$ | $I_F$ = 10 mA | 1.3 | 1.65 | 2.1 | V |
| | Reverse Current | $I_R$ | $V_R$ = 3 V | | | 200 | μA |
| | Terminal Capacitance | $C_t$ | V = 0 V, f = 1 MHz, $T_A$ = 25°C | | 30 | | pF |
| Detector | Low Level Output Voltage | $V_{OL}$ | $I_F$ = 10 mA, $I_{OL}$ = 2.4 mA | | 0.13 | 0.6 | V |
| | High Level Output Current | $I_{OH}$ | $V_{CC}$ = 20 V, $V_F$ = 0.8 V | | 1.0 | 50 | μA |
| | High Level Supply Current | $I_{CCH}$ | $V_{CC}$ = 20 V, $V_F$ = 0.8 V, $V_O$ = open | | 0.6 | 1.3 | mA |
| | Low Level Supply Current | $I_{CCL}$ | $V_{CC}$ = 20 V, $I_F$ = 10 mA, $V_O$ = open | | 0.6 | 1.3 | mA |
| Coupled | Threshold Input Current (H → L) | $I_{FHL}$ | $V_O$ = 0.8 V, $I_O$ = 0.75 mA | | 0.86 | 5.0 | mA |
| | Current Transfer Ratio ($I_C/I_F$) | CTR | $I_F$ = 10 mA, $V_O$ = 0.6 V | 44 | 110 | | % |
| | Isolation Resistance | $R_{I-O}$ | $V_{I-O}$ = 1 $kV_{DC}$, RH = 40 to 60%, $T_A$ = 25°C | $10^{11}$ | | | Ω |
| | Isolation Capacitance | $C_{I-O}$ | V = 0 V, f = 1 MHz, $T_A$ = 25°C | | 0.7 | | pF |
| | Propagation Delay Time (H → L)*2 | $t_{PHL}$ | $I_F$ = 10 mA, $R_L$ = 20 kΩ, $C_L$ = 100 pF, $V_{THHL}$ = 1.5 V, $V_{THLH}$ = 2.0 V | | 250 | 500 | ns |
| | Propagation Delay Time (L → H)*2 | $t_{PLH}$ | | | 520 | 750 | |
| | Propagation Delay Difference | $t_{PLH}–t_{PHL}$ | | –200 | 270 | 650 | |
| | Pulse Width Distortion (PWD)*2 | $\|t_{PHL}–t_{PLH}\|$ | | | 270 | 650 | |
| | Common Mode Transient Immunity at High Level Output*3 | $CM_H$ | $T_A$ = 25°C, $I_F$ = 0 mA, $V_O$ > 3.0 V, $V_{CM}$ = 1.5 kV, $R_L$ = 20 kΩ, $C_L$ = 100 pF | 15 | | | kV/μs |
| | Common Mode Transient Immunity at Low Level Output*3 | $CM_L$ | $T_A$ = 25°C, $I_F$ = 10 mA, $V_O$ < 1.0 V, $V_{CM}$ = 1.5 kV, $R_L$ = 20 kΩ, $C_L$ = 100 pF | -15 | | | kV/μs |

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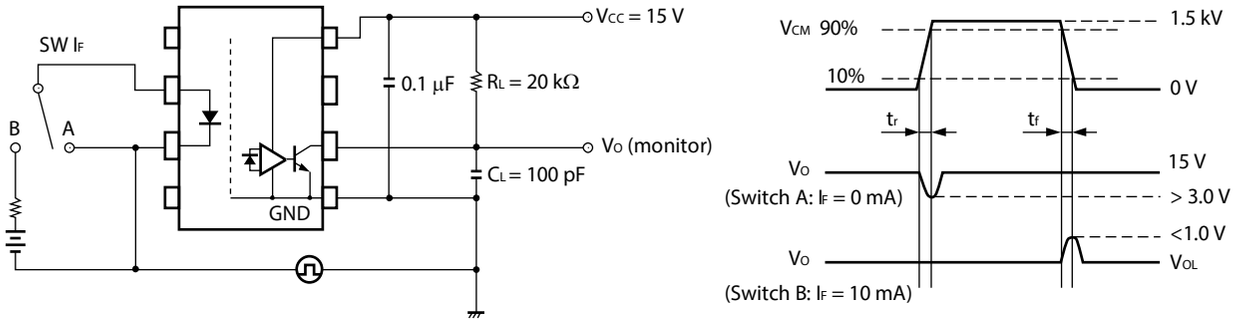
Notes*: 1. Typical values at $T_A$ = 25°C.

