

## 1 Mbps, OPEN COLLECTOR OUTPUT HIGH CMR, INTELLIGENT POWER MODULE 5-PIN SOP PHOTOCOUPLER FOR CREEPAGE DISTANCE OF 5.5 mm

–NEPOC Series–

### DESCRIPTION

The PS9213 is an optically coupled isolator containing a GaAlAs LED on the input side and a photo diode and a signal processing circuit on the output side on one chip.

The PS9213 is designed specifically for high common mode transient immunity (CMR) and low pulse width distortion with operating temperature. It is suitable for IPM drive.

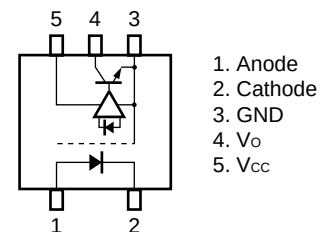
### FEATURES

- Long creepage distance (5.5 mm MIN.)
- High common mode transient immunity ( $CM_H$ ,  $CM_L = \pm 15 \text{ kV}/\mu\text{s}$  MIN.)
- High-speed response ( $t_{PHL} = 500 \text{ ns}$  MAX.,  $t_{PLH} = 750 \text{ ns}$  MAX.)
- Maximum propagation delays ( $t_{PLH} - t_{PHL} = 270 \text{ ns}$  TYP.)
- Pulse width distortion ( $|t_{PHL} - t_{PLH}| = 270 \text{ ns}$  TYP.)
- Ordering number of taping product: PS9213-F3, F4: 2 500 pcs/reel
- Pb-Free product
- Safety standards
  - UL approved: File No. E72422
  - DIN EN60747-5-2 (VDE0884 Part2) approved No.40008347 (Option)

