

To our customers,

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## Old Company Name in Catalogs and Other Documents

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On April 1<sup>st</sup>, 2010, NEC Electronics Corporation merged with Renesas Technology Corporation, and Renesas Electronics Corporation took over all the business of both companies. Therefore, although the old company name remains in this document, it is a valid Renesas Electronics document. We appreciate your understanding.

Renesas Electronics website: <http://www.renesas.com>

April 1<sup>st</sup>, 2010  
Renesas Electronics Corporation

Issued by: Renesas Electronics Corporation (<http://www.renesas.com>)

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# PHOTOCOUPLER PS9121

### HIGH CMR, 15 Mbps OPEN COLLECTOR OUTPUT TYPE 5-PIN SOP (SO-5) 3.3 V PHOTOCOUPLER

–NEPOC Series–

#### DESCRIPTION

The PS9121 is an optically coupled high-speed, active low type isolator containing a GaAlAs LED on the input side and a photodiode and a signal processing circuit on the output side on one chip.

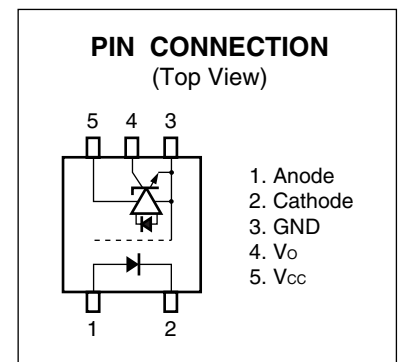
The PS9121 is designed specifically for high common mode transient immunity (CMR) and low pulse width distortion. The PS9121 is suitable for high density application.

#### FEATURES

- Low power consumption ( $V_{CC} = 3.3\text{ V}$ )
- Pulse width distortion ( $|t_{PHL} - t_{PLH}| = 35\text{ ns MAX.}$ )
- High common mode transient immunity ( $CM_H, CM_L = \pm 15\text{ kV}/\mu\text{s MIN.}$ )
- Small package (SO-5)
- High-speed (15 Mbps)
- High isolation voltage ( $BV = 3\ 750\text{ Vr.m.s.}$ )
- Open collector output
- Ordering number of taping product: PS9121-F3, F4: 2 500 pcs/reel
- Pb-Free product
- Safety standards
  - UL approved: File No. E72422
  - DIN EN60747-5-2 (VDE0884 Part2) approved No.40008902 (option)

