

## 1 Mbps OPEN COLLECTOR OUTPUT TYPE

### 5-PIN SOP (SO-5)

### HIGH-SPEED PHOTOCOUPLER

–NEPOC Series–

#### DESCRIPTION

The PS9122 is an optical 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 PS9122 is a high-speed digital output type photocoupler designed specifically for low circuit current.

The PS9122 is in 5-pin plastic SOP (Small Outline Package) and is suitable for high density application.

#### FEATURES

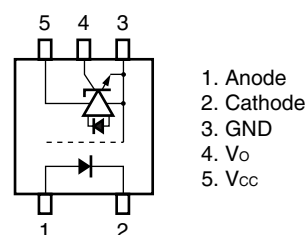
- Supply Voltage
  - N rank:  $V_{CC} = 3.3\text{ V}$
  - L rank:  $V_{CC} = 5\text{ V}$
- Pulse width distortion ( $|t_{PHL} - t_{PLH}| = 200\text{ ns MAX.}$ )
- Small package (SO-5)
- High-speed (1 Mbps)
- High isolation voltage ( $BV = 3\,750\text{ Vr.m.s.}$ )
- Open collector output
- Embossed tape product: PS9122-F3: 2 500 pcs/reel
- Pb-Free product
- Safety standards
  - UL approved: File No. E72422
  - DIN EN60747-5-2 (VDE0884 Part2) approved No.40008902 (option)

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#### APPLICATIONS

- PoE (Power over Ethernet)
- Measurement equipment
- FA Network

**PIN CONNECTION**  
(Top View)

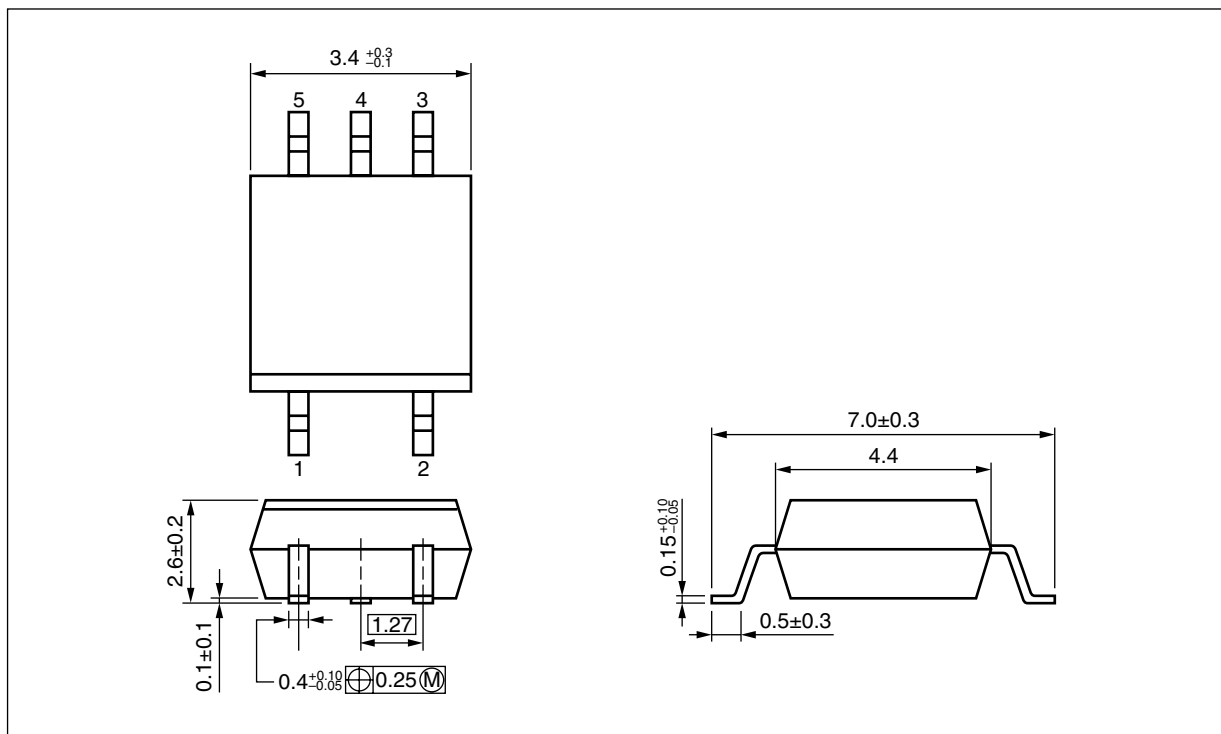


**TRUTH TABLE**

LED	Output
ON	L
OFF	H

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Not all products and/or types are available in every country. Please check with an NEC Electronics sales representative for availability and additional information.

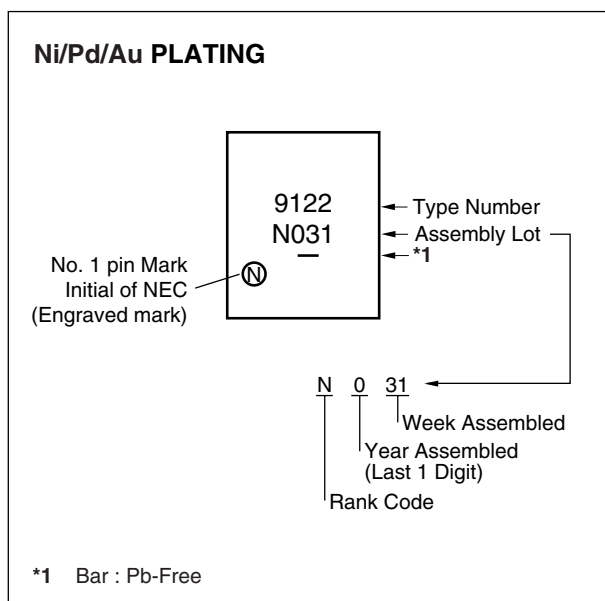
PACKAGE DIMENSIONS (UNIT: mm)



<R> PHOTOCOUPLER CONSTRUCTION

Parameter	Unit (MIN.)
Air Distance	4.2 mm
Outer Creepage Distance	4.2 mm
Isolation Distance	0.2 mm