### APPLICATIONS

- IPM Driver
- General purpose inverter

### PIN CONNECTION (Top View)

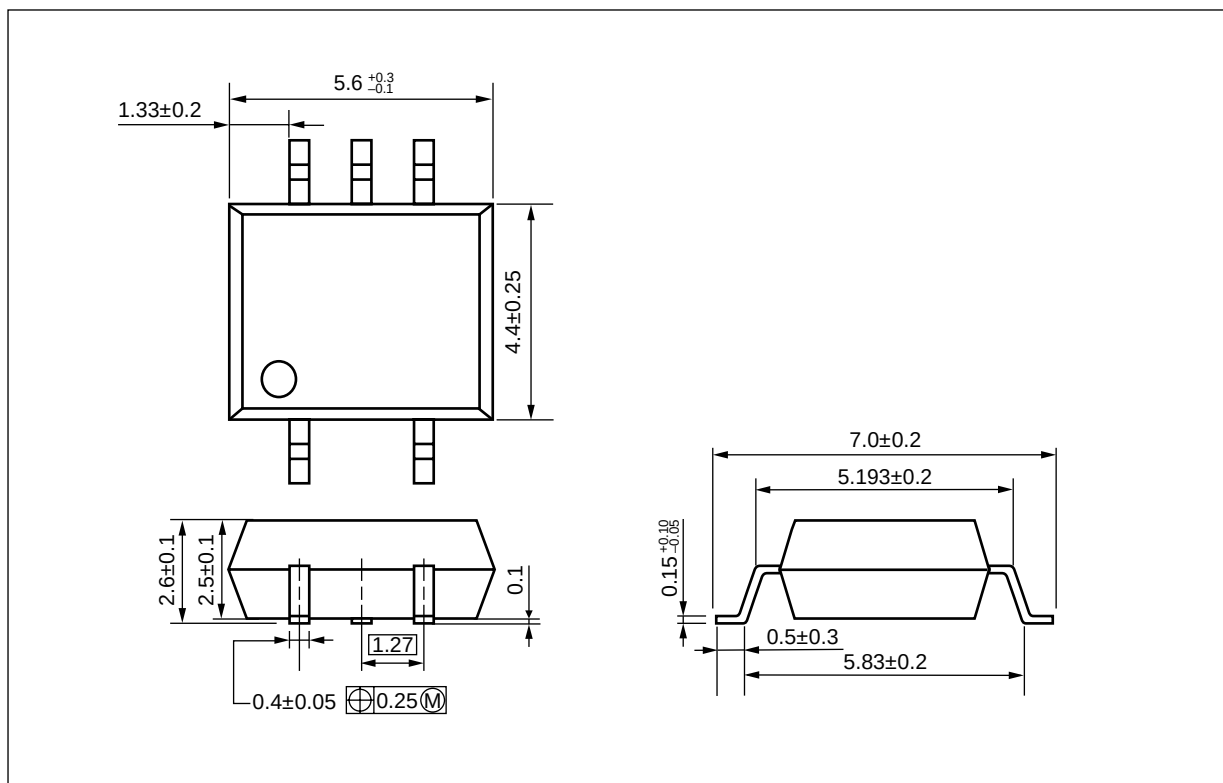


### TRUTH TABLE

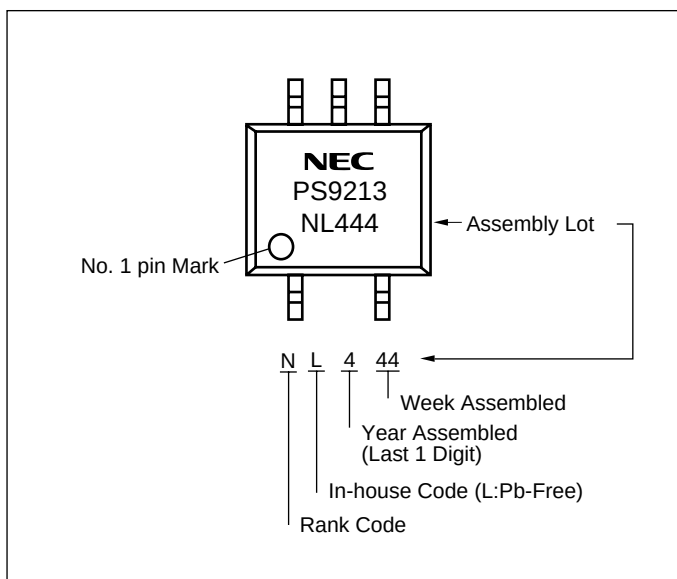
| LED | Output |
|-----|--------|
| ON  | L      |
| OFF | H      |

The information in this document is subject to change without notice. Before using this document, please confirm that this is the latest version.

**PACKAGE DIMENSIONS (UNIT: mm)**



**MARKING EXAMPLE**



**★ ORDERING INFORMATION**

| Part Number | Order Number  | Solder Plating Specification | Packing Style                | Safety Standard Approval           | Application Part Number <sup>*1</sup> |
|-------------|---------------|------------------------------|------------------------------|------------------------------------|---------------------------------------|
| PS9213      | PS9213-A      | Pb-Free                      | 20 pcs (Tape 20 pcs cut)     | Standard products<br>(UL approved) | PS9213                                |
| PS9213-F3   | PS9213-F3-A   |                              | Embossed Tape 2 500 pcs/reel |                                    |                                       |
| PS9213-F4   | PS9213-F4-A   |                              |                              |                                    |                                       |
| PS9213-V    | PS9213-V-A    |                              | 20 pcs (Tape 20 pcs cut)     | DIN EN60747-5-2                    |                                       |
| PS9213-V-F3 | PS9213-V-F3-A |                              | Embossed Tape 2 500 pcs/reel | (VDE0884 Part2)                    |                                       |
| PS9213-V-F4 | PS9213-V-F4-A |                              |                              | approved (Option)                  |                                       |

<sup>\*1</sup> 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>   | 25          | mA      |
|                                 | Reverse Voltage                 | V <sub>R</sub>   | 5           | V       |
| Detector                        | Supply Voltage                  | V <sub>CC</sub>  | -0.5 to +35 | V       |
|                                 | Output Voltage                  | V <sub>O</sub>   | -0.5 to +35 | V       |
|                                 | Output Current                  | I <sub>O</sub>   | 15          | mA      |
|                                 | Power Dissipation <sup>*2</sup> | P <sub>C</sub>   | 100         | mW      |
| Isolation Voltage <sup>*3</sup> |                                 | BV               | 2 500       | Vr.m.s. |
| Operating Ambient Temperature   |                                 | T <sub>A</sub>   | -40 to +100 | °C      |
| Storage Temperature             |                                 | T <sub>stg</sub> | -55 to +125 | °C      |

<sup>\*1</sup> Reduced to 0.33 mA/°C at T<sub>A</sub> = 70°C or more.

<sup>\*2</sup> Reduced to 1.9 mW/°C at T<sub>A</sub> = 70°C or more.

<sup>\*3</sup> 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**

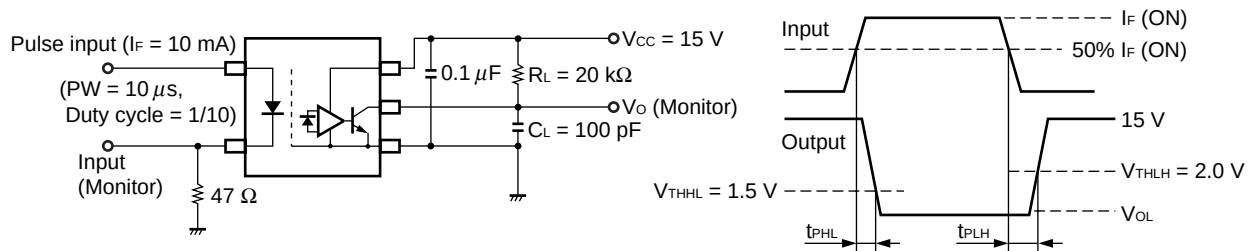
| Parameter                | Symbol          | MIN. | TYP. | MAX. | Unit |
|--------------------------|-----------------|------|------|------|------|
| High Level Input Current | I <sub>FH</sub> | 10   |      | 20   | mA   |
| Output Voltage           | V <sub>O</sub>  | 0    |      | 30   | V    |
| Supply Voltage           | V <sub>CC</sub> | 4.5  | 15   | 30   | V    |
| LED Off Voltage          | V <sub>F</sub>  | 0    |      | 0.8  | V    |