#### APPLICATIONS

- Measurement equipment
- PDP
- FA Network

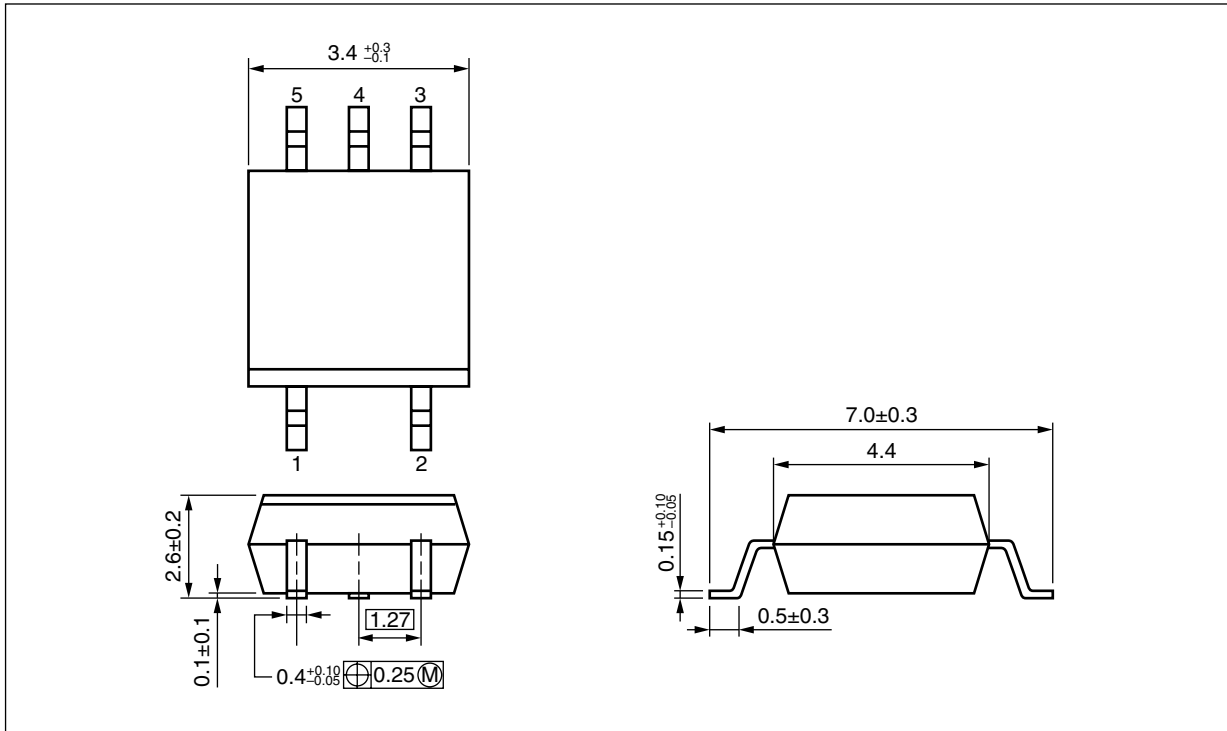


#### TRUTH TABLE

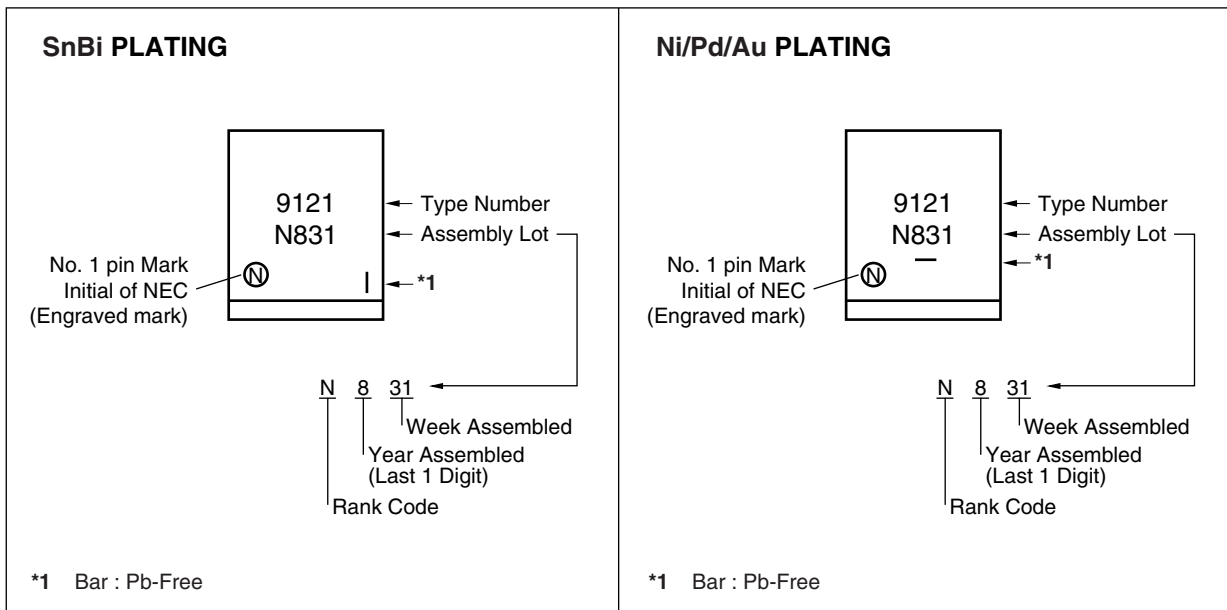
| LED | Output |
|-----|--------|
| ON  | L      |
| OFF | H      |

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PACKAGE DIMENSIONS (UNIT: mm)



<R> MARKING EXAMPLE



<R> ORDERING INFORMATION

| Part Number | Order Number   | Solder Plating Specification | Packing Style                | Safety Standards Approval          | Application Part Number <sup>*1</sup> |
|-------------|----------------|------------------------------|------------------------------|------------------------------------|---------------------------------------|
| PS9121      | PS9121-A       | Pb-Free<br>(SnBi)            | 20 pcs (Tape 20 pcs cut)     | Standard products<br>(UL approved) | PS9121                                |
| PS9121-F3   | PS9121-F3-A    |                              | Embossed Tape 2 500 pcs/reel |                                    |                                       |
| PS9121-F4   | PS9121-F4-A    |                              |                              |                                    |                                       |
| PS9121-V    | PS9121-V-A     |                              | 20 pcs (Tape 20 pcs cut)     | DIN EN60747-5-2                    |                                       |
| PS9121-V-F3 | PS9121-V-F3-A  |                              | Embossed Tape 2 500 pcs/reel | (VDE0884 Part2)                    |                                       |
| PS9121-V-F4 | PS9121-V-F4-A  |                              |                              | approved (Option)                  |                                       |
| PS9121      | PS9121-AX      | Pb-Free<br>(Ni/Pd/Au)        | 20 pcs (Tape 20 pcs cut)     | Standard products<br>(UL approved) | PS9121                                |
| PS9121-F3   | PS9121-F3-AX   |                              | Embossed Tape 2 500 pcs/reel |                                    |                                       |
| PS9121-F4   | PS9121-F4-AX   |                              |                              |                                    |                                       |
| PS9121-V    | PS9121-V-AX    |                              | 20 pcs (Tape 20 pcs cut)     | DIN EN60747-5-2                    |                                       |
| PS9121-V-F3 | PS9121-V-F3-AX |                              | Embossed Tape 2 500 pcs/reel | (VDE0884 Part2)                    |                                       |
| PS9121-V-F4 | PS9121-V-F4-AX |                              |                              | approved (Option)                  |                                       |

\*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>   | 30          | mA      |
|                                | Reverse Voltage                | V <sub>R</sub>   | 5           | V       |
| Detector                       | Supply Voltage                 | V <sub>CC</sub>  | 7           | V       |
|                                | Output Voltage                 | V <sub>O</sub>   | 7           | V       |
|                                | Output Current                 | I <sub>O</sub>   | 25          | mA      |
|                                | Power Dissipation <sup>2</sup> | P <sub>C</sub>   | 40          | mW      |
| Isolation Voltage <sup>3</sup> |                                | BV               | 3 750       | Vr.m.s. |
| Operating Ambient Temperature  |                                | T <sub>A</sub>   | -40 to +85  | °C      |
| Storage Temperature            |                                | T <sub>stg</sub> | -55 to +125 | °C      |

\*1 Reduced to 0.3 mA/°C at T<sub>A</sub> = 25°C or more.

\*2 Applies to output pin V<sub>O</sub> (collector pin). Reduced to 1.5 mW/°C at T<sub>A</sub> = 65°C or more.

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

Pins 1-2 shorted together, 3-5 shorted together.

