

# PHOTOCOUPLER

## PS9687L1, PS9687L2

**HIGH CMR, 10 Mbps OPEN COLLECTOR OUTPUT TYPE**  
**8-PIN DIP PHOTOCOUPLER**  
**FOR CREEPAGE DISTANCE OF 8 mm**

—NEPOC Series—

### DESCRIPTION

The PS9687L1 and PS9687L2 are optically coupled isolators 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 PS9687L1 and PS9687L2 are designed specifically for long creepage-distance as well as high common mode transient immunity (CMR) and high speed digital output type. Consequently, they are suitable for high speed logic interface that needs long creepage-distance (8 mm) on mounting.

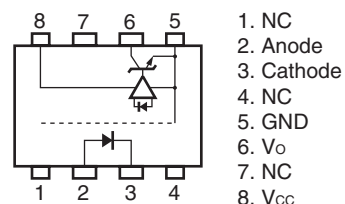
The PS9687L1 is in a plastic DIP (Dual In-line Package) and the PS9687L2 is lead bending type (Gull-wing) for surface mounting.

### FEATURES

- Long creepage distance (8 mm MIN.)
- High common mode transient immunity ( $CM_H, CM_L = \pm 20 \text{ kV}/\mu\text{s}$  TYP.)
- High isolation voltage ( $BV = 5\,000 \text{ Vr.m.s.}$ )
- High-speed response (10 Mbps)
- Pulse width distortion ( $|t_{PHL} - t_{PLH}| = 15 \text{ ns}$  TYP.)
- Open collector output
- Ordering number of tape product: PS9687L2-E3, E4: 1 000 pcs/reel
- Safety standards
  - UL approved: File No. E72422
  - BSI approved: No. 8990/8991
  - DIN EN60747-5-2 (VDE0884 Part2) approved: No.40008906 (Option)

### PIN CONNECTIONS

(Top View)



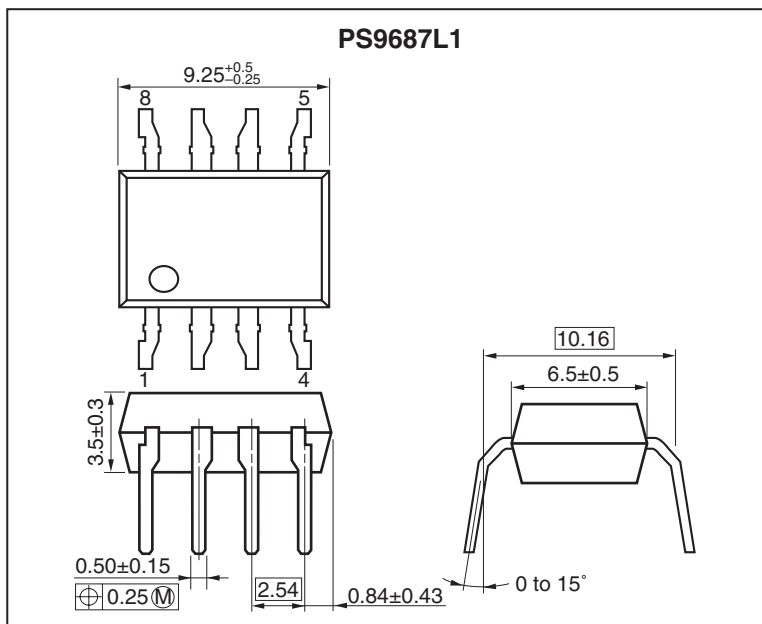
### APPLICATIONS

- FA Network
- Measurement equipment
- PDP

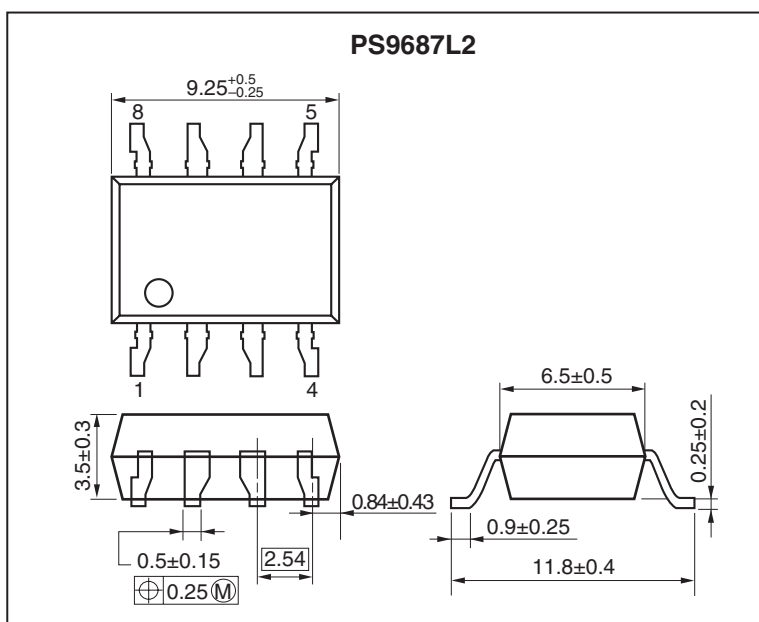
The information in this document is subject to change without notice. Before using this document, please confirm that this is the latest version.  
 Not all devices/types available in every country. Please check with local NEC Compound Semiconductor Devices representative for availability and additional information.