<R> MARKING EXAMPLE



<R> ORDERING INFORMATION

Part Number	Order Number	Rank	Solder Plating Specification	Packing Style	Safety Standards Approval	Application Part Number <sup>*1</sup>
PS9122	PS9122-AX	N <sup>2</sup>	Pb-Free (Ni/Pd/Au)	20 pcs (Tape 20 pcs cut)	Standard products (UL approved)	PS9122
		L <sup>3</sup>				
PS9122-F3	PS9122-F3-AX	N <sup>2</sup>		Embossed Tape 2 500 pcs/reel		
		L <sup>3</sup>				
PS9122-V	PS9122-V-AX	N <sup>2</sup>		20 pcs (Tape 20 pcs cut)	DIN EN60747-5-2 (VDE0884 Part2)	
		L <sup>3</sup>				
PS9122-V-F3	PS9122-V-F3-AX	N <sup>2</sup>		Embossed Tape 2 500 pcs/reel	approved (Option)	
		L <sup>3</sup>				

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

\*2 N rank: V<sub>CC</sub> = 3.3 V

\*3 L rank: V<sub>CC</sub> = 5 V

**ABSOLUTE MAXIMUM RATINGS ( $T_A = 25^\circ\text{C}$ , unless otherwise specified)**

Parameter		Symbol	Ratings	Unit
Diode	Forward Current <sup>*1</sup>	$I_F$	25	mA
	Reverse Voltage	$V_R$	5	V
Detector	Supply Voltage	$V_{CC}$	7	V
	Output Voltage	$V_O$	7	V
	Output Current	$I_O$	20	mA
	Power Dissipation <sup>*2</sup>	$P_C$	40	mW
Isolation Voltage <sup>*3</sup>		$BV$	3 750	Vr.m.s.
Operating Ambient Temperature		$T_A$	-40 to +100	$^\circ\text{C}$
Storage Temperature		$T_{stg}$	-55 to +125	$^\circ\text{C}$

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\*1 Reduced to 0.17 mA/ $^\circ\text{C}$  at  $T_A = 25^\circ\text{C}$  or more.

\*2 Applies to output pin  $V_O$  (collector pin). Reduced to 1.5 mW/ $^\circ\text{C}$  at  $T_A = 80^\circ\text{C}$  or more.

\*3 AC voltage for 1 minute at  $T_A = 25^\circ\text{C}$ , RH = 60% between input and output.

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

**RECOMMENDED OPERATING CONDITIONS**

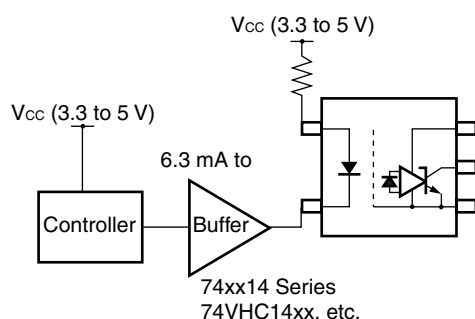
Parameter		Symbol	MIN.	TYP.	MAX.	Unit
Low Level Input Voltage		$V_{FL}$	0		0.8	V
High Level Input Current		$I_{FH}$	6.3	10	12.5	mA
Supply Voltage	N rank	$V_{CC}$	2.7	3.3	3.6	V
	L rank		4.5	5.0	5.5	
TTL ( $R_L = 1\text{ k}\Omega$ , loads)		N			3	
Pull-up Resistor		$R_L$	330		4 k	$\Omega$

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**DRIVER CIRCUIT**

It is recommended to use some buffer for low output current controller, especially in the case of low  $V_{CC}$ , otherwise to confirm that enough input current is supplied from controller.



**ELECTRICAL CHARACTERISTICS 1: N rank ( $T_A = -40$  to  $+100^\circ\text{C}$ , unless otherwise specified)**

	Parameter	Symbol	Conditions	MIN.	TYP. <sup>*1</sup>	MAX.	Unit
	Diode						
	Forward Voltage	$V_F$	$I_F = 10\text{ mA}$ , $T_A = 25^\circ\text{C}$		1.6	1.8	V
	Reverse Current	$I_R$	$V_R = 3\text{ V}$ , $T_A = 25^\circ\text{C}$			10	$\mu\text{A}$
	Terminal Capacitance	$C_t$	$V = 0\text{ V}$ , $f = 1\text{ MHz}$ , $T_A = 25^\circ\text{C}$		30		pF
<R>	Detector						
	High Level Output Current	$I_{OH}$	$V_{CC} = V_O = 3.3\text{ V}$ , $V_F = 0.8\text{ V}$		1	100	$\mu\text{A}$
	Low Level Output Voltage <sup>*2</sup>	$V_{OL}$	$V_{CC} = 3.3\text{ V}$ , $I_F = 5\text{ mA}$ , $I_{OL} = 10\text{ mA}$		0.2	0.6	V
	High Level Supply Current	$I_{CCH}$	$V_{CC} = 3.3\text{ V}$ , $I_F = 0\text{ mA}$ , $V_O = \text{Open}$			2	mA
	Low Level Supply Current	$I_{CCL}$	$V_{CC} = 3.3\text{ V}$ , $I_F = 10\text{ mA}$ , $V_O = \text{Open}$			3	
<R>	Coupled						
	Threshold Input Current ( $H \rightarrow L$ )	$I_{FHL}$	$V_{CC} = 3.3\text{ V}$ , $V_O = 0.8\text{ V}$ , $R_L = 350\ \Omega$		2	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	$C_{I-O}$	$V = 0\text{ V}$ , $f = 1\text{ MHz}$ , $T_A = 25^\circ\text{C}$		0.6		pF
	Propagation Delay Time ( $H \rightarrow L$ ) <sup>*3</sup>	$t_{PHL}$	$V_{CC} = 3.3\text{ V}$ , $R_L = 350\ \Omega$ , $I_F = 7.5\text{ mA}$ , $V_{THHL} = V_{THLH} = 1.5\text{ V}$			500	ns
	Propagation Delay Time ( $L \rightarrow H$ ) <sup>*3</sup>	$t_{PLH}$				700	
<R>	Rise Time	$t_r$			60		ns
<R>	Fall Time	$t_f$			70		
	Pulse Width Distortion (PWD) <sup>*3</sup>	$ t_{PHL} - t_{PLH} $				200	ns
<R>	Common Mode Transient Immunity at High Level Output <sup>*4</sup>	$CM_H$	$V_{CC} = 3.3\text{ V}$ , $R_L = 350\ \Omega$ , $T_A = 25^\circ\text{C}$ , $I_F = 0\text{ mA}$ , $V_O > 2.0\text{ V}$ , $V_{CM} = 1.0\text{ kV}$	15	20		kV/ $\mu\text{s}$
<R>	Common Mode Transient Immunity at Low Level Output <sup>*4</sup>	$CM_L$	$V_{CC} = 3.3\text{ V}$ , $R_L = 350\ \Omega$ , $T_A = 25^\circ\text{C}$ , $I_F = 7.5\text{ mA}$ , $V_O < 0.8\text{ V}$ , $V_{CM} = 1.0\text{ kV}$	15	20		