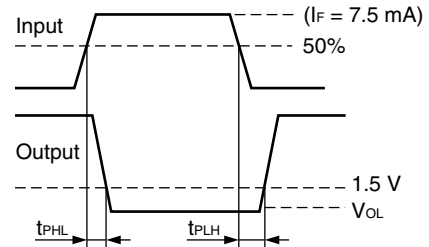
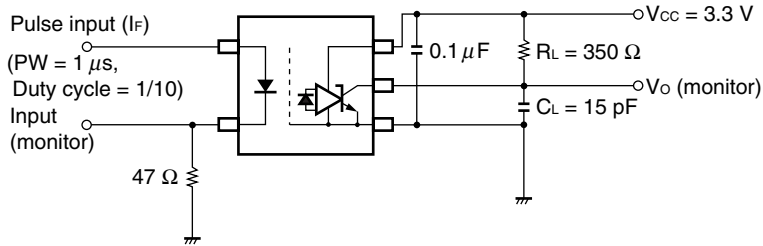
**RECOMMENDED OPERATING CONDITIONS**

| Parameter                          | Symbol          | MIN. | TYP. | MAX. | Unit |
|------------------------------------|-----------------|------|------|------|------|
| Low Level Input Voltage            | V <sub>FL</sub> | 0    |      | 0.8  | V    |
| High Level Input Current           | I <sub>FH</sub> | 6.3  | 10   | 12.5 | mA   |
| Supply Voltage                     | V <sub>CC</sub> | 2.7  | 3.3  | 3.6  | V    |
| TTL (R <sub>L</sub> = 1 kΩ, loads) | N               |      |      | 5    |      |
| Pull-up Resistor                   | R <sub>L</sub>  | 330  |      | 4 k  | Ω    |