PACKAGE DIMENSIONS (UNIT: mm)

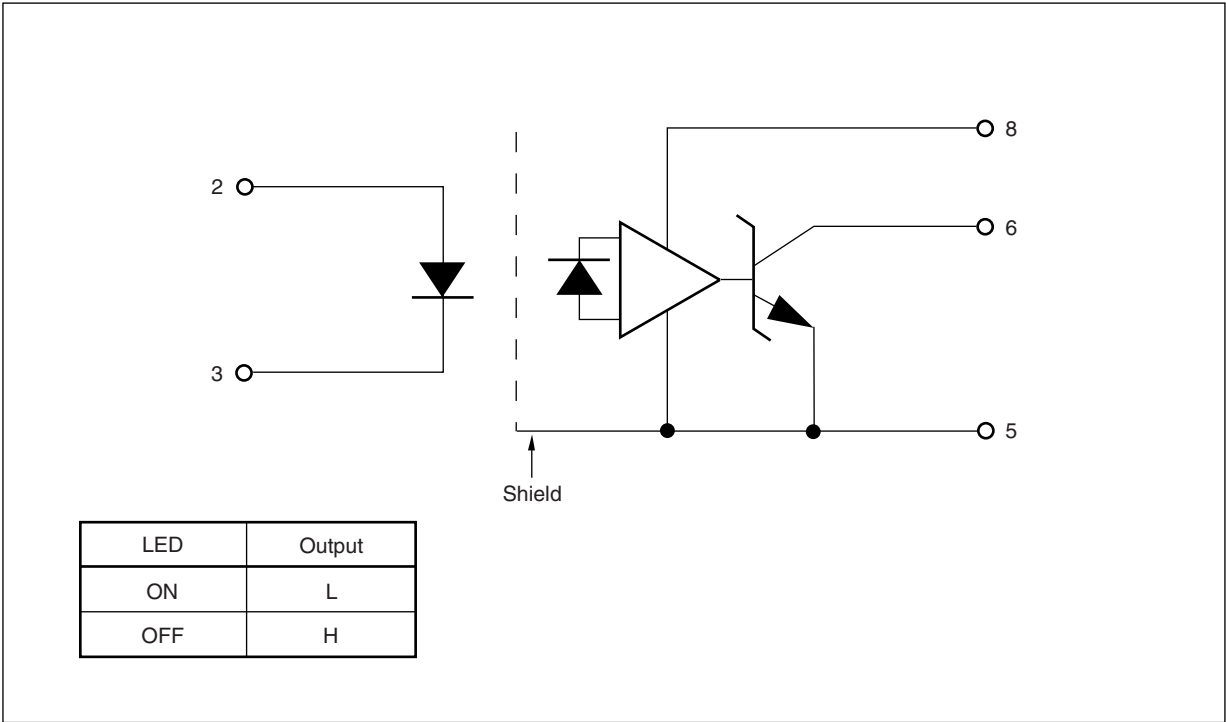
DIP Type



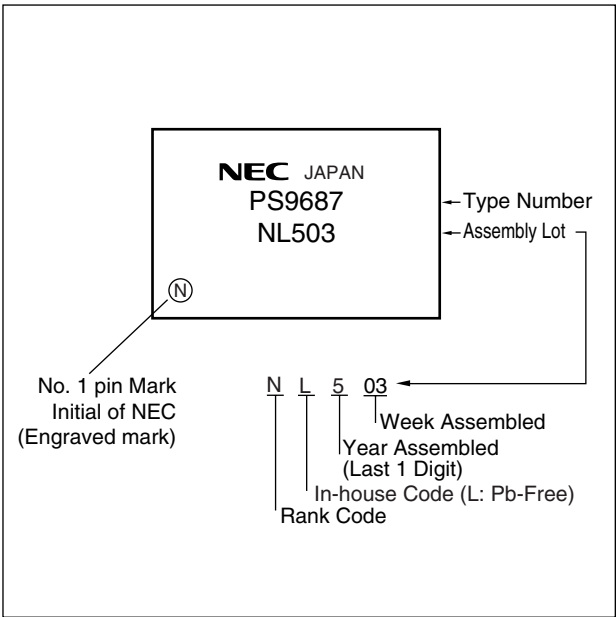
Lead Bending Type



FUNCTIONAL DIAGRAM



MARKING EXAMPLE



# ORDERING INFORMATION

Part Number	Order Number	Solder Plating Specification	Packing Style	Safety Standard Approval	Application Part Number* <sup>1</sup>
PS9687L1	PS9687L1-A	Pb-Free	Magazine case 50 pcs	Standard products (UL, BSI approved)	PS9687L1
PS9687L2	PS9687L2-A		Embossed Tape 1 000 pcs/reel		PS9687L2
PS9687L2-E3	PS9687L2-E3-A				
PS9687L2-E4	PS9687L2-E4-A				
PS9687L1-V	PS9687L1-V-A		Magazine case 50 pcs	DIN EN60747-5-2 (VDE0884 Part2) approved (Option)	PS9687L1
PS9687L2-V	PS9687L2-V-A		Embossed Tape 1 000 pcs/reel		PS9687L2
PS9687L2-V-E3	PS9687L2-V-E3-A				
PS9687L2-V-E4	PS9687L2-V-E4-A				

\*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	5 000	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 1-4 shorted together, 5-8 shorted together.