**★ ELECTRICAL CHARACTERISTICS ( $T_A = -40$  to  $+100^\circ\text{C}$ ,  $V_{CC} = 15\text{ V}$ , unless otherwise specified)**

| Parameter |                                                                   | Symbol                | Conditions                                                                                                                                                  | MIN.      | TYP.* <sup>1</sup> | MAX. | Unit              |
|-----------|-------------------------------------------------------------------|-----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|--------------------|------|-------------------|
| Diode     | Forward Voltage                                                   | $V_F$                 | $I_F = 10\text{ mA}$                                                                                                                                        | 1.3       | 1.65               | 2.1  | V                 |
|           | Reverse Current                                                   | $I_R$                 | $V_R = 3\text{ V}$                                                                                                                                          |           |                    | 200  | $\mu\text{A}$     |
|           | Terminal Capacitance                                              | $C_t$                 | $V = 0\text{ V}$ , $f = 1\text{ MHz}$ , $T_A = 25^\circ\text{C}$                                                                                            |           | 30                 |      | pF                |
| Detector  | Low Level Output Voltage                                          | $V_{OL}$              | $I_F = 10\text{ mA}$ , $I_{OL} = 2.4\text{ mA}$                                                                                                             |           | 0.13               | 0.6  | V                 |
|           | High Level Output Current                                         | $I_{OH}$              | $V_{CC} = V_O = 30\text{ V}$ , $V_F = 0.8\text{ V}$                                                                                                         |           | 0.01               | 50   | $\mu\text{A}$     |
|           | High Level Supply Current                                         | $I_{CCH}$             | $V_{CC} = 30\text{ V}$ , $V_F = 0.8\text{ V}$ , $V_O = \text{open}$                                                                                         |           | 0.6                | 1.3  | mA                |
|           | Low Level Supply Current                                          | $I_{CCL}$             | $V_{CC} = 30\text{ V}$ , $I_F = 10\text{ mA}$ , $V_O = \text{open}$                                                                                         |           | 0.6                | 1.3  | mA                |
| Coupled   | Threshold Input Current ( $H \rightarrow L$ )                     | $I_{FHL}$             | $V_O = 0.8\text{ V}$ , $I_O = 0.75\text{ mA}$                                                                                                               |           | 1.5                | 5.0  | mA                |
|           | Current Transfer Ratio ( $I_C/I_F$ )                              | CTR                   | $I_F = 10\text{ mA}$ , $V_O = 0.6\text{ V}$                                                                                                                 | 44        | 110                |      | %                 |
|           | Isolation Resistance                                              | $R_{I-O}$             | $V_{I-O} = 1\text{ kV}_{DC}$ , $R_H = 40$ to $60\%$ , $T_A = 25^\circ\text{C}$                                                                              | $10^{11}$ |                    |      | $\Omega$          |
|           | Isolation Capacitance                                             | $C_{I-O}$             | $V_{I-O} = 0\text{ V}$ , $f = 1\text{ MHz}$ , $T_A = 25^\circ\text{C}$                                                                                      |           | 1.5                |      | pF                |
|           | Propagation Delay Time ( $H \rightarrow L$ )* <sup>2</sup>        | $t_{PHL}$             | $I_F = 10\text{ mA}$ , $R_L = 20\text{ k}\Omega$ , $C_L = 100\text{ pF}$ ,<br>$V_{THHL} = 1.5\text{ V}$ , $V_{THLH} = 2.0\text{ V}$                         |           | 250                | 500  | ns                |
|           | Propagation Delay Time ( $L \rightarrow H$ )* <sup>2</sup>        | $t_{PLH}$             |                                                                                                                                                             |           | 520                | 750  |                   |
|           | Maximum Propagation Delays                                        | $t_{PLH} - t_{PHL}$   |                                                                                                                                                             | -200      | 270                | 650  |                   |
|           | Pulse Width Distortion (PWD)* <sup>2</sup>                        | $ t_{PHL} - t_{PLH} $ |                                                                                                                                                             |           | 270                | 650  |                   |
|           | Common Mode Transient Immunity at High Level Output* <sup>3</sup> | $CM_H$                | $T_A = 25^\circ\text{C}$ , $I_F = 0\text{ mA}$ , $V_O > 3.0\text{ V}$ ,<br>$V_{CM} = 1.5\text{ kV}$ , $R_L = 20\text{ k}\Omega$ ,<br>$C_L = 100\text{ pF}$  | 15        |                    |      | kV/ $\mu\text{s}$ |
|           | Common Mode Transient Immunity at Low Level Output* <sup>3</sup>  | $CM_L$                | $T_A = 25^\circ\text{C}$ , $I_F = 10\text{ mA}$ , $V_O < 1.0\text{ V}$ ,<br>$V_{CM} = 1.5\text{ kV}$ , $R_L = 20\text{ k}\Omega$ ,<br>$C_L = 100\text{ pF}$ | 15        |                    |      | kV/ $\mu\text{s}$ |