**ELECTRICAL CHARACTERISTICS (T<sub>A</sub> = -40 to +85°C, unless otherwise specified)**

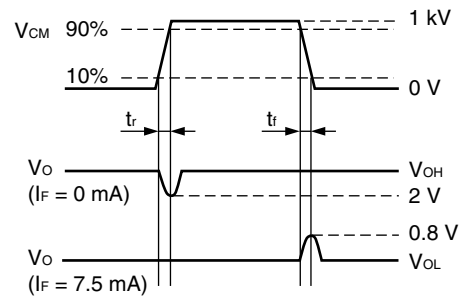
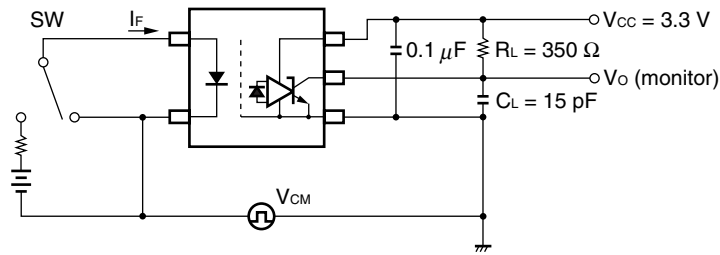
| Parameter   |   | Symbol   | Conditions   | MIN.              | TYP. <sup>1)</sup> | MAX.  | Unit |
|---|---|--|--|-------------------|--------------------|-------|------|
| Diode   | Forward Voltage                                 | V <sub>F</sub>   | I <sub>F</sub> = 10 mA, T <sub>A</sub> = 25°C                                    | 1.4               | 1.65               | 1.8   | V    |
|   | Reverse Current                                 | I <sub>R</sub>   | V <sub>R</sub> = 3 V, T <sub>A</sub> = 25°C                                      |                   |                    | 10    | μA   |
|   | Terminal Capacitance                            | C <sub>t</sub>   | V = 0 V, f = 1 MHz, T <sub>A</sub> = 25°C  |                   | 30                 |       | pF   |
| Detector  | High Level Output Current                       | I <sub>OH</sub>  | V <sub>CC</sub> = V <sub>O</sub> = 3.3 V, V <sub>F</sub> = 0.8 V                 |                   | 1                  | 80    | μA   |
|   |   |  | V <sub>CC</sub> = V <sub>O</sub> = 5.5 V, V <sub>F</sub> = 0.8 V                 |                   | 1 <sup>2)</sup>    |       |      |
|   | Low Level Output Voltage <sup>3)</sup>          | V <sub>OL</sub>  | V <sub>CC</sub> = 3.3 V, I <sub>F</sub> = 5 mA, I <sub>OL</sub> = 13 mA          |                   | 0.2                | 0.6   | V    |
|   |   |  | V <sub>CC</sub> = 5.5 V, I <sub>F</sub> = 5 mA, I <sub>OL</sub> = 13 mA          |                   | 0.2 <sup>2)</sup>  |       |      |
|   | High Level Supply Current                       | I <sub>COH</sub>   | V <sub>CC</sub> = 3.3 V, I <sub>F</sub> = 0 mA, V <sub>O</sub> = Open            |                   | 4                  | 7     | mA   |
|   |   |  | V <sub>CC</sub> = 5.5 V, I <sub>F</sub> = 0 mA, V <sub>O</sub> = Open            |                   | 5 <sup>2)</sup>    |       |      |
| Low Level Supply Current  | I <sub>COL</sub>                                | V <sub>CC</sub> = 3.3 V, I <sub>F</sub> = 10 mA, V <sub>O</sub> = Open   |  | 7                 | 10                 |       |      |
|   |   | V <sub>CC</sub> = 5.5 V, I <sub>F</sub> = 10 mA, V <sub>O</sub> = Open   |  | 9 <sup>2)</sup>   |                    |       |      |
| Coupled   | Threshold Input Current<br>(H → L)              | I <sub>FHL</sub>   | V <sub>CC</sub> = 3.3 V, V <sub>O</sub> = 0.8 V, R <sub>L</sub> = 350 Ω          |                   | 2.5                | 5     |      |
|   |   |  | V <sub>CC</sub> = 5 V, V <sub>O</sub> = 0.8 V, R <sub>L</sub> = 350 Ω            |                   | 2.5 <sup>2)</sup>  |       |      |
|   | Isolation Resistance                            | R <sub>I-O</sub>   | V <sub>I-O</sub> = 1 kV <sub>DC</sub> , RH = 40 to 60%,<br>T <sub>A</sub> = 25°C | 10 <sup>11)</sup> |                    |       | Ω    |
|   | Isolation Capacitance                           | C <sub>I-O</sub>   | V = 0 V, f = 1 MHz, T <sub>A</sub> = 25°C  |                   | 0.6                |       | pF   |
|   | Propagation Delay Time<br>(H → L) <sup>4)</sup> | t <sub>PHL</sub>   | T <sub>A</sub> = 25°C  |                   | 40                 | 75    | ns   |
|   |   |  | V <sub>CC</sub> = 3.3 V, R <sub>L</sub> = 350 Ω, I <sub>F</sub> = 7.5 mA         |                   |                    | 100   |      |
|   |   |  | V <sub>CC</sub> = 5 V, R <sub>L</sub> = 350 Ω, I <sub>F</sub> = 7.5 mA           |                   | 37 <sup>2)</sup>   |       |      |
|   | Propagation Delay Time<br>(L → H) <sup>4)</sup> | t <sub>PLH</sub>   | T <sub>A</sub> = 25°C  |                   | 45                 | 75    |      |
|   |   |  | V <sub>CC</sub> = 3.3 V, R <sub>L</sub> = 350 Ω, I <sub>F</sub> = 7.5 mA         |                   |                    | 100   |      |
|   |   |  | V <sub>CC</sub> = 5 V, R <sub>L</sub> = 350 Ω, I <sub>F</sub> = 7.5 mA           |                   | 40 <sup>2)</sup>   |       |      |
|   | Rise Time                                       | t <sub>r</sub>   | V <sub>CC</sub> = 3.3 V, R <sub>L</sub> = 350 Ω, I <sub>F</sub> = 7.5 mA         |                   | 20                 |       |      |
|   |   |  | V <sub>CC</sub> = 5 V, R <sub>L</sub> = 350 Ω, I <sub>F</sub> = 7.5 mA           |                   | 20 <sup>2)</sup>   |       |      |
|   | Fall Time                                       | t <sub>f</sub>   | V <sub>CC</sub> = 3.3 V, R <sub>L</sub> = 350 Ω, I <sub>F</sub> = 7.5 mA         |                   | 5                  |       |      |
| V <sub>CC</sub> = 5 V, R <sub>L</sub> = 350 Ω, I <sub>F</sub> = 7.5 mA  |   |  |  | 5 <sup>2)</sup>   |                    |       |      |
| Pulse Width Distortion<br>(PWD) <sup>4)</sup>                           | t <sub>PHL</sub> -t <sub>PLH</sub>              | V <sub>CC</sub> = 3.3 V, R <sub>L</sub> = 350 Ω, I <sub>F</sub> = 7.5 mA   |  | 5                 | 35                 |       |      |
|   |   | V <sub>CC</sub> = 5 V, R <sub>L</sub> = 350 Ω, I <sub>F</sub> = 7.5 mA   |  | 3 <sup>2)</sup>   |                    |       |      |
| Propagation Delay Skew  | t <sub>PSK</sub>                                | V <sub>CC</sub> = 3.3 V, R <sub>L</sub> = 350 Ω, I <sub>F</sub> = 7.5 mA   |  |                   | 40                 |       |      |
| Common Mode<br>Transient Immunity at High<br>Level Output <sup>5)</sup> | CM <sub>H</sub>                                 | V <sub>CC</sub> = 3.3 V, R <sub>L</sub> = 350 Ω, T <sub>A</sub> = 25°C,<br>I <sub>F</sub> = 0 mA, V <sub>O</sub> > 2 V, V <sub>CM</sub> = 1 kV     | 15   | 20                |                    | kV/μs |      |
|   |   | V <sub>CC</sub> = 5 V, R <sub>L</sub> = 350 Ω, T <sub>A</sub> = 25°C,<br>I <sub>F</sub> = 0 mA, V <sub>O</sub> > 2 V, V <sub>CM</sub> = 1 kV       |  | 20 <sup>2)</sup>  |                    |       |      |
| Common Mode<br>Transient Immunity at Low<br>Level Output <sup>5)</sup>  | CM <sub>L</sub>                                 | V <sub>CC</sub> = 3.3 V, R <sub>L</sub> = 350 Ω, T <sub>A</sub> = 25°C,<br>I <sub>F</sub> = 7.5 mA, V <sub>O</sub> < 0.8 V, V <sub>CM</sub> = 1 kV | 15   | 20                |                    |       |      |
|   |   | V <sub>CC</sub> = 5 V, R <sub>L</sub> = 350 Ω, T <sub>A</sub> = 25°C,<br>I <sub>F</sub> = 7.5 mA, V <sub>O</sub> < 0.8 V, V <sub>CM</sub> = 1 kV   |  | 20 <sup>2)</sup>  |                    |       |      |

- \*1 Typical values at  $T_A = 25^\circ\text{C}$
- \*2 These values are reference values.
- \*3 Because  $V_{OL}$  of 2 V or more may be output when LED current input and when output supply of  $V_{CC} = 2.6\text{ V}$  or less, it is important to confirm the characteristics (operation with the power supply on and off) during design, before using this device.
- \*4 Test circuit for propagation delay time