2. Test circuit for propagation delay time




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

3. Test circuit for common mode transient immunity




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

## USAGE CAUTIONS

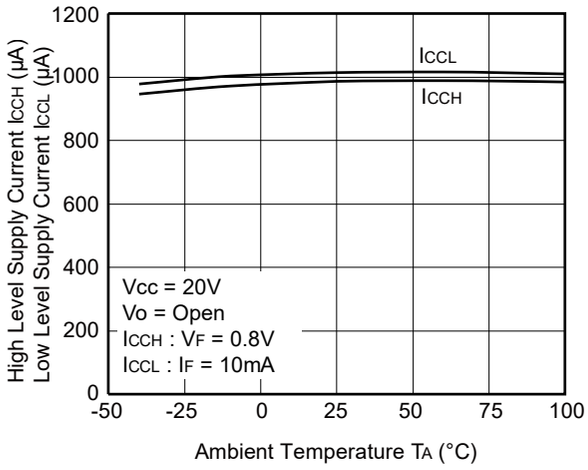
1. This product is weak for static electricity by designed with high-speed integrated circuit so protect against static electricity when handling.
2. By-pass capacitor of more than 0.1 μF is used between $V_{CC}$ and GND near device. Also, ensure that the distance between the leads of the photocoupler and capacitor is no more than 10 mm.
3. 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. Also, Pin 7 (which is an NC*1 pin) can either be connected directly to the GND pin on the detector 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)
4. Avoid storage at a high temperature and high humidity.
5. Do not use adhesives or coating materials including halogens to fix this device.

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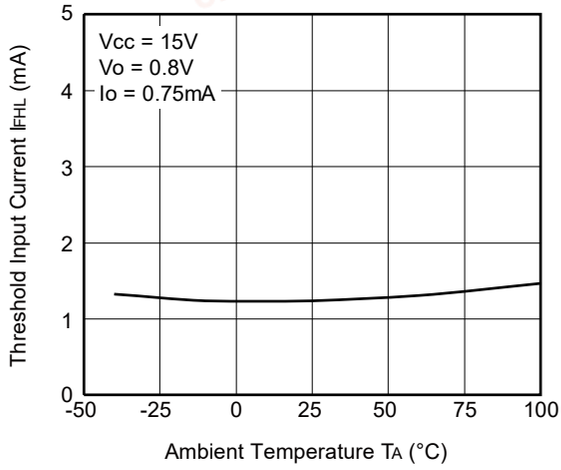