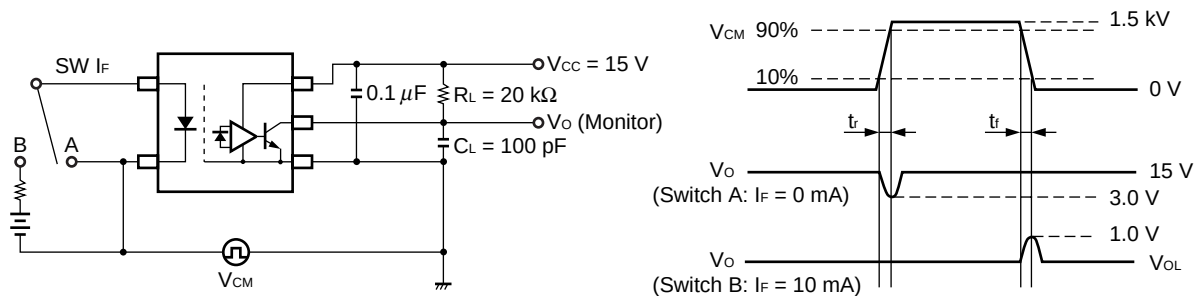
\*1 Typical values at  $T_A = 25^\circ\text{C}$ .

\*2 Test circuit for propagation delay time



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

\*3 Test circuit for common mode transient immunity



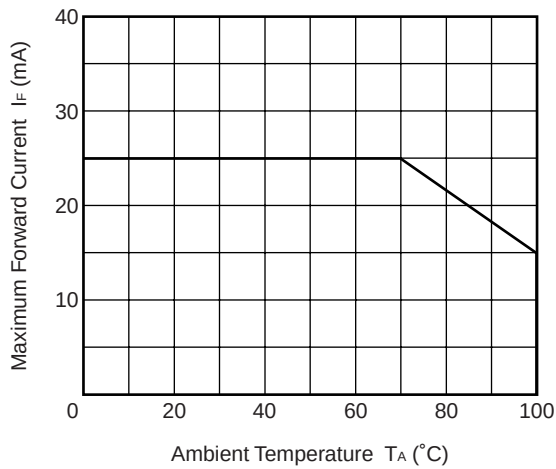
**Remark**  $C_L$  includes probe and stray wiring capacitance.

## USAGE CAUTIONS

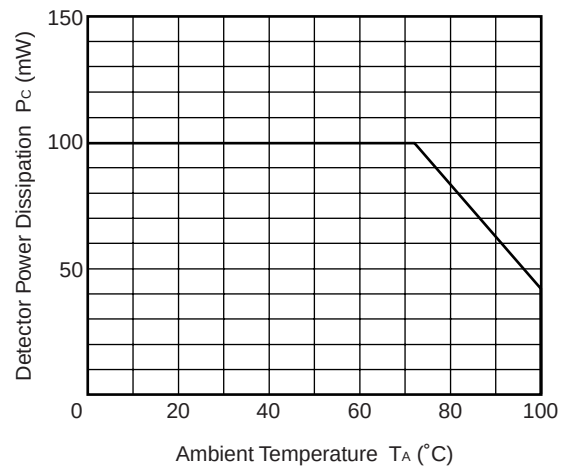
1. This product is weak for static electricity by designed with high-speed integrated circuit so protect against static electricity when handling.
2. By-pass capacitor of  $0.1\text{ }\mu\text{F}$  is used between  $V_{CC}$  and GND near device. Also, ensure that the distance between the leads of the photocoupler and capacitor is no more than  $10\text{ mm}$ .
3. Avoid storage at a high temperature and high humidity.

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

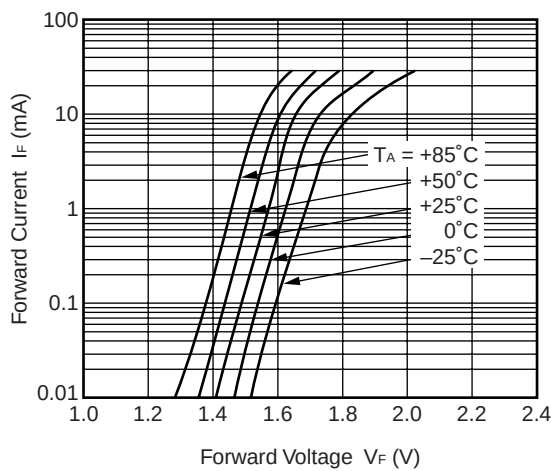
MAXIMUM FORWARD CURRENT  
vs. AMBIENT TEMPERATURE



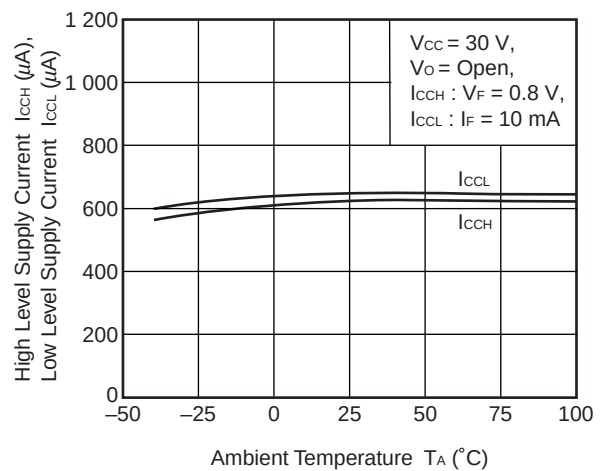
DETECTOR POWER DISSIPATION  
vs. AMBIENT TEMPERATURE