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

- \*5 Test circuit for common mode transient immunity



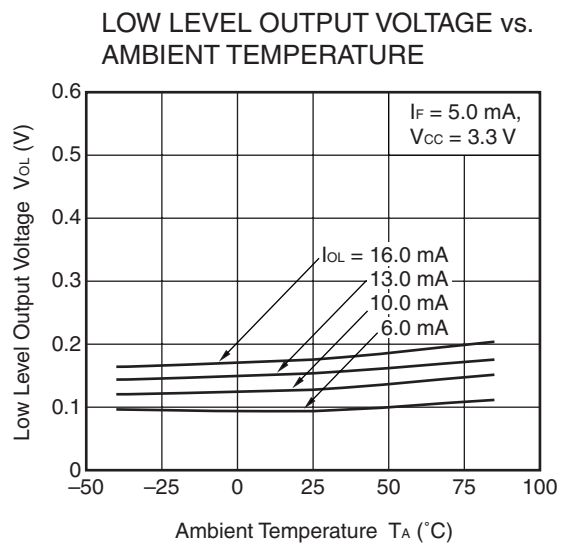
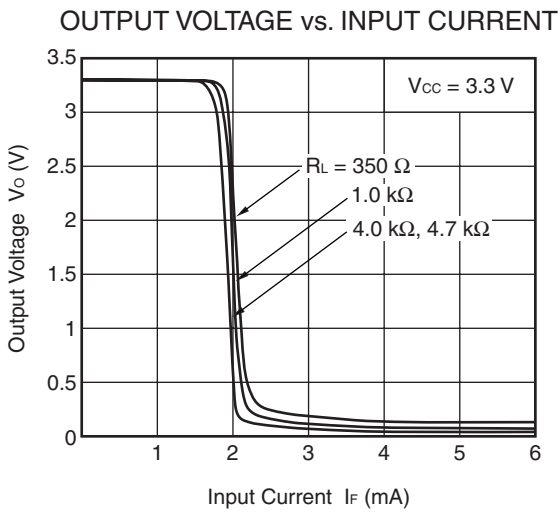
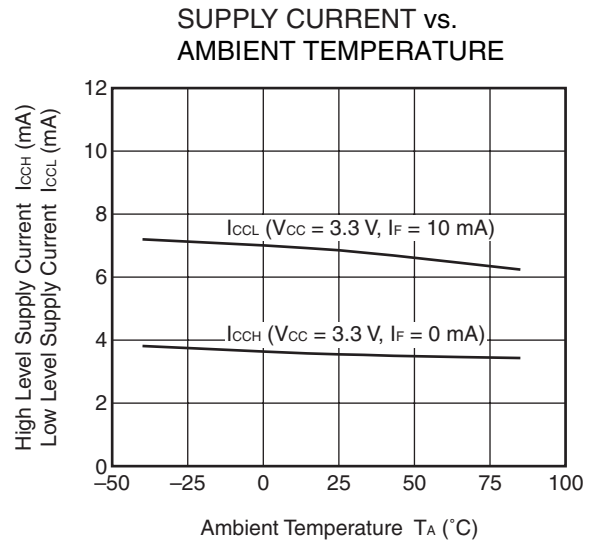
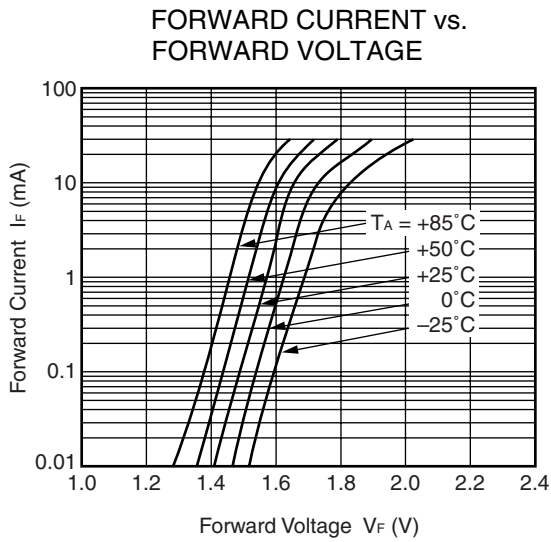
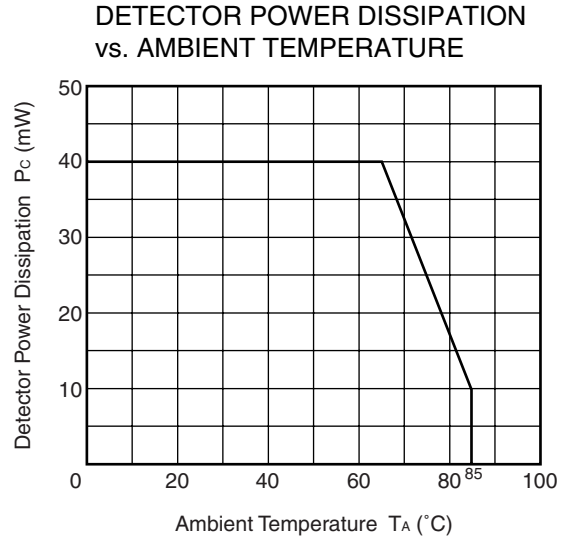
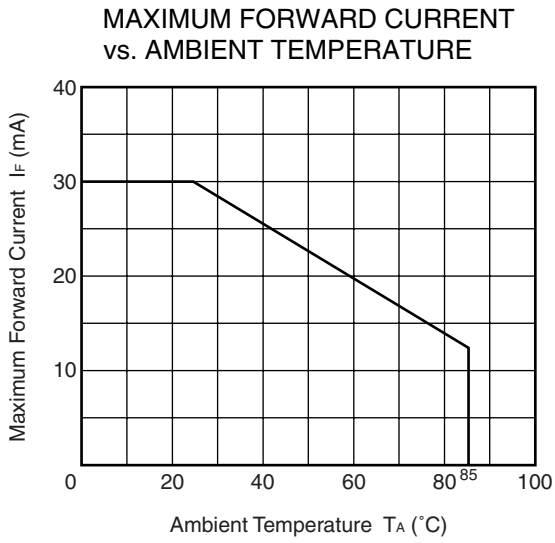
**Remark**  $C_L$  includes probe and stray wiring capacitance.