## TYPICAL CHARACTERISTICS ($T_A$ = 25°C unless otherwise specified)

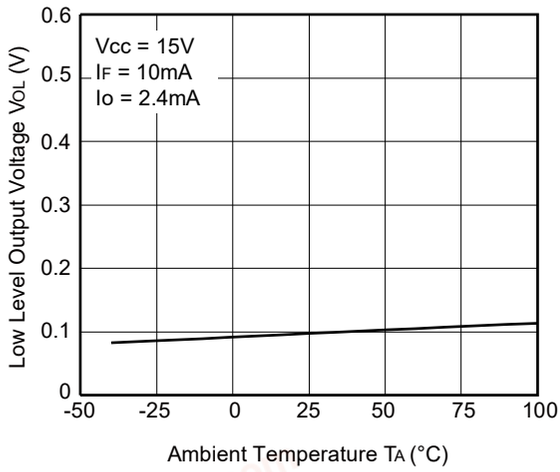
SUPPLY CURRENT vs. AMBIENT TEMPERATURE



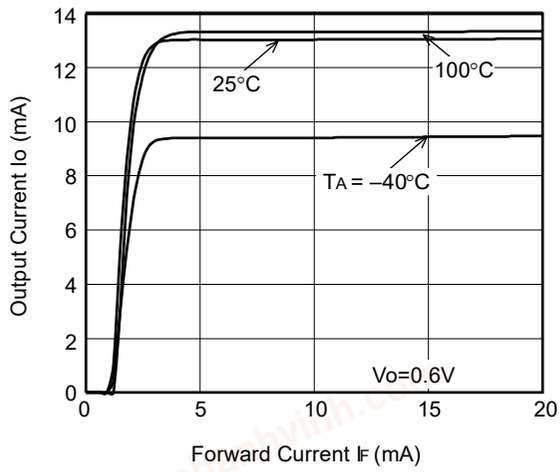

THRESHOLD INPUT CURRENT vs. AMBIENT TEMPERATURE



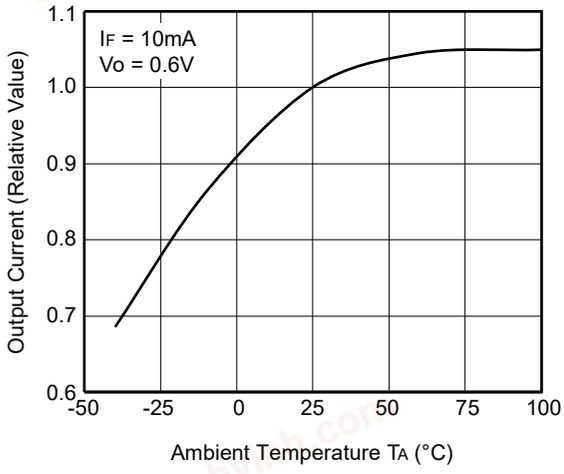

LOW LEVEL OUTPUT VOLTAGE vs. AMBIENT TEMPERATURE



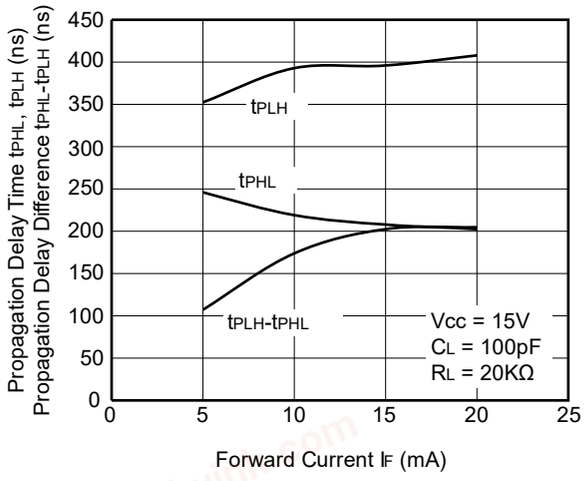

OUTPUT CURRENT vs. FORWARD CURRENT




OUTPUT CURRENT vs. AMBIENT TEMPERATURE




PROPAGATION DELAY TIME, PROPAGATION DELAY DIFFERENCE vs. FORWARD CURRENT

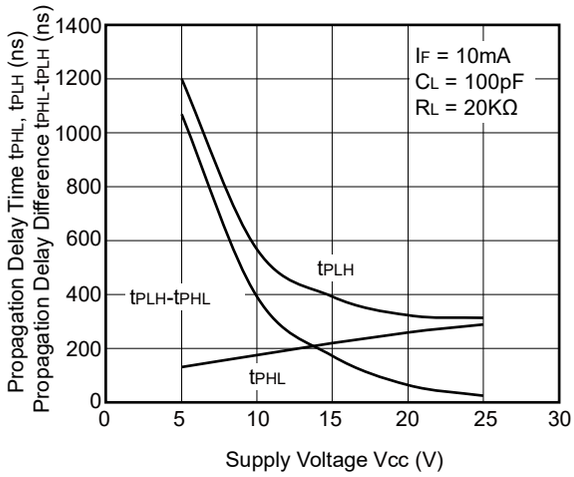



**Remark** The graphs indicate nominal characteristics.

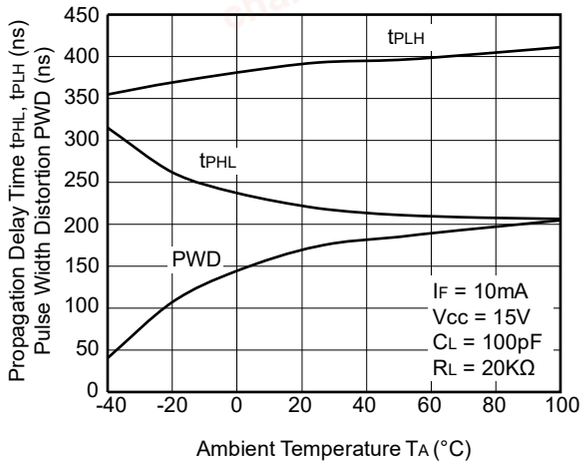
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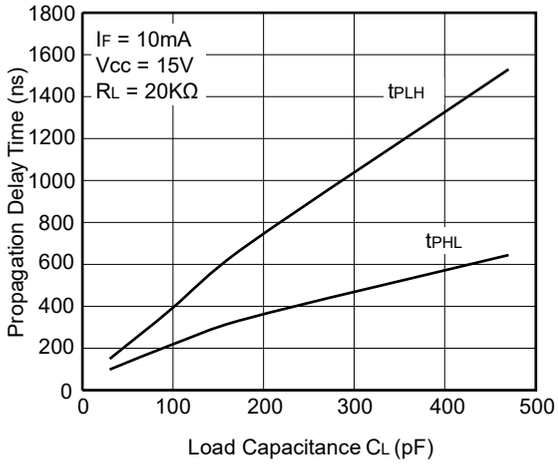
PROPAGATION DELAY TIME,
PROPAGATION DELAY DIFFERENCE
vs. SUPPLY VOLTAGE