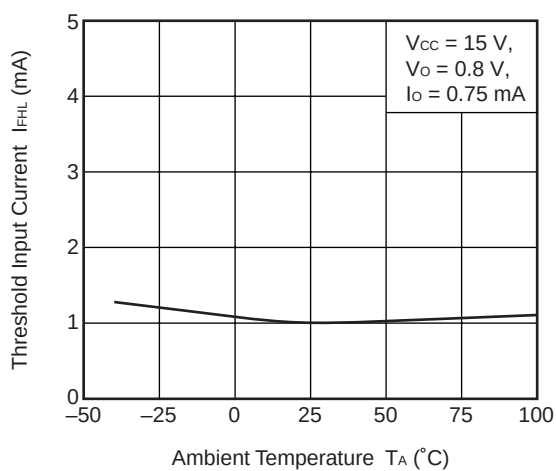
FORWARD CURRENT vs.  
FORWARD VOLTAGE



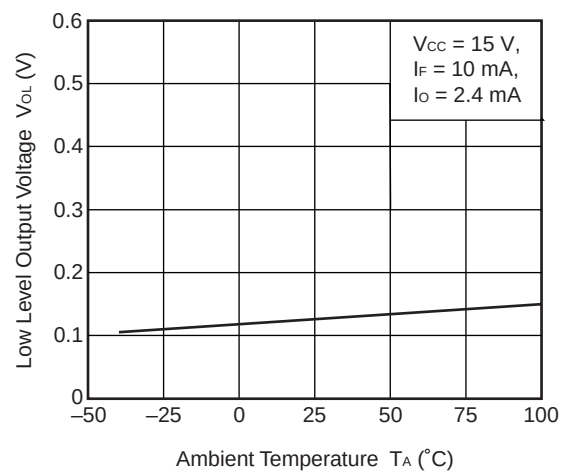
SUPPLY CURRENT vs.  
AMBIENT TEMPERATURE