# RECOMMENDED OPERATING CONDITIONS (T<sub>A</sub> = 25°C)

Parameter	Symbol	MIN.	TYP.	MAX.	Unit
High Level Input Current	I <sub>FH</sub>	6.3	10	12.0	mA
Low Level Input Voltage	V <sub>FL</sub>	0		0.8	V
Supply Voltage	V <sub>CC</sub>	4.5	5.0	5.5	V
TTL (R <sub>L</sub> = 1 kΩ, loads)	N			5	
Pull-up Resistance	R <sub>L</sub>	330		4 k	Ω

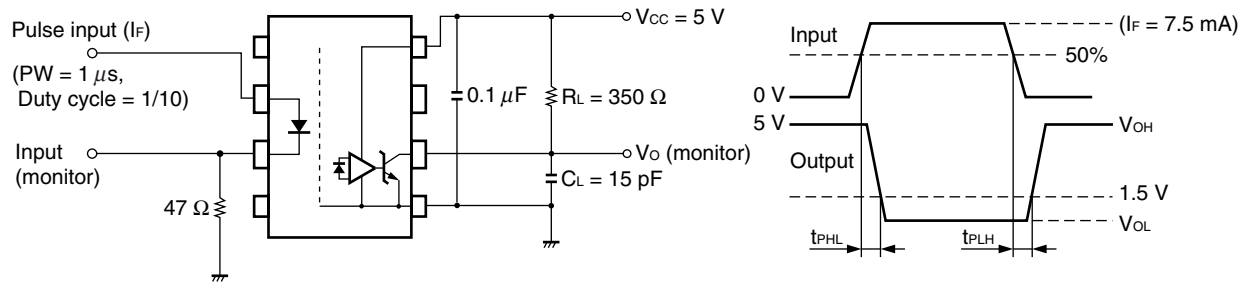
**ELECTRICAL CHARACTERISTICS ( $T_A = -40$  to  $+85^\circ\text{C}$ , unless otherwise specified)**

Parameter		Symbol	Conditions	MIN.	TYP. <sup>1)</sup>	MAX.	Unit
Diode	Forward Voltage	$V_F$	$I_F = 10\text{ mA}$ , $T_A = 25^\circ\text{C}$	1.4	1.65	1.8	V
	Reverse Current	$I_R$	$V_R = 3\text{ V}$ , $T_A = 25^\circ\text{C}$			10	$\mu\text{A}$
	Terminal Capacitance	$C_t$	$V_F = 0\text{ V}$ , $f = 1\text{ MHz}$ , $T_A = 25^\circ\text{C}$		30	150	pF
Detector	High Level Output Current	$I_{OH}$	$V_{CC} = V_O = 5.5\text{ V}$ , $V_F = 0.8\text{ V}$		1	100	$\mu\text{A}$
	Low Level Output Voltage <sup>2)</sup>	$V_{OL}$	$V_{CC} = 5.5\text{ V}$ , $I_F = 5\text{ mA}$ , $I_{OL} = 13\text{ mA}$		0.35	0.6	V
	High Level Supply Current	$I_{CCH}$	$V_{CC} = 5.5\text{ V}$ , $I_F = 0\text{ mA}$ , $V_O = \text{Open}$		6	10	mA
	Low Level Supply Current	$I_{CCL}$	$V_{CC} = 5.5\text{ V}$ , $I_F = 10\text{ mA}$ , $V_O = \text{Open}$		11	13	mA
Coupled	Threshold Input Current (H $\rightarrow$ L)	$I_{FHL}$	$V_{CC} = 5\text{ V}$ , $V_O = 0.8\text{ V}$ , $R_L = 350\ \Omega$		2.5	5	mA
	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	$C_{I-O}$	$V = 0\text{ V}$ , $f = 1\text{ MHz}$ , $T_A = 25^\circ\text{C}$		0.9	5	pF
	Propagation Delay Time (H $\rightarrow$ L) <sup>3)</sup>	$t_{PHL}$	$V_{CC} = 5\text{ V}$ , $T_A = 25^\circ\text{C}$		40	75	ns
			$R_L = 350\ \Omega$ , $I_F = 7.5\text{ mA}$ , $C_L = 15\text{ pF}$			100	
	Propagation Delay Time (L $\rightarrow$ H) <sup>3)</sup>	$t_{PLH}$	$T_A = 25^\circ\text{C}$		55	75	ns
						100	
	Rise Time	$t_r$			20		ns
	Fall Time	$t_f$			10		ns
	Pulse Width Distortion (PWD) <sup>3)</sup>	$ t_{PHL} - t_{PLH} $			15	50	ns
	Propagation Delay Skew	$t_{PSK}$				60	ns
	Common Mode Transient Immunity at High Level Output <sup>4)</sup>	$CM_H$	$V_{CC} = 5\text{ V}$ , $T_A = 25^\circ\text{C}$ , $I_F = 0\text{ mA}$ , $V_{O(MIN.)} = 2\text{ V}$ , $V_{CM} = 1\text{ kV}$ , $R_L = 350\ \Omega$	10	20		kV/ $\mu\text{s}$
	Common Mode Transient Immunity at Low Level Output <sup>4)</sup>	$CM_L$	$V_{CC} = 5\text{ V}$ , $T_A = 25^\circ\text{C}$ , $I_F = 7.5\text{ mA}$ , $V_{O(MAX.)} = 0.8\text{ V}$ , $V_{CM} = 1\text{ kV}$ , $R_L = 350\ \Omega$	10	20		kV/ $\mu\text{s}$