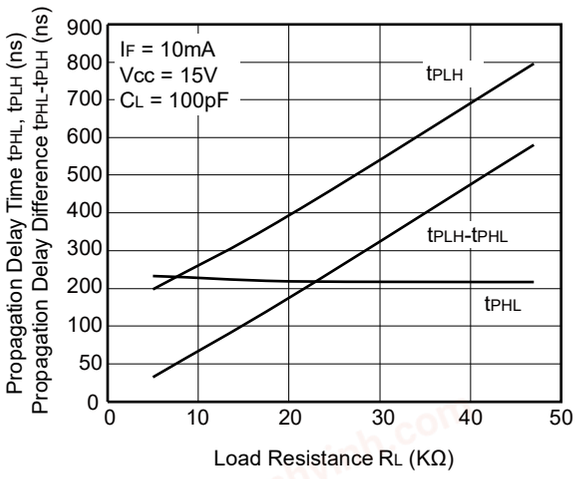

PROPAGATION DELAY TIME,
PULSE WIDTH DISTORTION
vs. AMBIENT TEMPERATURE



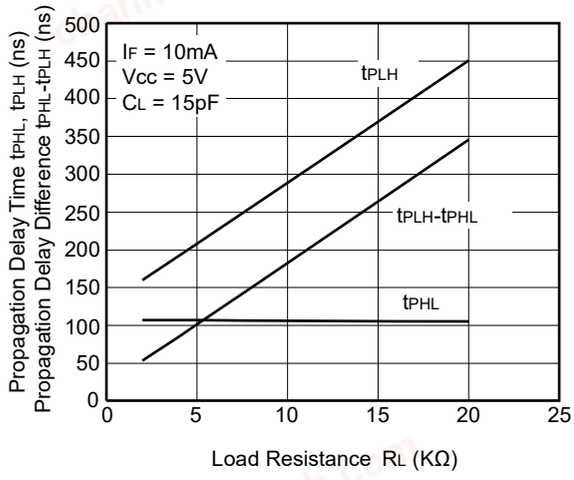

PROPAGATION DELAY TIME
vs. LOAD CAPACITANCE




PROPAGATION DELAY TIME,
PROPAGATION DELAY DIFFERENCE
vs. LOAD RESISTANCE




PROPAGATION DELAY TIME,
PROPAGATION DELAY DIFFERENCE
vs. LOAD RESISTANCE



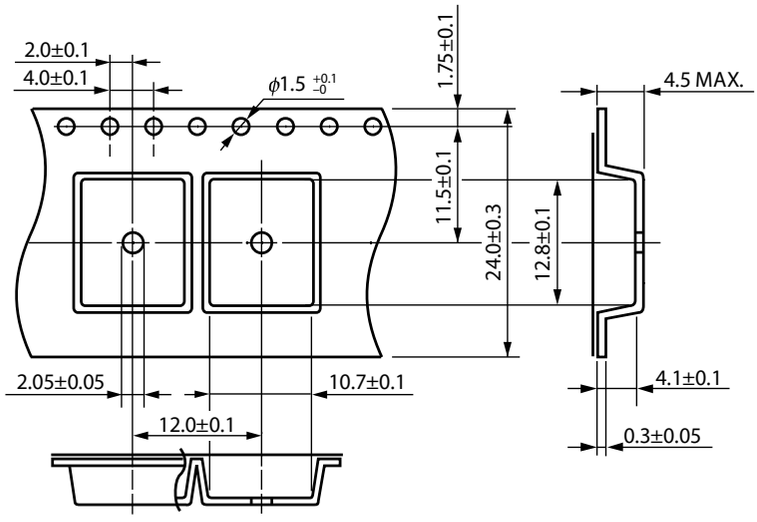

**Remark** The graphs indicate nominal characteristics.

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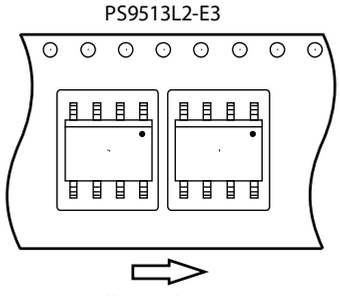