THRESHOLD INPUT CURRENT vs.  
AMBIENT TEMPERATURE

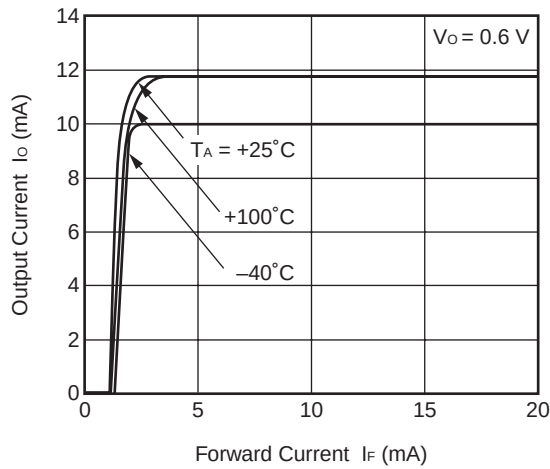


LOW LEVEL OUTPUT VOLTAGE vs.  
AMBIENT TEMPERATURE

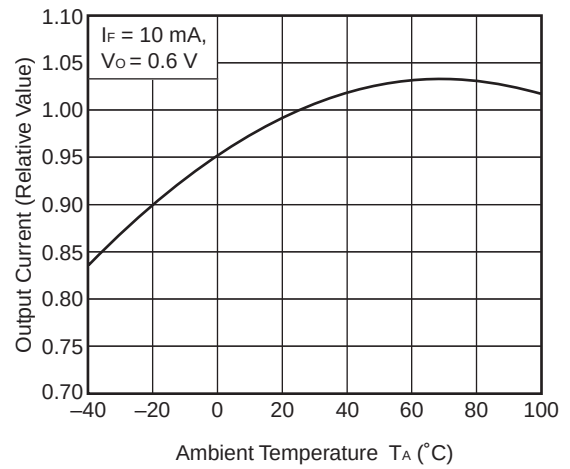


**Remark** The graphs indicate nominal characteristics.

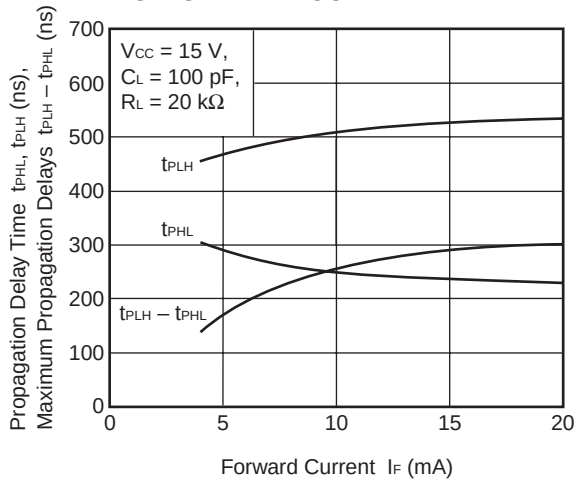
OUTPUT CURRENT vs. FORWARD CURRENT



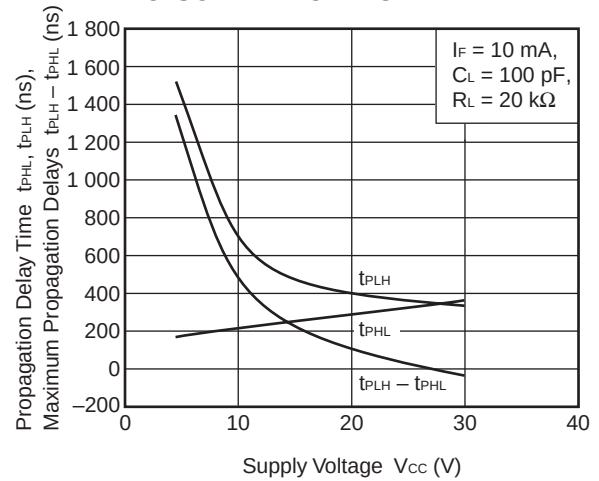
OUTPUT CURRENT vs. AMBIENT TEMPERATURE



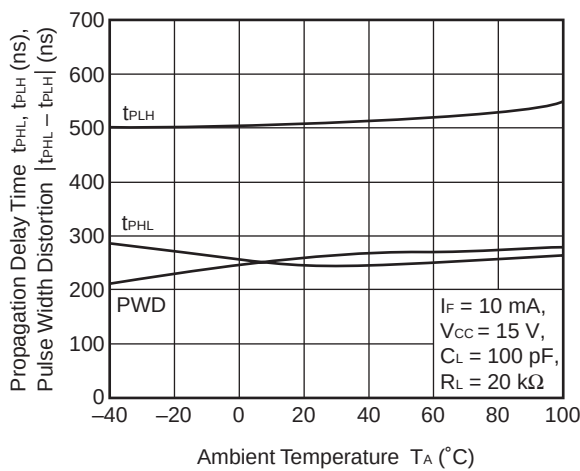
PROPAGATION DELAY TIME, MAXIMUM PROPAGATION DELAYS vs. FORWARD CURRENT



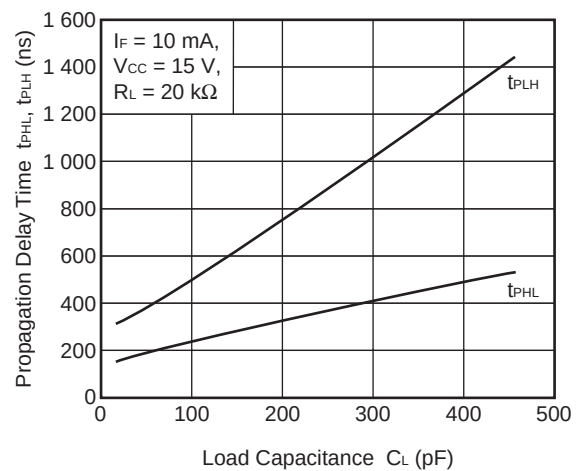
PROPAGATION DELAY TIME, MAXIMUM PROPAGATION DELAYS vs. SUPPLY VOLTAGE



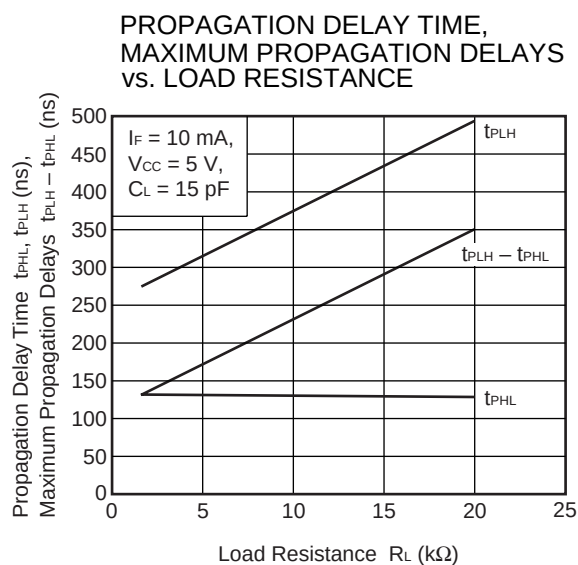
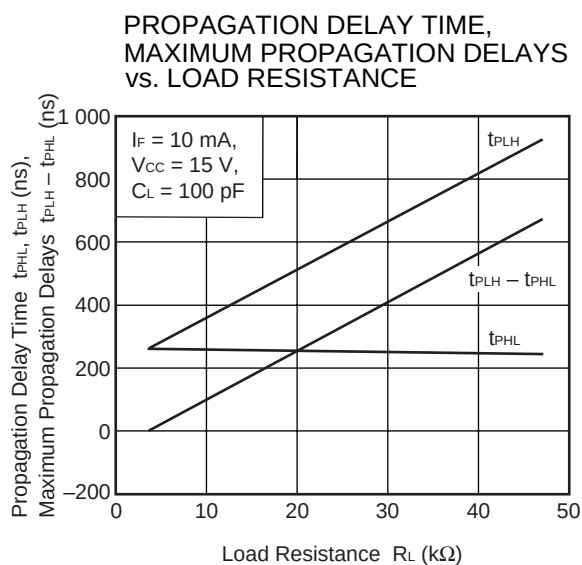
PROPAGATION DELAY TIME, PULSE WIDTH DISTORTION vs. AMBIENT TEMPERATURE