**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  $0.1\ \mu\text{F}$  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. Avoid storage at a high temperature and high humidity.

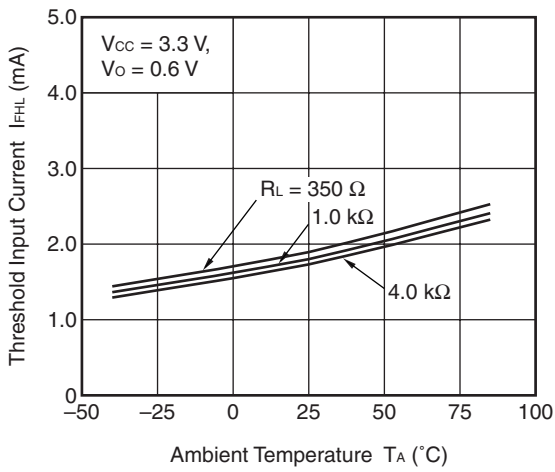


**TYPICAL CHARACTERISTICS ( $T_A = 25^\circ\text{C}$ , unless otherwise specified)**

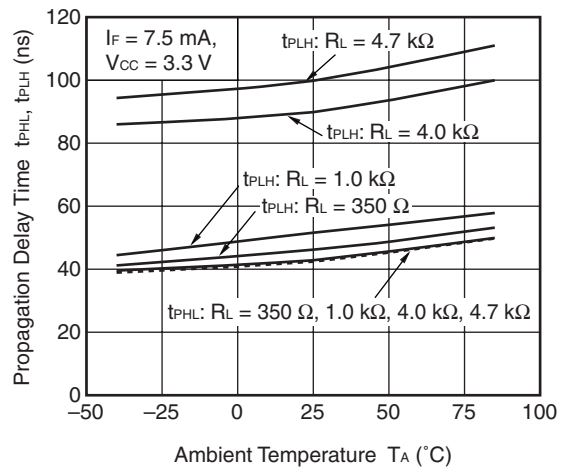


**Remark** The graphs indicate nominal characteristics.

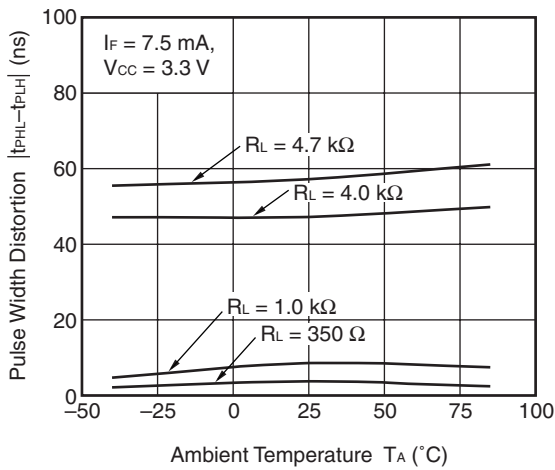
THRESHOLD INPUT CURRENT vs. AMBIENT TEMPERATURE



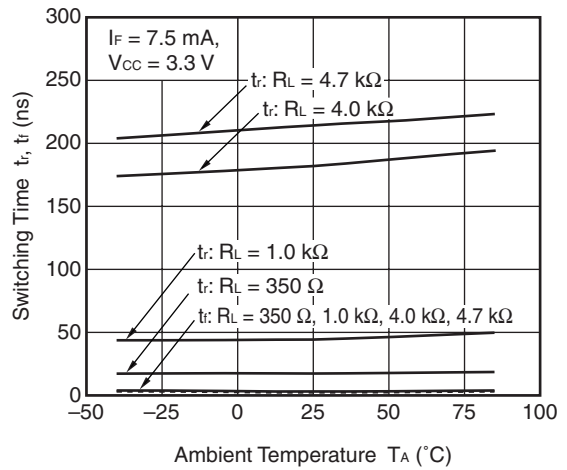
PROPAGATION DELAY TIME vs. AMBIENT TEMPERATURE



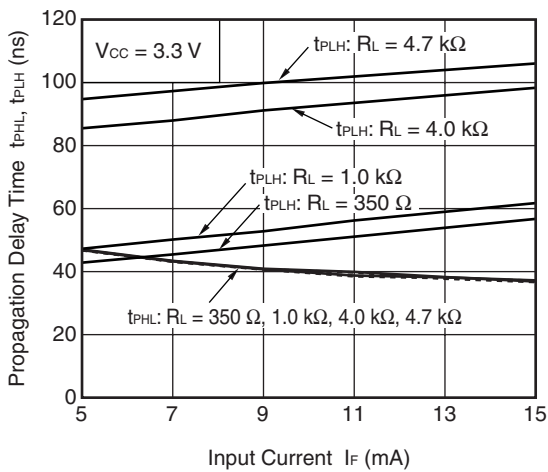
PULSE WIDTH DISTORTION vs. AMBIENT TEMPERATURE