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

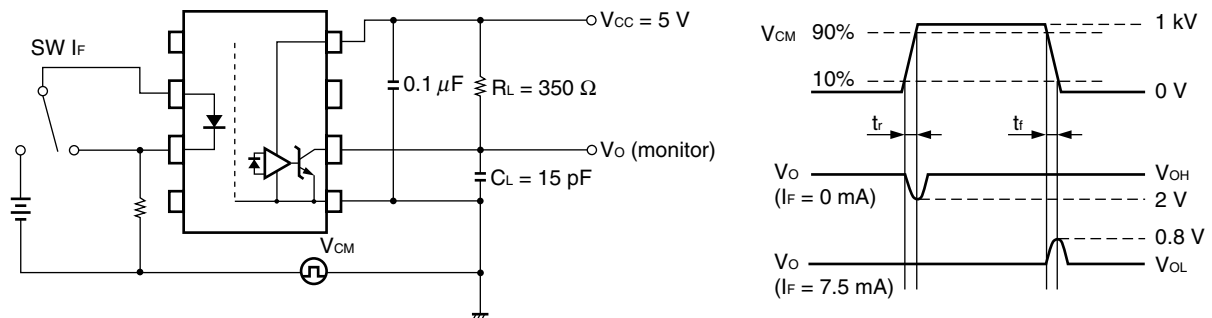
\*2 Because  $V_{OL}$  of 2 V or more may be output when LED current is input and when output power supply is on and off, confirm the characteristics (operation with the power supply on and off) during design, before using this device.

\*3 Test circuit for propagation delay time



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

\*4 Test circuit for common mode transient immunity



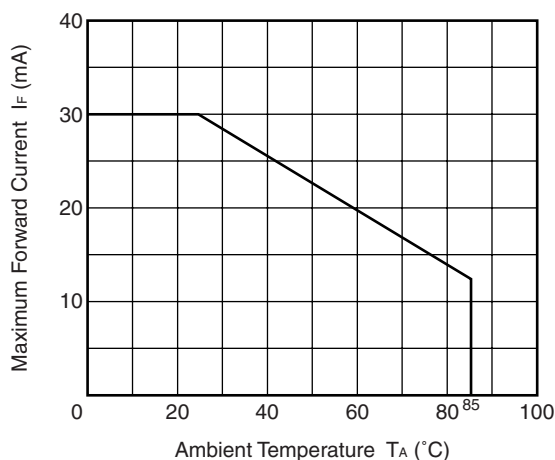
**Remark**  $C_L$  includes probe and stray wiring capacitance.

## USAGE CAUTIONS

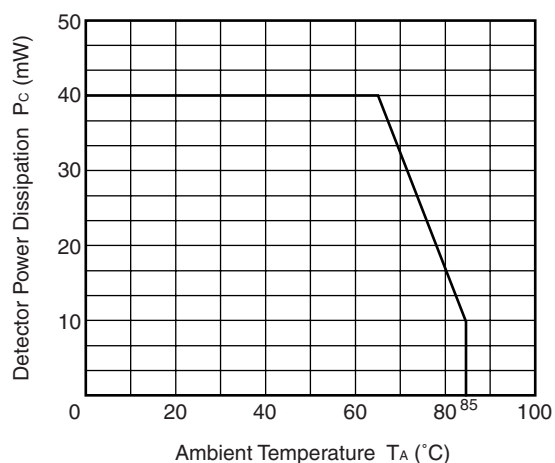
1. This product is weak for static electricity by designed with high-speed integrated circuit so protect against static electricity when handling.
2. By-pass capacitor of more than 0.1  $\mu\text{F}$  is used between  $V_{CC}$  and GND near device. Also, ensure that the distance between the leads of 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)**