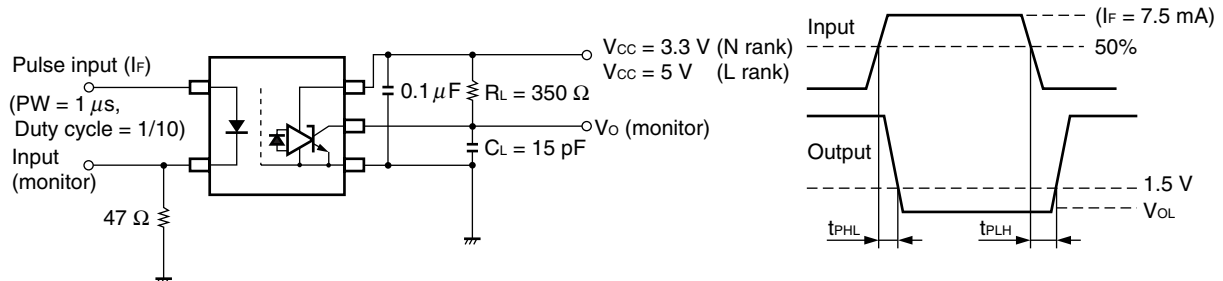
**ELECTRICAL CHARACTERISTICS 2: L rank ( $T_A = -40$  to  $+100^\circ\text{C}$ , unless otherwise specified)**

	Parameter		Symbol	Conditions	MIN.	TYP. <sup>*5</sup>	MAX.	Unit
	Diode	Forward Voltage	V <sub>F</sub>	I <sub>F</sub> = 10 mA, T <sub>A</sub> = 25°C		1.6	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>i</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> = 5 V, V <sub>F</sub> = 0.8 V		1	100	μA
		Low Level Output Voltage <sup>*6</sup>	V <sub>OL</sub>	V <sub>CC</sub> = 5 V, I <sub>F</sub> = 5 mA, I <sub>OL</sub> = 13 mA		0.2	0.6	V
		High Level Supply Current	I <sub>CCH</sub>	V <sub>CC</sub> = 5 V, I <sub>F</sub> = 0 mA, V <sub>O</sub> = Open			2.5	mA
		Low Level Supply Current	I <sub>CCL</sub>	V <sub>CC</sub> = 5 V, I <sub>F</sub> = 10 mA, V <sub>O</sub> = Open			3.5	
<R>	Coupled	Threshold Input Current (H → L)	I <sub>FHL</sub>	V <sub>CC</sub> = 5 V, V <sub>O</sub> = 0.8 V, R <sub>L</sub> = 350 Ω		2	5	mA
		Isolation Resistance	R <sub>I-O</sub>	V <sub>I-O</sub> = 1 kV <sub>DC</sub> , R <sub>H</sub> = 40 to 60%, 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 (H → L) <sup>*7</sup>	t <sub>PHL</sub>	V <sub>CC</sub> = 5 V, R <sub>L</sub> = 350 Ω, I <sub>F</sub> = 7.5 mA, V <sub>THHL</sub> = V <sub>THLH</sub> = 1.5 V			500	ns
		Propagation Delay Time (L → H) <sup>*7</sup>	t <sub>PLH</sub>				700	
		Rise Time	t <sub>r</sub>			60		ns
		Fall Time	t <sub>f</sub>			70		
		<R>	Pulse Width Distortion (PWD) <sup>*7</sup>		t <sub>PHL</sub> -t <sub>PLH</sub>			200
<R>	Common Mode Transient Immunity at High Level Output <sup>*8</sup>	CM <sub>H</sub>	V <sub>CC</sub> = 5 V, R <sub>L</sub> = 350 Ω, T <sub>A</sub> = 25°C, I <sub>F</sub> = 0 mA, V <sub>O</sub> > 2.0 V, V <sub>CM</sub> = 1.0 kV	15	20		kV/μs	
<R>	Common Mode Transient Immunity at Low Level Output <sup>*8</sup>	CM <sub>L</sub>	V <sub>CC</sub> = 5 V, R <sub>L</sub> = 350 Ω, T <sub>A</sub> = 25°C, I <sub>F</sub> = 7.5 mA, V <sub>O</sub> < 0.8 V, V <sub>CM</sub> = 1.0 kV	15	20			

\*1, 5. Typical values at  $T_A = 25^\circ\text{C}$

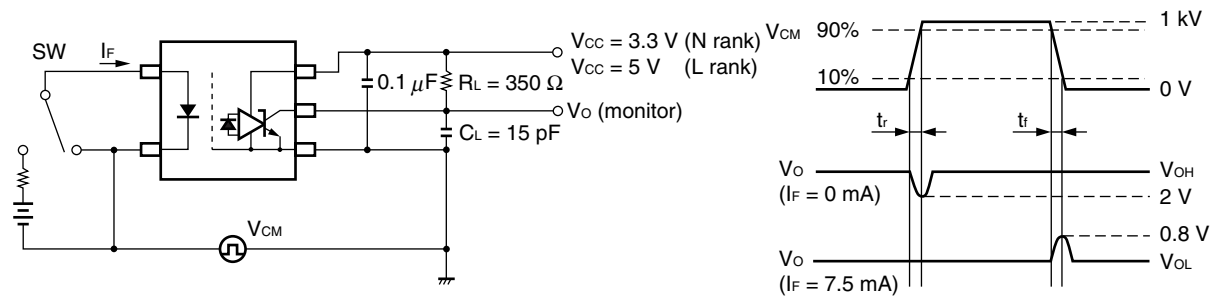
<R> \*2, 6. Because  $V_{OL}$  of 2 V or more may be output when LED current input and when output supply of  $V_{CC} = 2$  V more or less, it is important to confirm the characteristics (operation with the power supply on and off) during design, before using this device.