SWITCHING TIME vs. AMBIENT TEMPERATURE



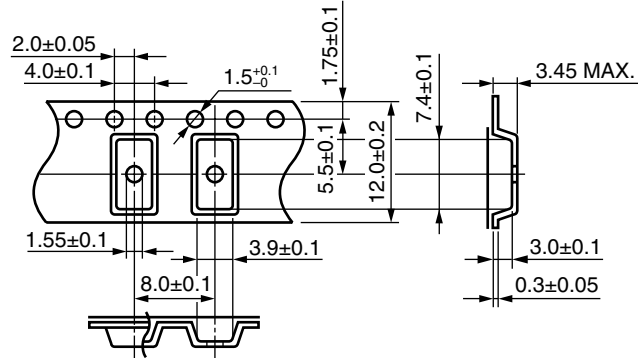
PROPAGATION DELAY TIME vs. INPUT CURRENT



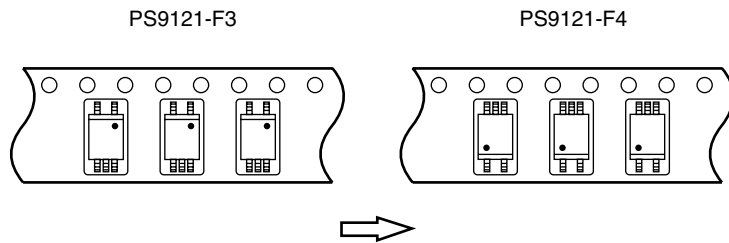
**Remark** The graphs indicate nominal characteristics.

TAPING SPECIFICATIONS (UNIT: mm)

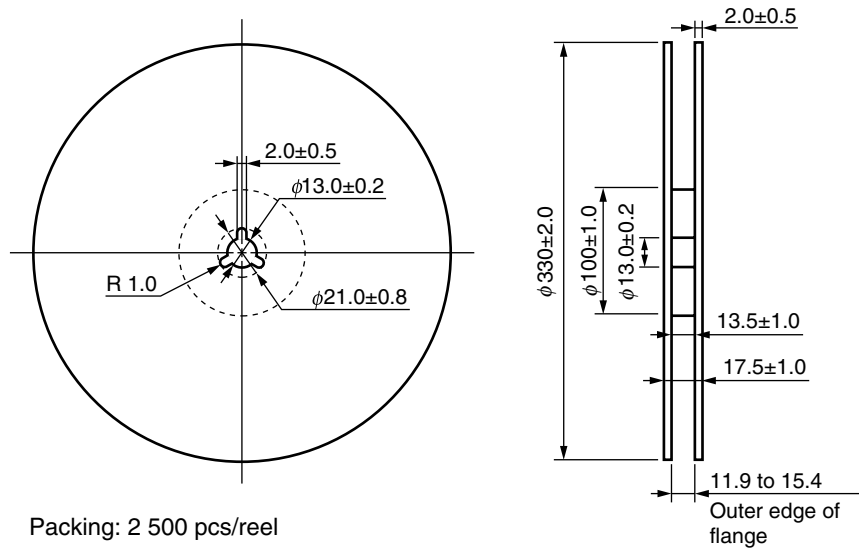
Outline and Dimensions (Tape)



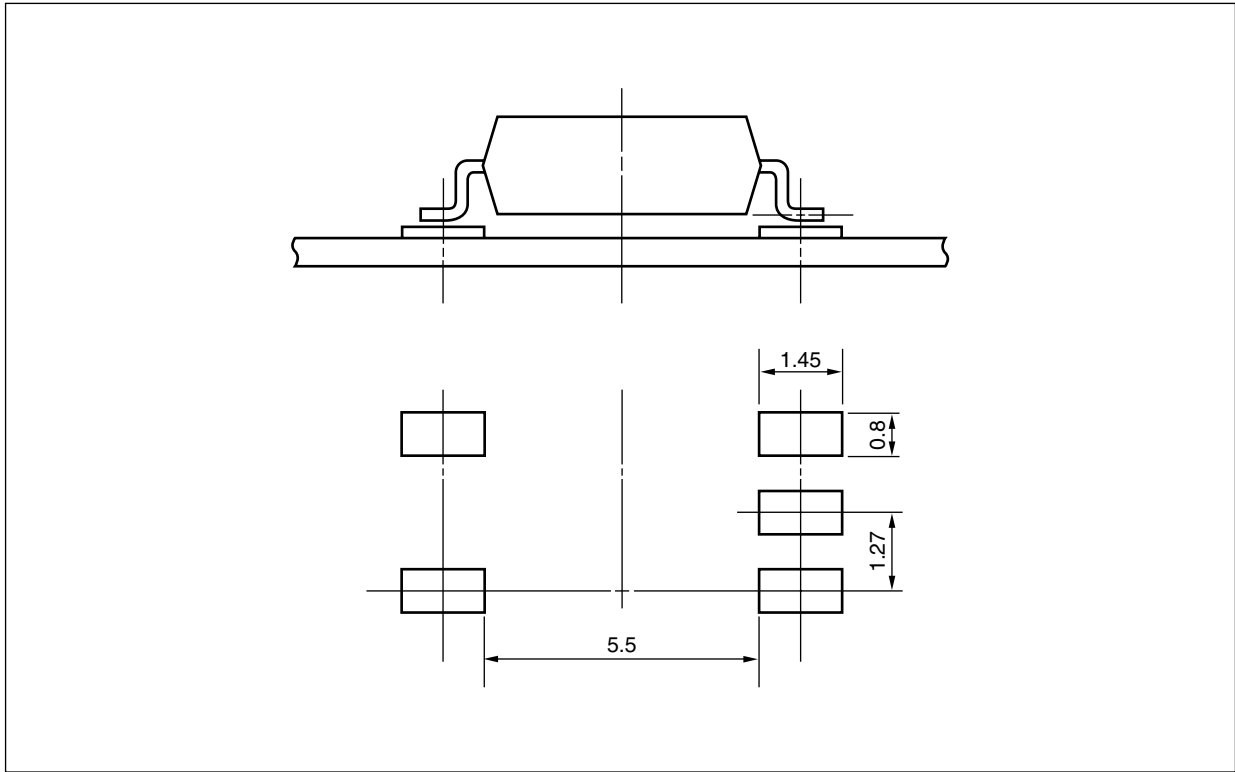
Tape Direction



Outline and Dimensions (Reel)