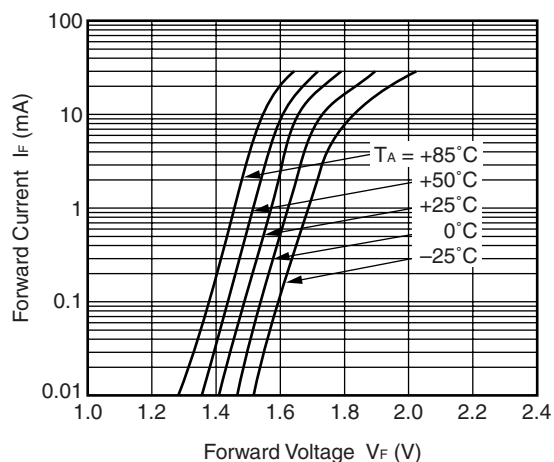
**MAXIMUM FORWARD CURRENT  
vs. AMBIENT TEMPERATURE**



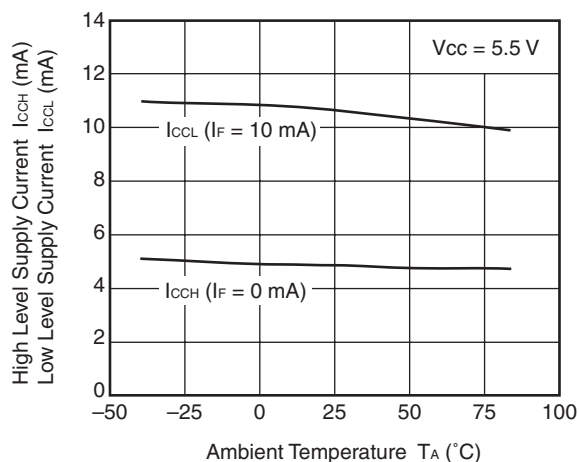
**DETECTOR POWER DISSIPATION  
vs. AMBIENT TEMPERATURE**



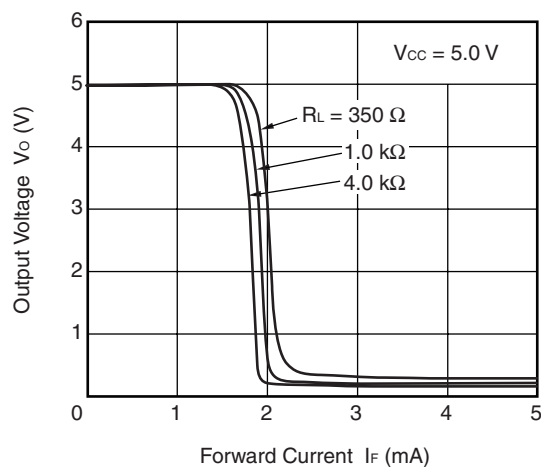
**FORWARD CURRENT vs.  
FORWARD VOLTAGE**



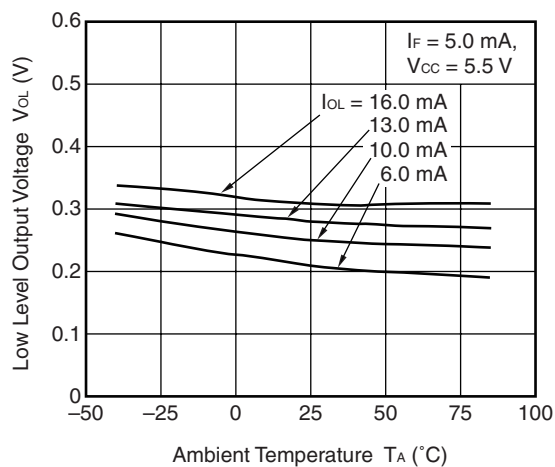
**SUPPLY CURRENT vs.  
AMBIENT TEMPERATURE**