<R> \*3, 7. Test circuit for propagation delay time



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

<R> \*4, 8. Test circuit for common mode transient immunity



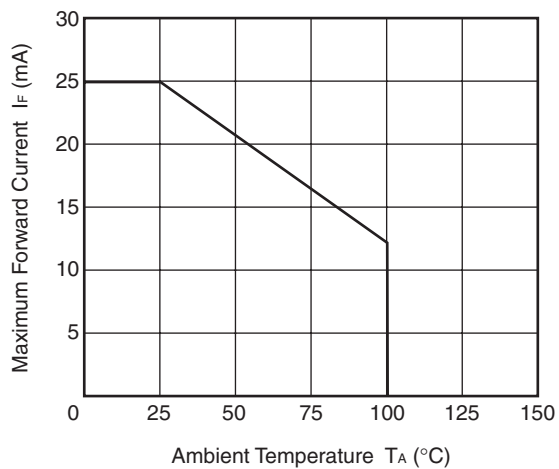
**Remark**  $C_L$  includes probe and stray wiring capacitance.

## <R> USAGE CAUTIONS

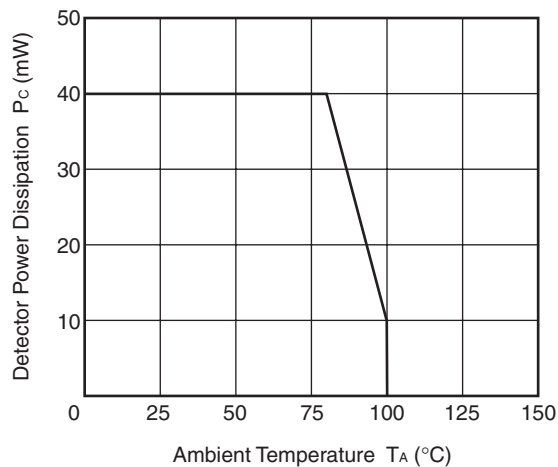
1. This product is weak for static electricity by designed with high-speed integrated circuit so protect against static electricity when handling.
2. By-pass capacitor of 0.1  $\mu\text{F}$  is used between  $V_{CC}$  and GND near device. Also, ensure that the distance between the leads of the photocoupler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

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

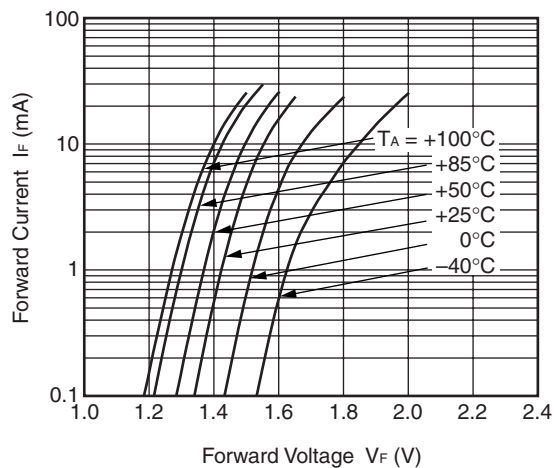
**MAXIMUM FORWARD CURRENT  
vs. AMBIENT TEMPERATURE**



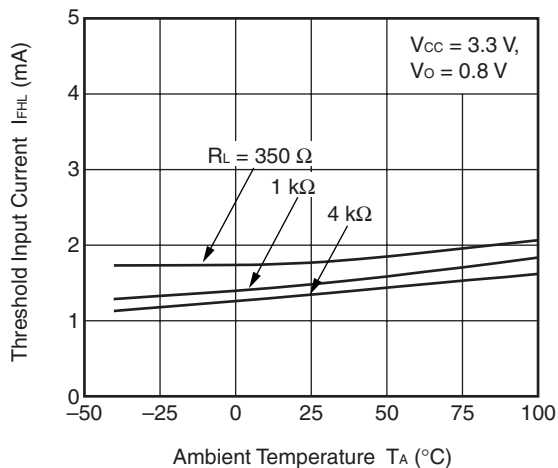
**DETECTOR POWER DISSIPATION  
vs. AMBIENT TEMPERATURE**



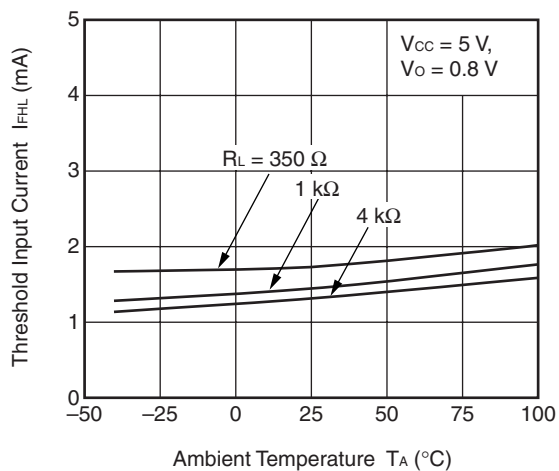
**FORWARD CURRENT vs.  
FORWARD VOLTAGE**



**THRESHOLD INPUT CURRENT vs.  
AMBIENT TEMPERATURE**



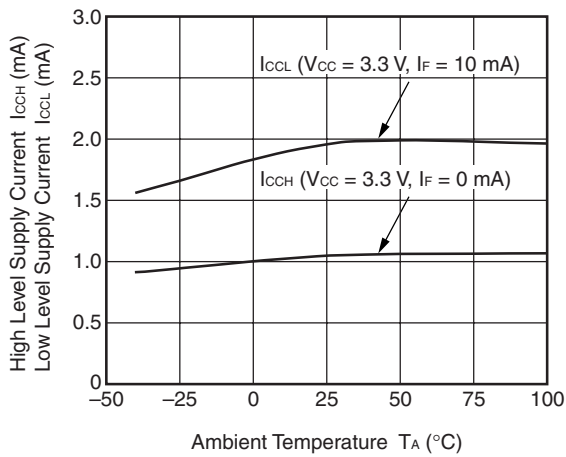
**THRESHOLD INPUT CURRENT vs.  
AMBIENT TEMPERATURE**



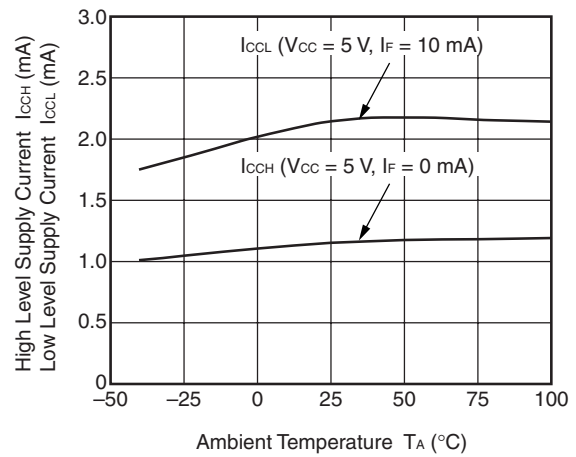
**Remark** The graphs indicate nominal characteristics.