PROPAGATION DELAY TIME vs. LOAD CAPACITANCE



**Remark** The graphs indicate nominal characteristics.

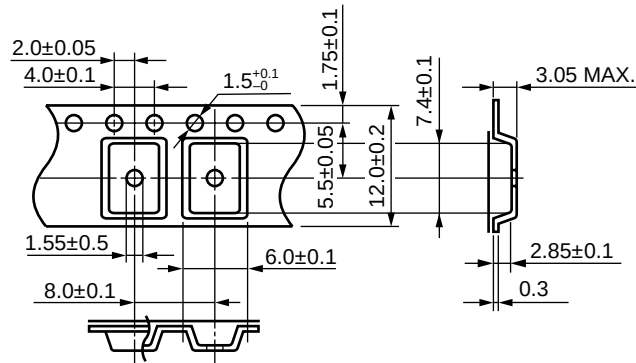


**Remark** The graphs indicate nominal characteristics.

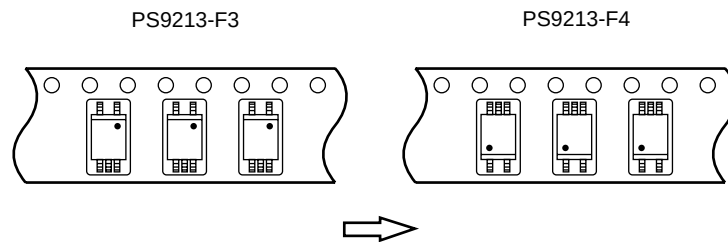


TAPING SPECIFICATIONS (UNIT: mm)

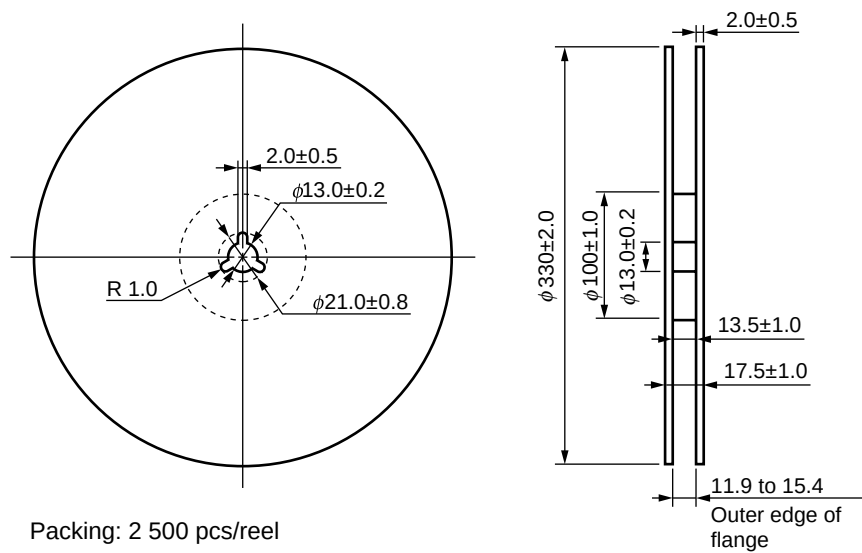
Outline and Dimensions (Tape)