**OUTPUT VOLTAGE vs.  
FORWARD CURRENT**

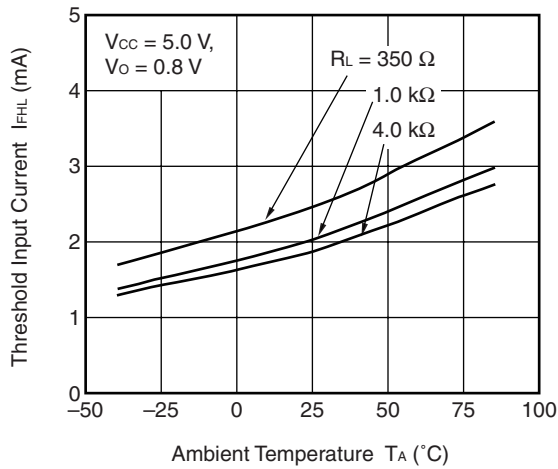


**LOW LEVEL OUTPUT VOLTAGE vs.  
AMBIENT TEMPERATURE**

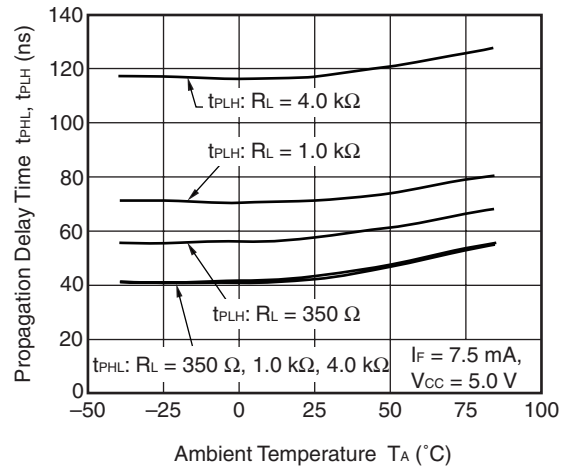


**Remark** The graphs indicate nominal characteristics.

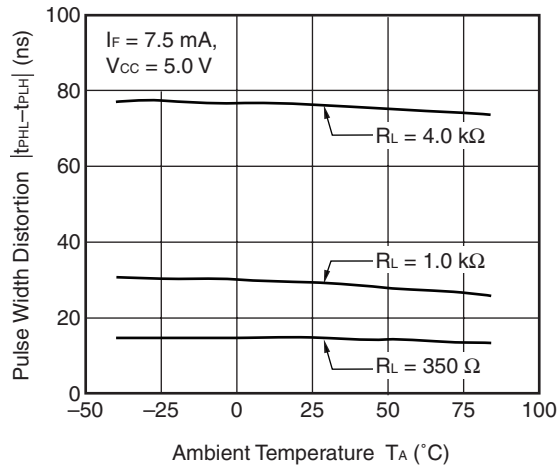
THRESHOLD INPUT CURRENT vs. AMBIENT TEMPERATURE



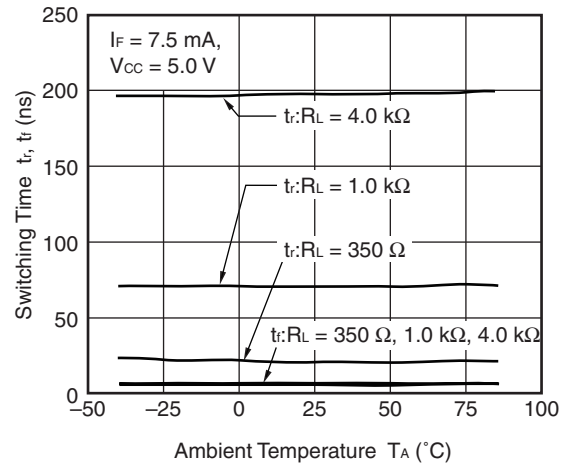
PROPAGATION DELAY TIME vs. AMBIENT TEMPERATURE



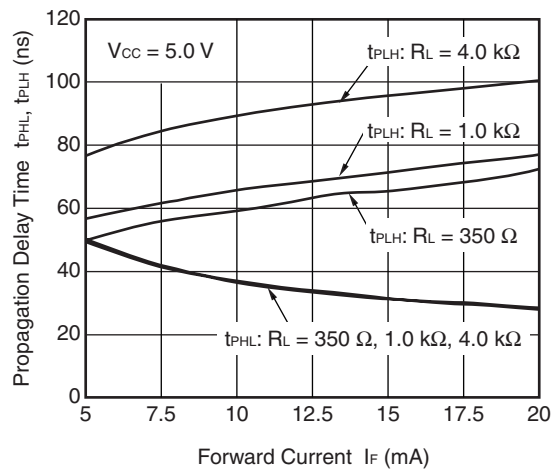
PULSE WIDTH DISTORTION vs. AMBIENT TEMPERATURE