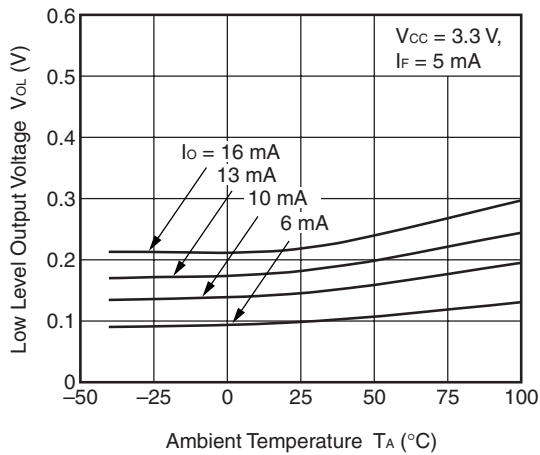
SUPPLY CURRENT vs.  
AMBIENT TEMPERATURE



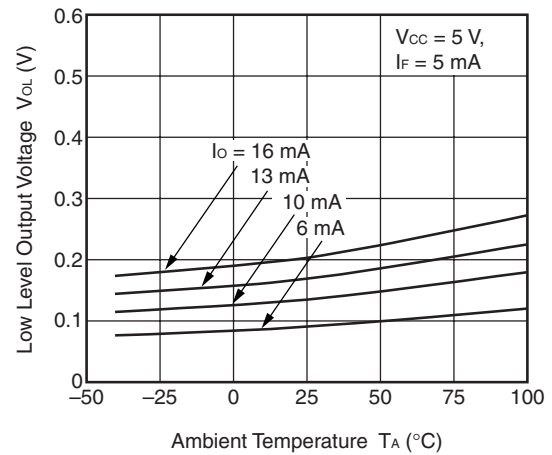
SUPPLY CURRENT vs.  
AMBIENT TEMPERATURE



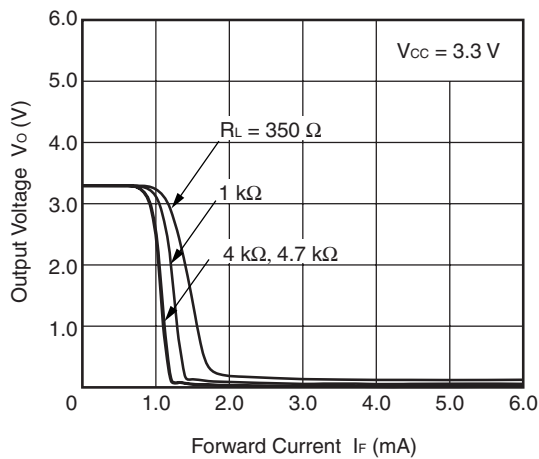
LOW LEVEL OUTPUT VOLTAGE vs.  
AMBIENT TEMPERATURE



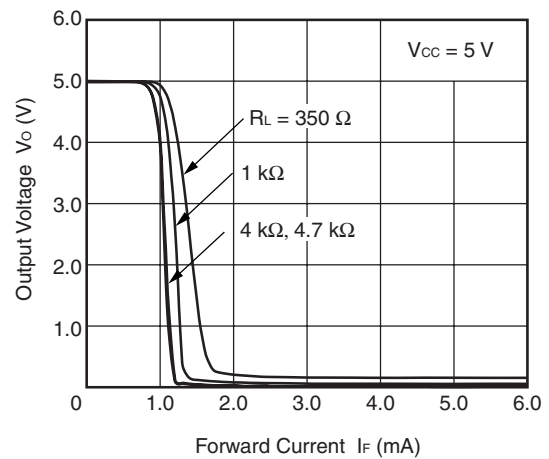
LOW LEVEL OUTPUT VOLTAGE vs.  
AMBIENT TEMPERATURE



OUTPUT VOLTAGE vs. FORWARD CURRENT

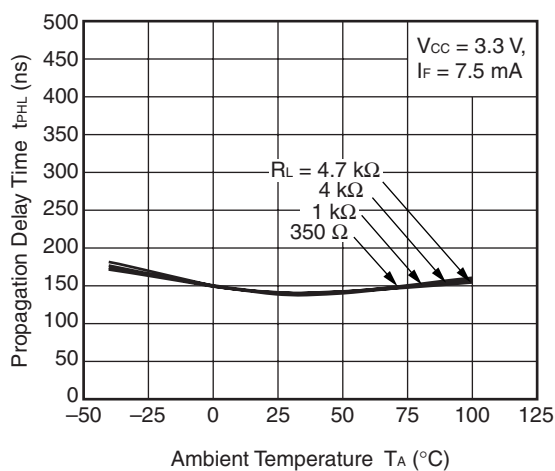


OUTPUT VOLTAGE vs. FORWARD CURRENT

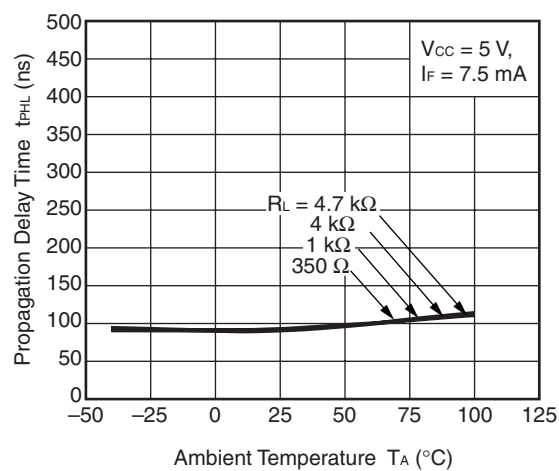


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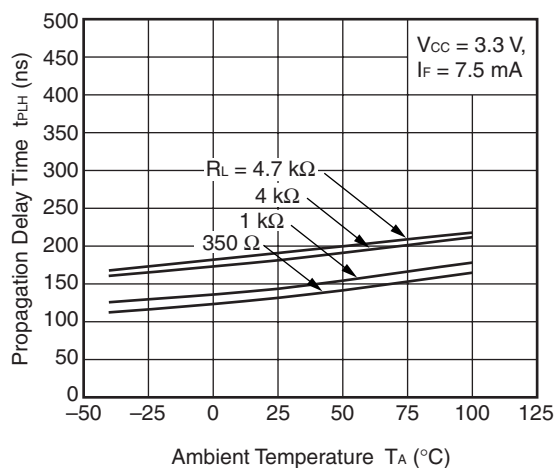
PROPAGATION DELAY TIME vs.  
AMBIENT TEMPERATURE