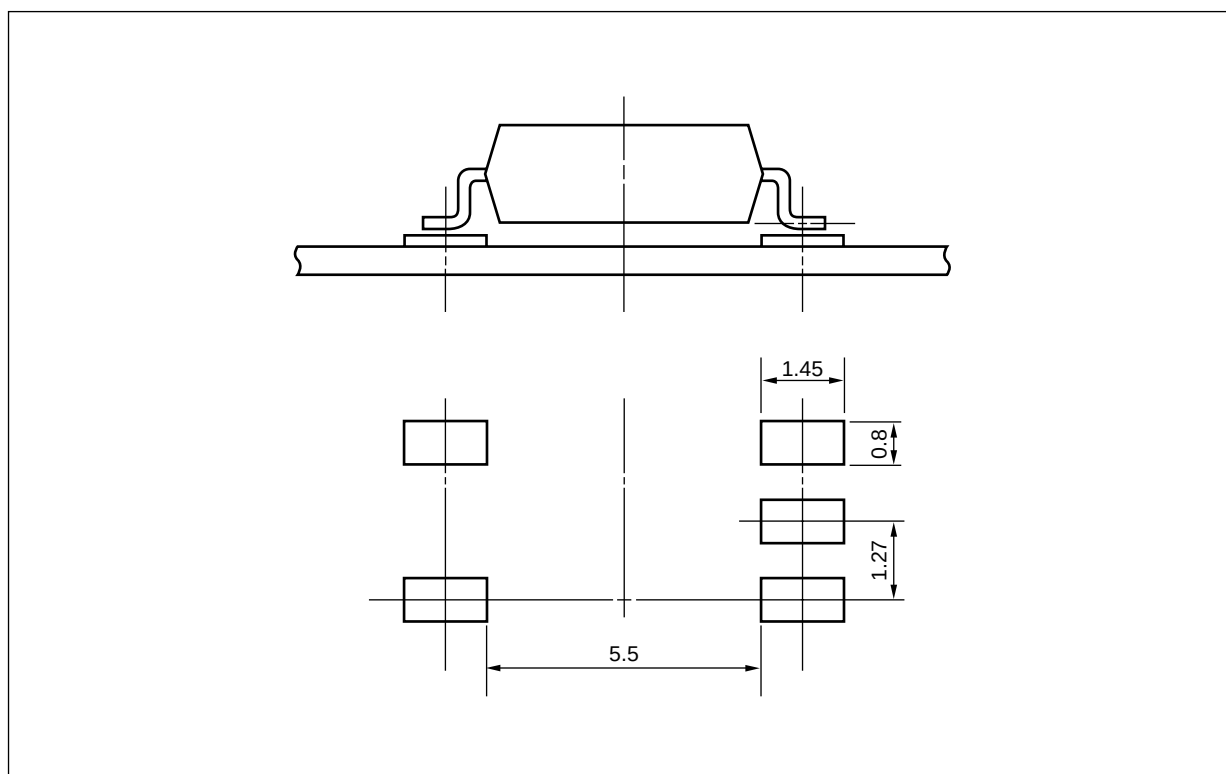
Tape Direction



Outline and Dimensions (Reel)



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



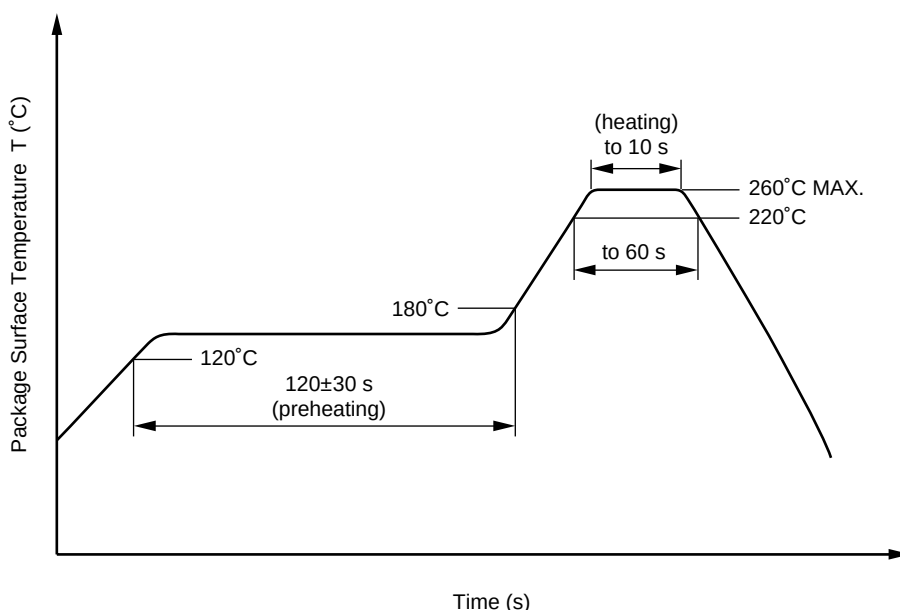
## NOTES ON HANDLING

### 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.

Subject: Compliance with EU Directives

CEL certifies, to its knowledge, that semiconductor and laser products detailed below are compliant with the requirements of European Union (EU) Directive 2002/95/EC Restriction on Use of Hazardous Substances in electrical and electronic equipment (RoHS) and the requirements of EU Directive 2003/11/EC Restriction on Penta and Octa BDE.

CEL Pb-free products have the same base part number with a suffix added. The suffix –A indicates that the device is Pb-free. The –AZ suffix is used to designate devices containing Pb which are exempted from the requirement of RoHS directive (\*). In all cases the devices have Pb-free terminals. All devices with these suffixes meet the requirements of the RoHS directive.

This status is based on CEL's understanding of the EU Directives and knowledge of the materials that go into its products as of the date of disclosure of this information.

| Restricted Substance per RoHS | Concentration Limit per RoHS (values are not yet fixed) | Concentration contained in CEL devices |     |
|-------------------------------|---------------------------------------------------------|----------------------------------------|-----|
|                               |                                                         | -A                                     | -AZ |
| Lead (Pb)                     | < 1000 PPM                                              | Not Detected                           | (*) |
| Mercury                       | < 1000 PPM                                              | Not Detected                           |     |
| Cadmium                       | < 100 PPM                                               | Not Detected                           |     |
| Hexavalent Chromium           | < 1000 PPM                                              | Not Detected                           |     |
| PBB                           | < 1000 PPM                                              | Not Detected                           |     |
| PBDE                          | < 1000 PPM                                              | Not Detected                           |     |

If you should have any additional questions regarding our devices and compliance to environmental standards, please do not hesitate to contact your local representative.

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