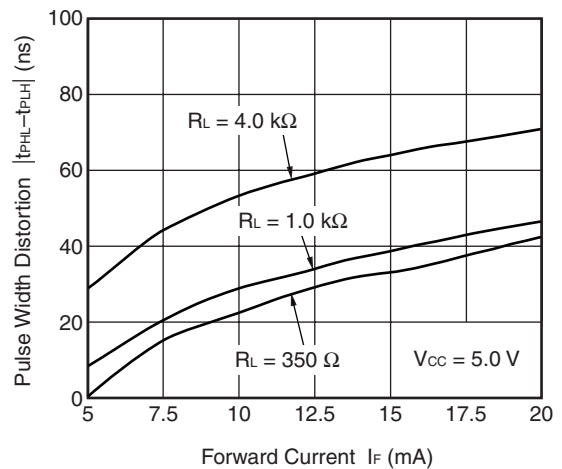
SWITCHING TIME vs. AMBIENT TEMPERATURE



PROPAGATION DELAY TIME vs. FORWARD CURRENT



PULSE WIDTH DISTORTION vs. FORWARD CURRENT

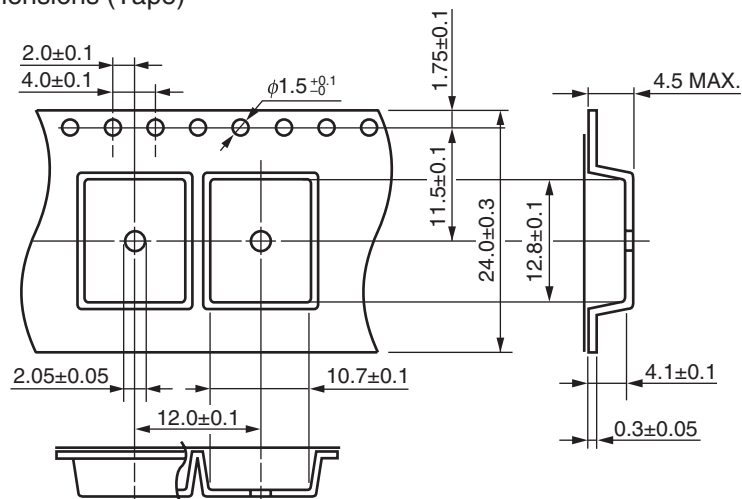


**Remark** The graphs indicate nominal characteristics.

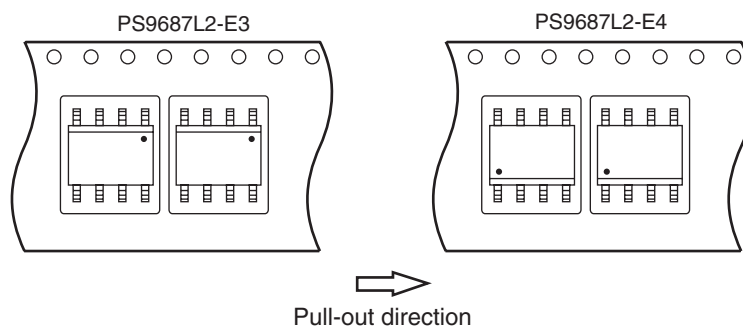


TAPING SPECIFICATIONS (UNIT: mm)

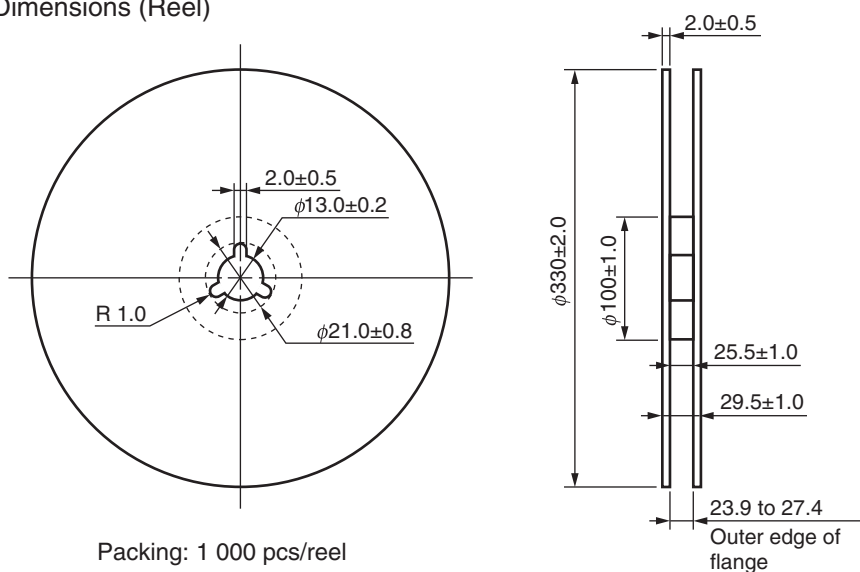
Outline and Dimensions (Tape)



Tape Direction



Outline and Dimensions (Reel)



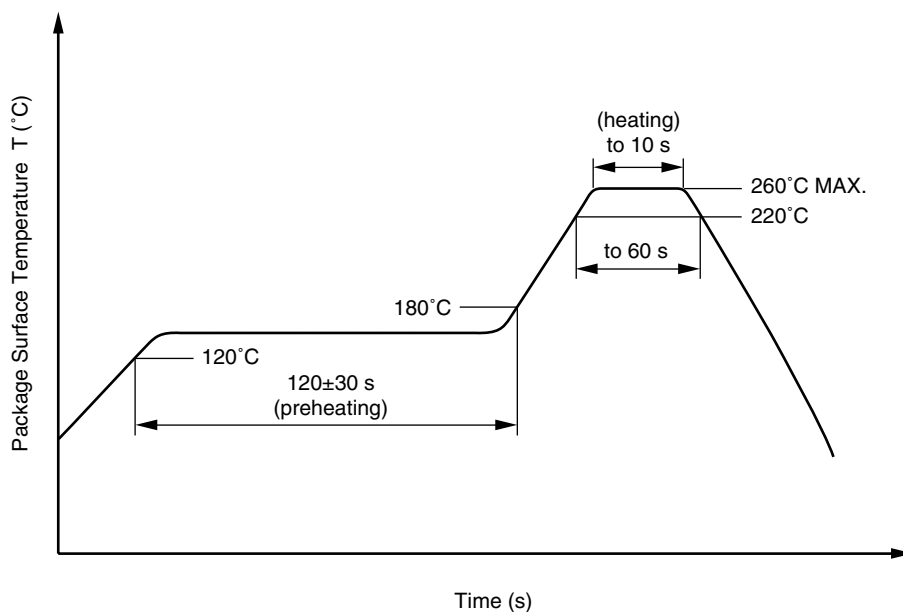
## NOTES ON HANDLING

### 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.

When the product(s) listed in this document is subject to any applicable import or export control laws and regulation of the authority having competent jurisdiction, such product(s) shall not be imported or exported without obtaining the import or export license.