## TAPING SPECIFICATIONS (UNIT: mm)

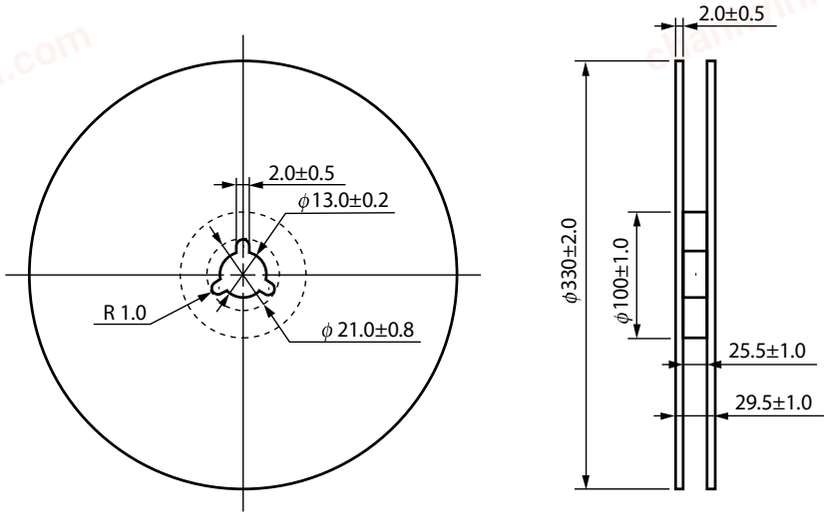
Outline and Dimensions (Tape)




Tape Direction




Outline and Dimensions (Reel)

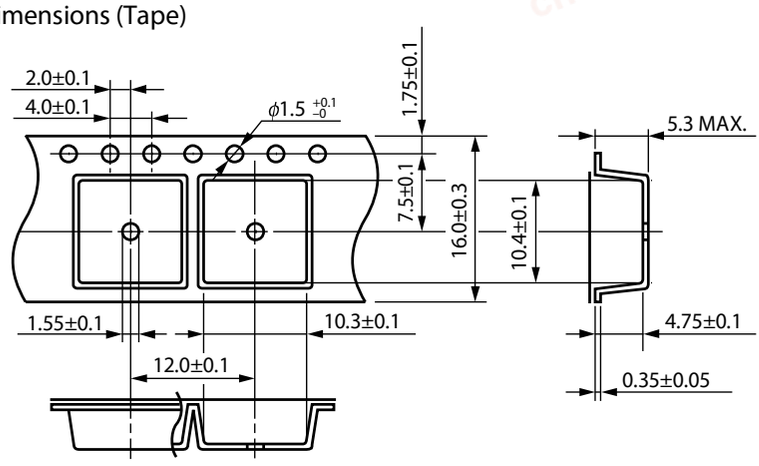



Packing: 1 000 pcs/reel

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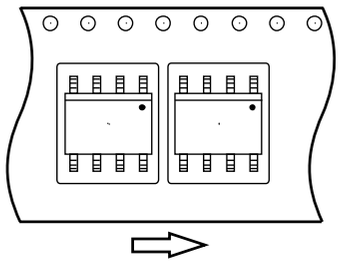


Outline and Dimensions (Tape)