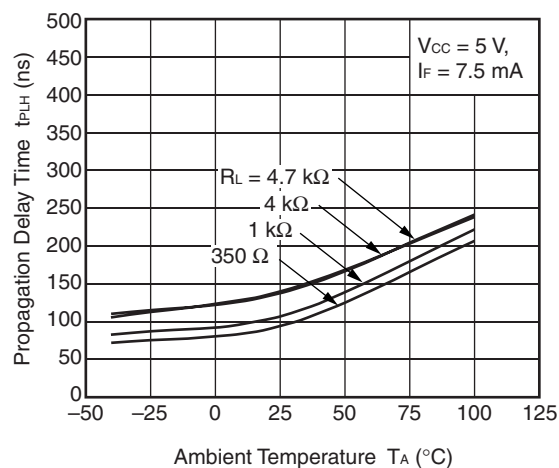
PROPAGATION DELAY TIME vs.  
AMBIENT TEMPERATURE



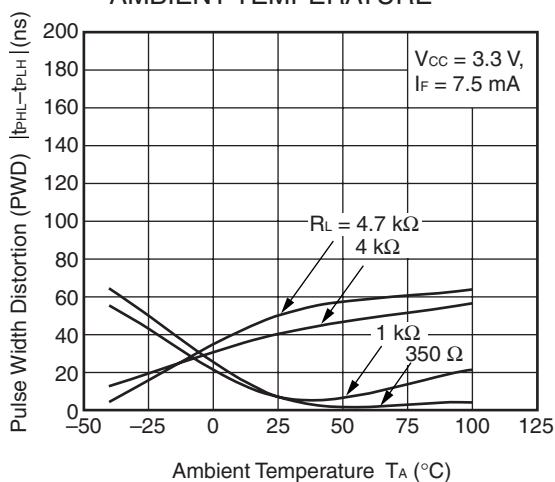
PROPAGATION DELAY TIME vs.  
AMBIENT TEMPERATURE



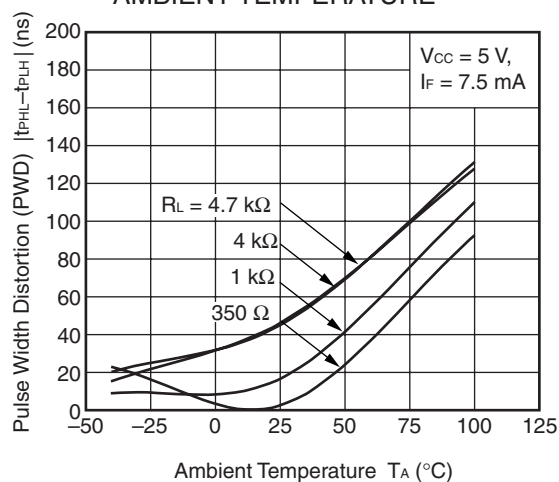
PROPAGATION DELAY TIME vs.  
AMBIENT TEMPERATURE



PULSE WIDTH DISTORTION vs.  
AMBIENT TEMPERATURE

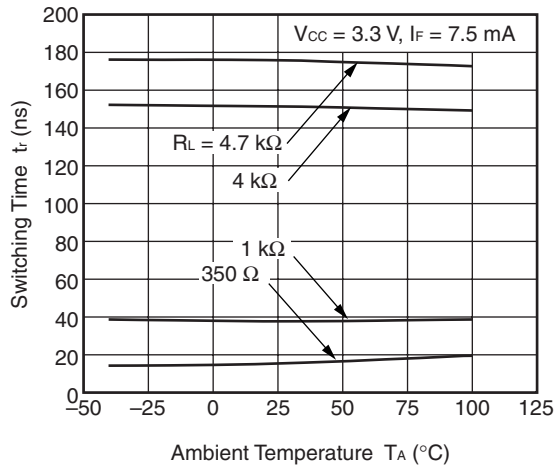


PULSE WIDTH DISTORTION vs.  
AMBIENT TEMPERATURE

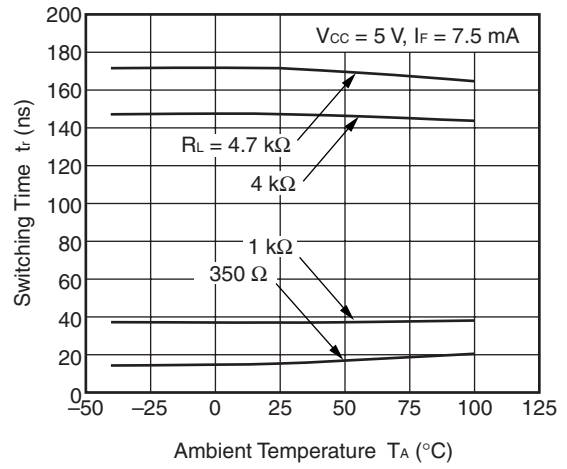


**Remark** The graphs indicate nominal characteristics.

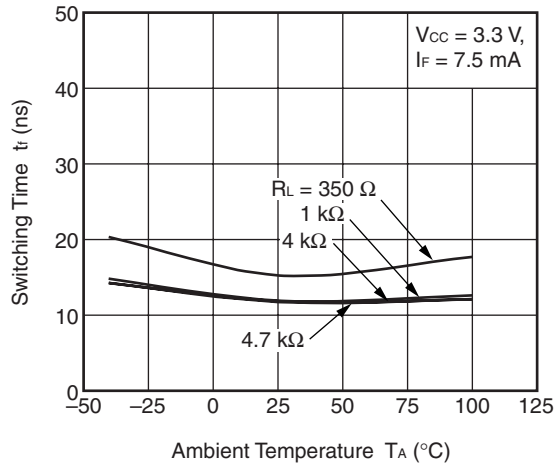
SWITCHING TIME vs.  
AMBIENT TEMPERATURE