• **The information in this document is current as of July, 2005. The information is subject to change without notice. For actual design-in, refer to the latest publications of NEC's data sheets or data books, etc., for the most up-to-date specifications of NEC semiconductor products. Not all products and/or types are available in every country. Please check with an NEC sales representative for availability and additional information.**

• No part of this document may be copied or reproduced in any form or by any means without prior written consent of NEC. NEC assumes no responsibility for any errors that may appear in this document.

• NEC does not assume any liability for infringement of patents, copyrights or other intellectual property rights of third parties by or arising from the use of NEC semiconductor products listed in this document or any other liability arising from the use of such products. No license, express, implied or otherwise, is granted under any patents, copyrights or other intellectual property rights of NEC or others.

• Descriptions of circuits, software and other related information in this document are provided for illustrative purposes in semiconductor product operation and application examples. The incorporation of these circuits, software and information in the design of customer's equipment shall be done under the full responsibility of customer. NEC assumes no responsibility for any losses incurred by customers or third parties arising from the use of these circuits, software and information.

• While NEC endeavours to enhance the quality, reliability and safety of NEC semiconductor products, customers agree and acknowledge that the possibility of defects thereof cannot be eliminated entirely. To minimize risks of damage to property or injury (including death) to persons arising from defects in NEC semiconductor products, customers must incorporate sufficient safety measures in their design, such as redundancy, fire-containment, and anti-failure features.

• NEC semiconductor products are classified into the following three quality grades:

"Standard", "Special" and "Specific". The "Specific" quality grade applies only to semiconductor products developed based on a customer-designated "quality assurance program" for a specific application. The recommended applications of a semiconductor product depend on its quality grade, as indicated below. Customers must check the quality grade of each semiconductor product before using it in a particular application.

"Standard": Computers, office equipment, communications equipment, test and measurement equipment, audio and visual equipment, home electronic appliances, machine tools, personal electronic equipment and industrial robots

"Special": Transportation equipment (automobiles, trains, ships, etc.), traffic control systems, anti-disaster systems, anti-crime systems, safety equipment and medical equipment (not specifically designed for life support)

"Specific": Aircraft, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support systems and medical equipment for life support, etc.

The quality grade of NEC semiconductor products is "Standard" unless otherwise expressly specified in NEC's data sheets or data books, etc. If customers wish to use NEC semiconductor products in applications not intended by NEC, they must contact an NEC sales representative in advance to determine NEC's willingness to support a given application.

(Note)

(1) "NEC" as used in this statement means NEC Corporation, NEC Compound Semiconductor Devices, Ltd. and also includes its majority-owned subsidiaries.

(2) "NEC semiconductor products" means any semiconductor product developed or manufactured by or for NEC (as defined above).

M8E 00.4-0110

<div data-bbox="175 235 287 280" style="border: 1px solid black; padding: 2px; display: inline-block;"><b>Caution</b></div> <div data-bbox="300 241 446 264" style="display: inline-block; vertical-align: top;">GaAs Products</div>	<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>
--	---

► For further information, please contact

**NEC Compound Semiconductor Devices, Ltd.**    <http://www.ncsd.necel.com/>

E-mail: [salesinfo@ml.ncsd.necel.com](mailto:salesinfo@ml.ncsd.necel.com) (sales and general)

[techinfo@ml.ncsd.necel.com](mailto:techinfo@ml.ncsd.necel.com) (technical)

Sales Division TEL: +81-44-435-1573 FAX: +81-44-435-1579

**NEC Compound Semiconductor Devices Hong Kong Limited**

E-mail: [ncsd-hk@elhk.nec.com.hk](mailto:ncsd-hk@elhk.nec.com.hk) (sales, technical and general)

Hong Kong Head Office TEL: +852-3107-7303 FAX: +852-3107-7309

Taipei Branch Office TEL: +886-2-8712-0478 FAX: +886-2-2545-3859

Korea Branch Office TEL: +82-2-558-2120 FAX: +82-2-558-5209

**NEC Electronics (Europe) GmbH**    <http://www.ee.nec.de/>

TEL: +49-211-6503-0 FAX: +49-211-6503-1327

**California Eastern Laboratories, Inc.**    <http://www.cel.com/>

TEL: +1-408-988-3500 FAX: +1-408-988-0279