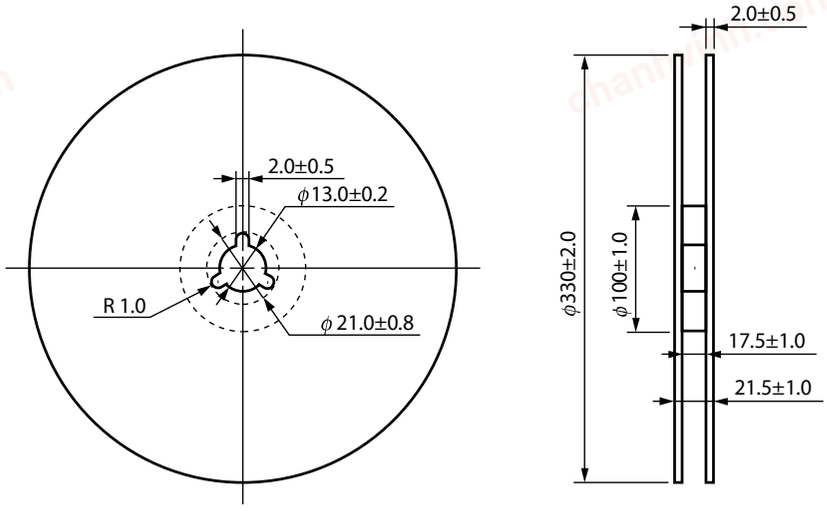



Tape Direction

PS9513L3-E3



Outline and Dimensions (Reel)

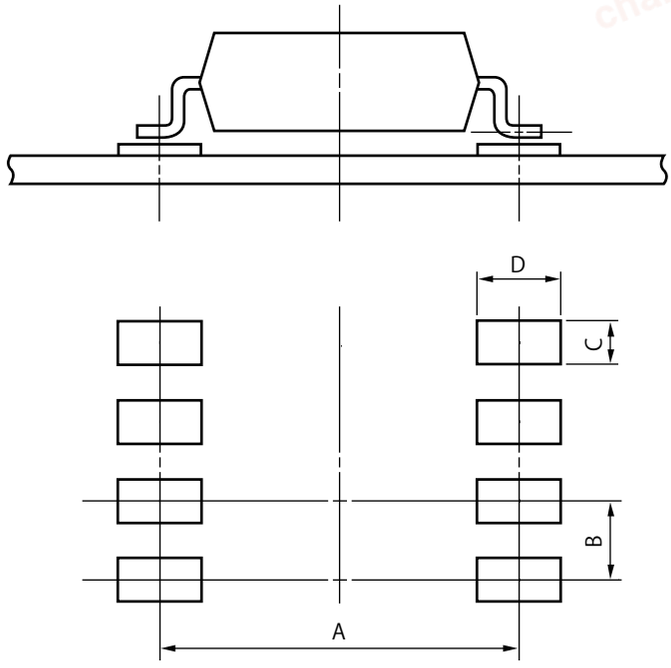



Packing: 1 000 pcs/reel

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## RECOMMENDED MOUNT PAD DIMENSIONS (UNIT: mm)




| Part Number | Lead Bending | A | B | C | D |
|---|---|---|---|---|---|
| PS9513L2 | lead bending type (Gull-wing)<br>for long creepage distance (surface mount) | 10.2 | 2.54 | 1.7 | 2.2 |
| PS9513L3 | lead bending type (Gull-wing)<br>for surface mount | 8.2 | 2.54 | 1.7 | 2.2 |

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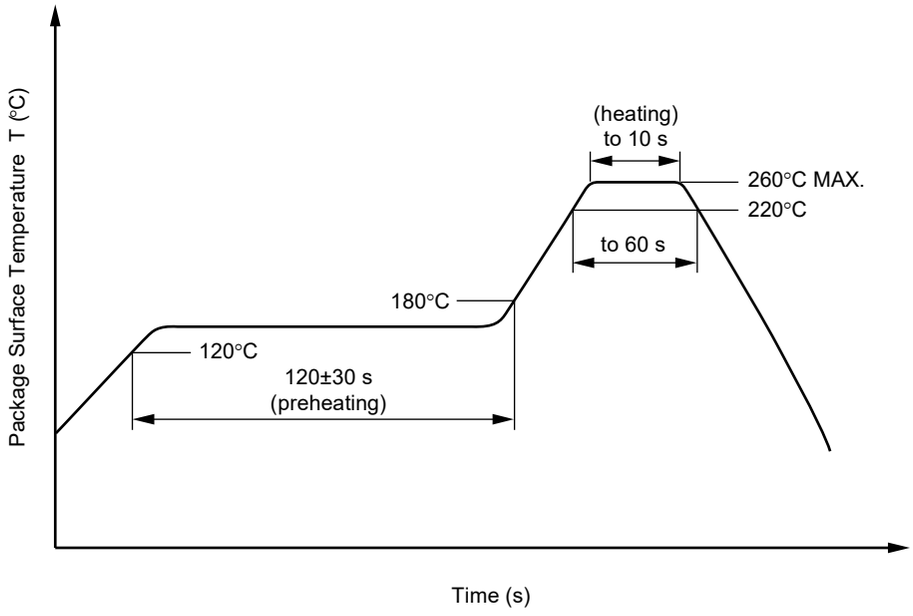
## NOTES ON HANDLING

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 halogens - based (chlorine-based) cleaning solvent .