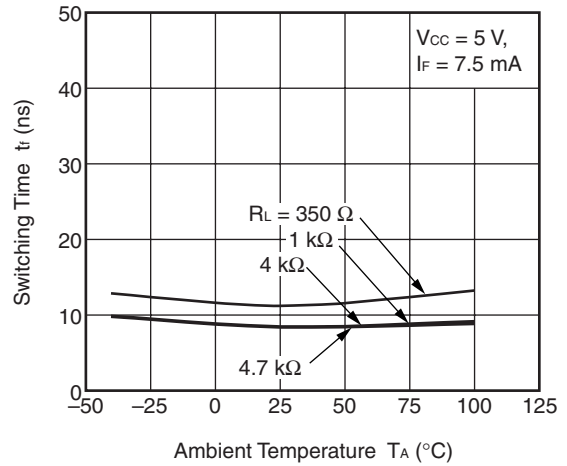
SWITCHING TIME vs.  
AMBIENT TEMPERATURE



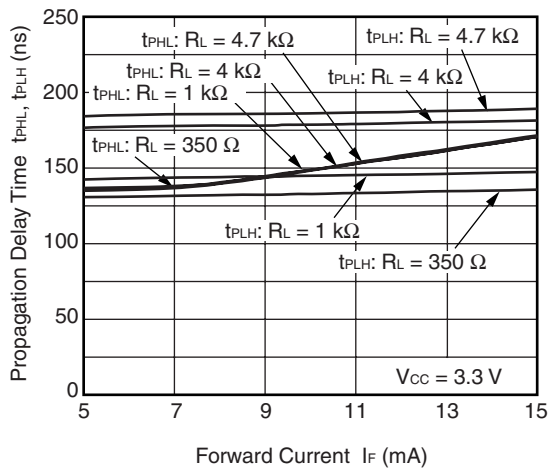
SWITCHING TIME vs.  
AMBIENT TEMPERATURE



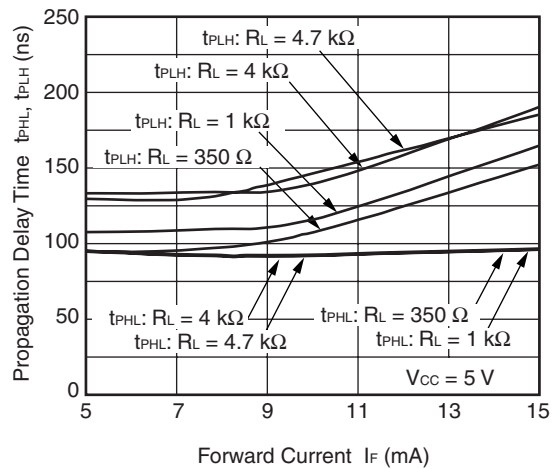
SWITCHING TIME vs.  
AMBIENT TEMPERATURE



PROPAGATION DELAY TIME vs.  
FORWARD CURRENT



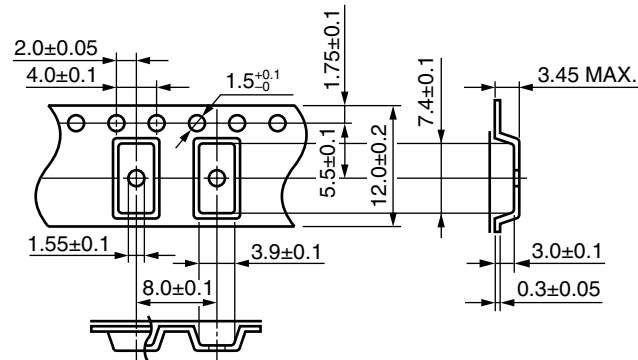
PROPAGATION DELAY TIME vs.  
FORWARD CURRENT



**Remark** The graphs indicate nominal characteristics.

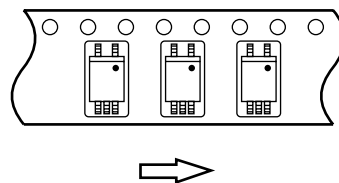
TAPING SPECIFICATIONS (UNIT: mm)

Outline and Dimensions (Tape)