<R> RECOMMENDED MOUNT PAD DIMENSIONS (UNIT: mm)



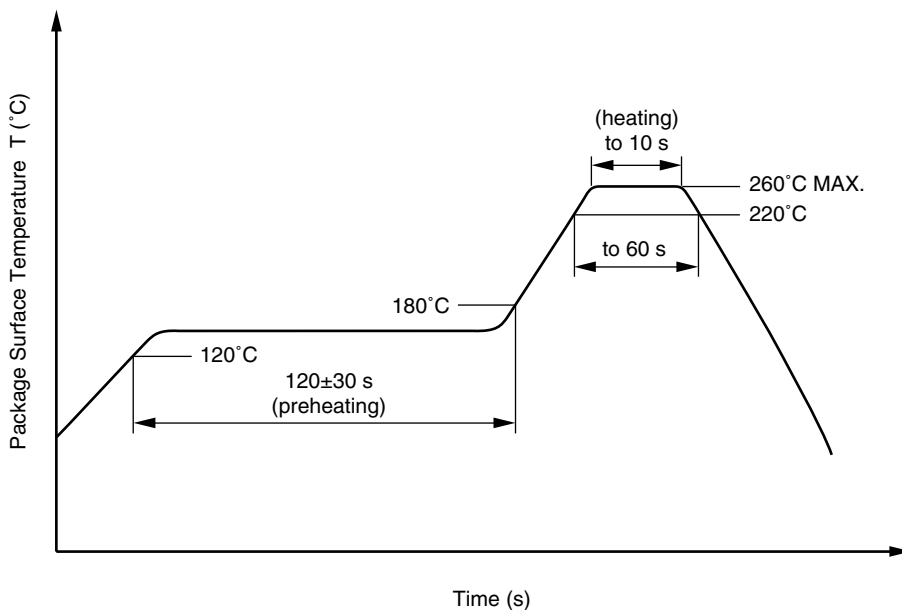
**NOTES ON HANDLING**

**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 or between collector-emitters at startup, the output transistor may enter the on state, even if the voltage is within the absolute maximum ratings.

**USAGE CAUTIONS**

1. Protect against static electricity when handling.
2. Avoid storage at a high temperature and high humidity.

<R> SPECIFICATION OF VDE MARKS LICENSE DOCUMENT

| Parameter   | Symbol                                       | Speck                       | Unit                                |
|---|--|-----------------------------|-------------------------------------|
| Application classification (DIN EN 60664-1 VDE0110 Part 1)<br>for rated line voltages $\leq 300$ Vr.m.s.<br>for rated line voltages $\leq 600$ Vr.m.s.  |  | IV<br>III                   |                                     |
| Climatic test class (DIN EN 60664-1 VDE0110)  |  | 40/85/21                    |                                     |
| Dielectric strength<br>maximum operating isolation voltage<br>Test voltage (partial discharge test, procedure a for type test and random test)<br>$U_{pr} = 1.5 \times U_{IORM}$ , $P_d < 5$ pC   | $U_{IORM}$<br>$U_{pr}$                       | 707<br>1 061                | $V_{peak}$<br>$V_{peak}$            |
| Test voltage (partial discharge test, procedure b for all devices)<br>$U_{pr} = 1.875 \times U_{IORM}$ , $P_d < 5$ pC   | $U_{pr}$                                     | 1 326                       | $V_{peak}$                          |
| Highest permissible overvoltage   | $U_{TR}$                                     | 6 000                       | $V_{peak}$                          |
| Degree of pollution (DIN EN 60664-1 VDE0110 Part 1)   |  | 2                           |                                     |
| Clearance distance  |  | >4.2                        | mm                                  |
| Creepage distance   |  | >4.2                        | mm                                  |
| Comparative tracking index (DIN IEC 112/VDE 0303 Part 1)  | CTI  | 175                         |                                     |
| Material group (DIN EN 60664-1 VDE0110 Part 1)  |  | III a                       |                                     |
| Storage temperature range   | $T_{stg}$                                    | -55 to +125                 | $^{\circ}C$                         |
| Operating temperature range   | $T_A$  | -40 to +85                  | $^{\circ}C$                         |
| Isolation resistance, minimum value<br>$V_{IO} = 500$ V dc at $T_A = 25^{\circ}C$<br>$V_{IO} = 500$ V dc at $T_A$ MAX. at least $100^{\circ}C$  | 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)<br>Package temperature<br>Current (input current $I_F$ , $P_{si} = 0$ )<br>Power (output or total power dissipation)<br>Isolation resistance<br>$V_{IO} = 500$ V dc at $T_A = T_{si}$ | $T_{si}$<br>$I_{si}$<br>$P_{si}$<br>Ris MIN. | 150<br>200<br>300<br>$10^9$ | $^{\circ}C$<br>mA<br>mW<br>$\Omega$ |

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|-------------------------------------|---|
| <p><b>Caution</b> GaAs Products</p> | <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> |
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