2. Cautions regarding noise

Be aware that when voltage is applied suddenly between the photocoupler's input and output or between $V_{CC}$-GND at startup, the output transistor may enter the on state, even if the voltage is within the absolute maximum ratings.

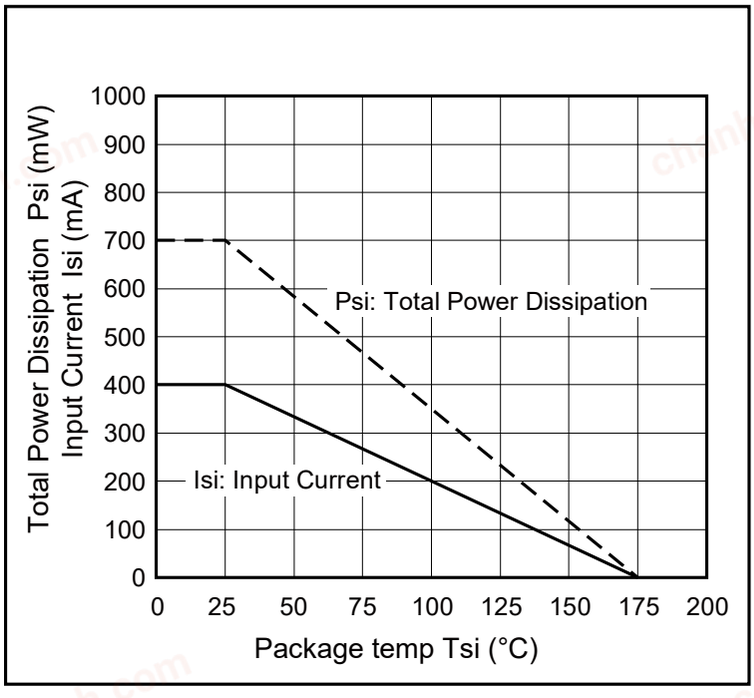
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## SPECIFICATION OF VDE MARKS LICENSE DOCUMENT

| Parameter | Symbol | Rating | Unit |
|---|---|---|---|
| Climatic test class (IEC 60068-1/DIN EN 60068-1) | | 40/100/21 | |
| Dielectric strength<br>maximum operating isolation voltage<br>Test voltage (partial discharge test, procedure a for type test and random test)<br>$U_{pr}$ = 1.6 × $U_{IORM}$, $P_d$ < 5 pC | <br>$U_{IORM}$<br>$U_{pr}$ | <br>1 130<br>1 808 | <br>$V_{peak}$<br>$V_{peak}$ |
| Test voltage (partial discharge test, procedure b for all devices)<br>$U_{pr}$ = 1.875 × $U_{IORM}$, $P_d$ < 5 pC | $U_{pr}$ | 2 119 | $V_{peak}$ |
| Highest permissible overvoltage | $U_{IOTM}$ | 8 000 | $V_{peak}$ |
| Degree of pollution (DIN EN 60664-1 VDE 0110 Part 1) | | 2 | |
| Comparative tracking index (IEC 60112/DIN EN 60112 (VDE 0303 Part 11)) | CTI | 175 | |
| Material group (DIN EN 60664-1 VDE 0110 Part 1) | | III a | |
| Storage temperature range | $T_{stg}$ | –55 to +125 | °C |
| Operating temperature range | $T_A$ | –40 to +100 | °C |
| Isolation resistance, minimum value<br>$V_{IO}$ = 500 V dc at $T_A$ = 25°C<br>$V_{IO}$ = 500 V dc at $T_A$ MAX. at least 100°C | <br>Ris MIN.<br>Ris MIN. | <br>$10^{12}$<br>$10^{11}$ | <br>Ω<br>Ω |
| Safety maximum ratings (maximum permissible in case of fault, see thermal derating curve)<br>Package temperature<br>Current (input current $I_F$, Psi = 0)<br>Power (output or total power dissipation)<br>Isolation resistance<br>$V_{IO}$ = 500 V dc at $T_A$ = Tsi | <br>Tsi<br>Isi<br>Psi<br><br>Ris MIN. | <br>175<br>400<br>700<br><br>$10^9$ | <br>°C<br>mA<br>mW<br><br>Ω |