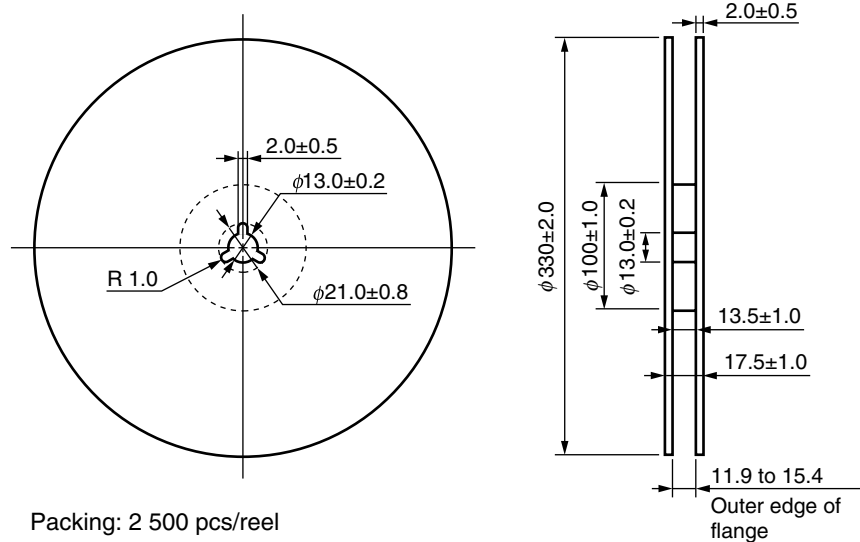


Tape Direction

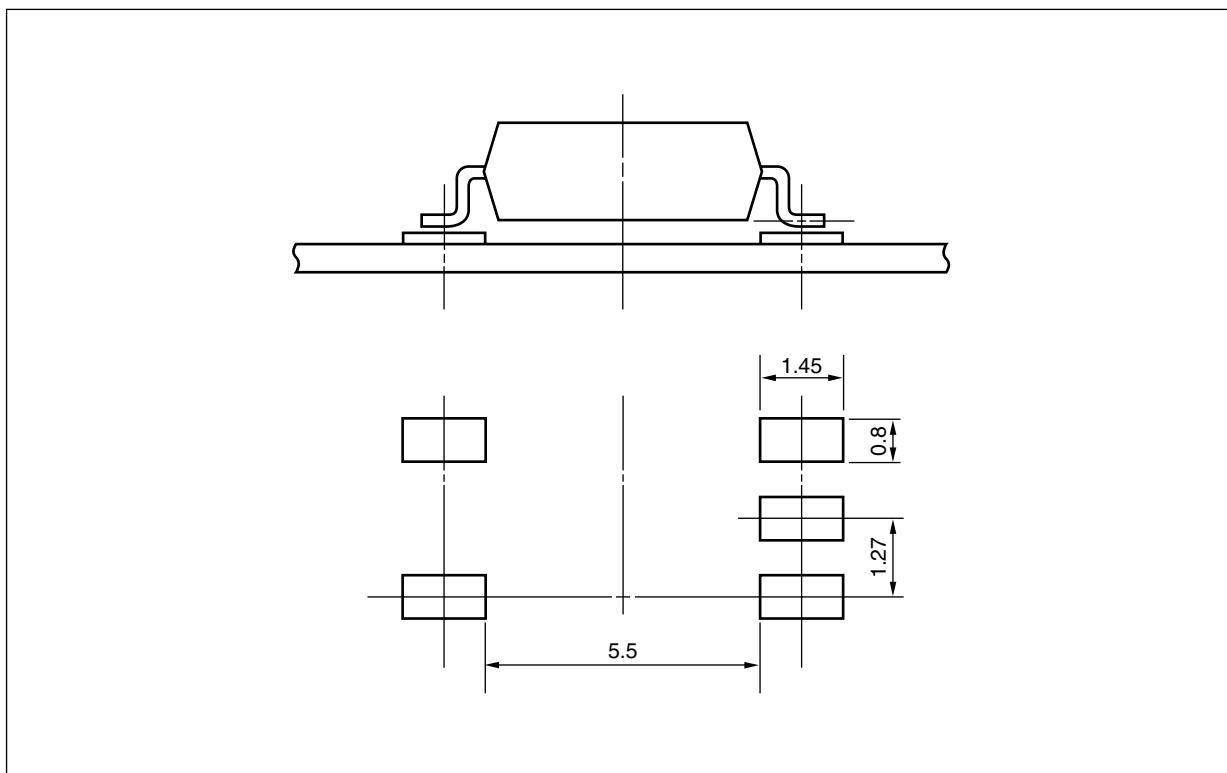
PS9122-F3



Outline and Dimensions (Reel)



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



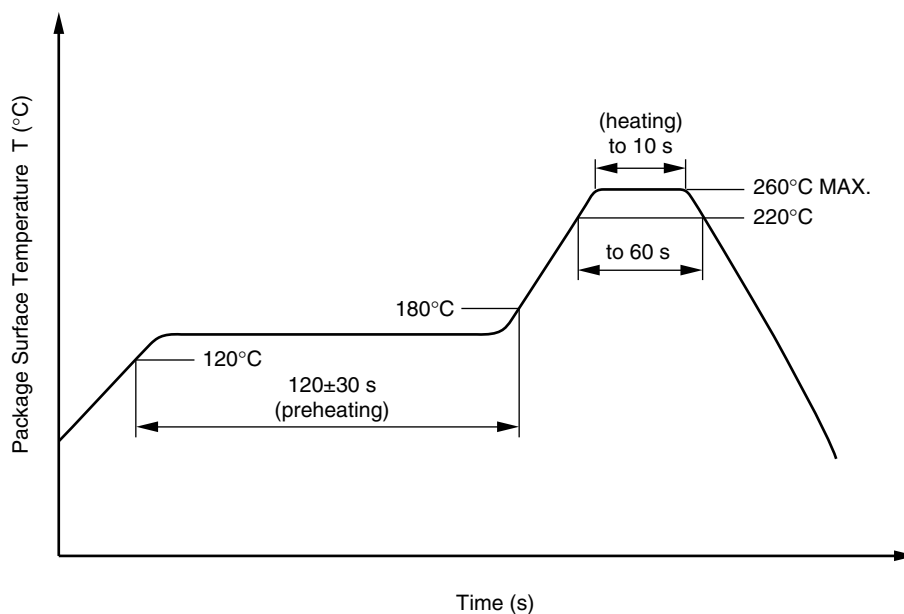
## NOTES ON HANDLING

### 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.

<R> SPECIFICATION OF VDE MARKS LICENSE DOCUMENT

Parameter	Symbol	Spec	Unit
Climatic test class (IEC 60068-1/DIN EN 60068-1)		40/100/21	
Dielectric strength maximum operating isolation voltage Test voltage (partial discharge test, procedure a for type test and random test) $U_{pr} = 1.5 \times U_{IORM}$ , $P_d < 5 \text{ pC}$	$U_{IORM}$ $U_{pr}$	707 1 061	$V_{peak}$ $V_{peak}$
Test voltage (partial discharge test, procedure b for all devices) $U_{pr} = 1.875 \times U_{IORM}$ , $P_d < 5 \text{ pC}$	$U_{pr}$	1 326	$V_{peak}$
Highest permissible overvoltage	$U_{TR}$	6 000	$V_{peak}$
Degree of pollution (DIN EN 60664-1 VDE0110 Part 1)		2	
Comparative tracking index (IEC 60112/DIN EN 60112 (VDE 0303 Part 11))	CTI	175	
Material group (DIN EN 60664-1 VDE0110 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 $V_{IO} = 500 \text{ V dc}$ at $T_A = 25^\circ\text{C}$ $V_{IO} = 500 \text{ V dc}$ at $T_A \text{ MAX.}$ at least $100^\circ\text{C}$	$R_{is \text{ MIN.}}$ $R_{is \text{ MIN.}}$	$10^{12}$ $10^{11}$	$\Omega$ $\Omega$
Safety maximum ratings (maximum permissible in case of fault, see thermal derating curve) Package temperature Current (input current $I_F$ , $P_{si} = 0$ ) Power (output or total power dissipation) Isolation resistance $V_{IO} = 500 \text{ V dc}$ at $T_A = T_{si}$	$T_{si}$ $I_{si}$ $P_{si}$ $R_{is \text{ MIN.}}$	150 200 300 $10^9$	°C mA mW $\Omega$



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To our customers,

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

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