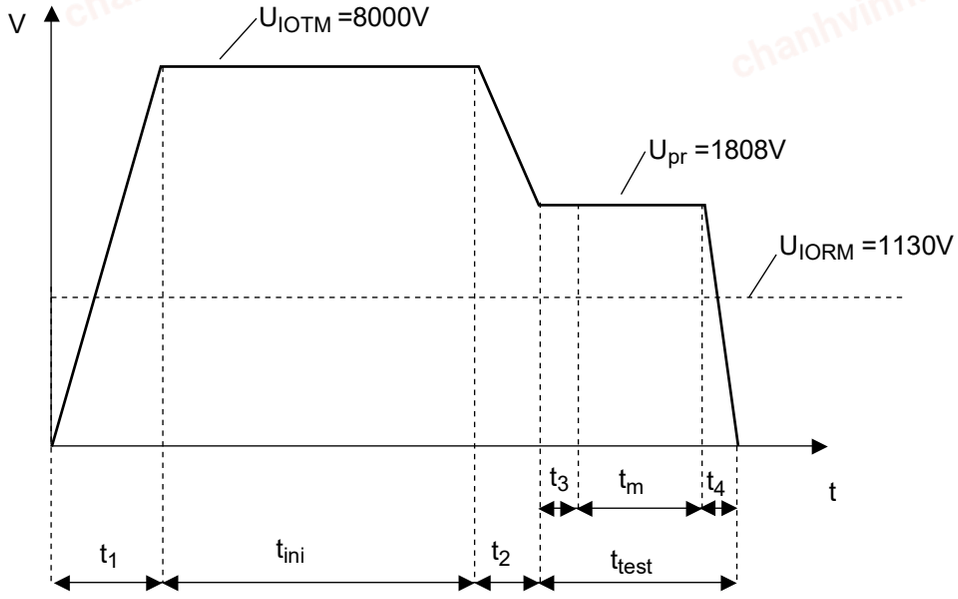
### Dependence of maximum safety ratings with package temperature



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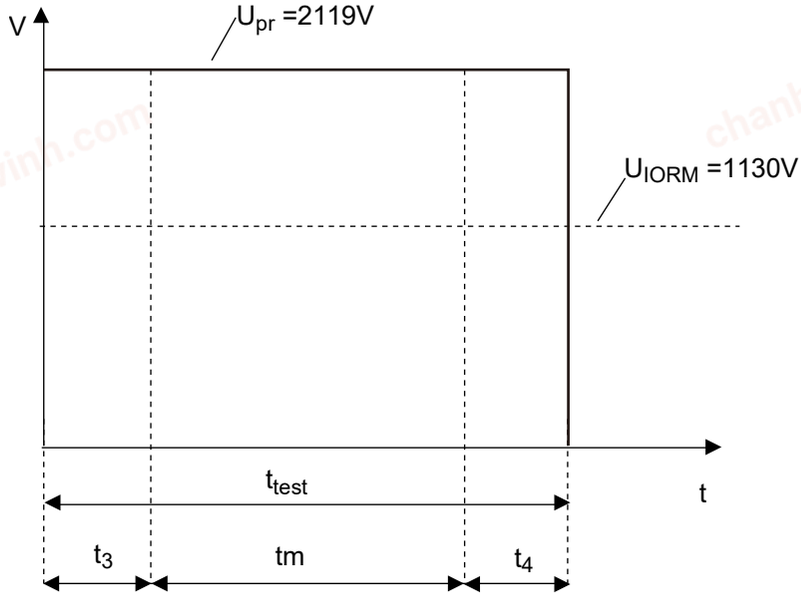


### Method a) Destructive Test, Type and Sample Test




$t_1$,$t_2$ = 1 to 10 sec
$t_3$,$t_4$ = 1 sec
$t_{m(PARTIAL\ DISCHARGE)}$= 10 sec
$t_{test}$ = 12 sec
$t_{ini}$ = 60 sec

### Method b) Non-destructive Test, 100% Production Test




$t_3$,$t_4$ = 0.1 sec
$t_{m(PARTIAL\ DISCHARGE)}$= 1.0 sec
$t_{test}$ = 1.2 sec

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| | |
|---|---|
| **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 i any way allow it to enter the mouth. |

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