

# PS9009

R08DS0133EJ0200

Rev.2.00

Mar 11, 2016

LOW IF TOTEM POLE OUTPUT TYPE HIGH CMR, IPM DRIVER, 5-PIN SSOP (LSO5) PHOTOCOUPLER

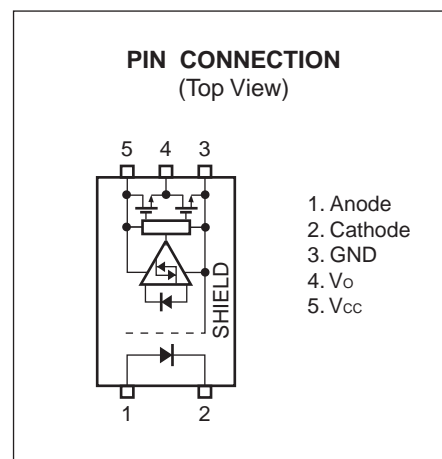
## DESCRIPTION

The PS9009 is optical coupled high-speed, totem pole output (active high output type) isolators containing a GaAlAs LED on the input side and a photodiode and a signal processing circuit on the output side on one chip.

The PS9009 is specified high CMR and pulse width distortion with operating temperature. It is suitable for IPM (Intelligent Power Module) drive.

## FEATURES

- Long creepage distance (8 mm MIN.)
- Totem pole output (Active High Output Type)
- Pulse width distortion ( $|t_{PLH} - t_{PHL}| = 80 \text{ ns MAX.}$ )
- High common mode transient immunity ( $CM_H, CM_L = \pm 50 \text{ kV}/\mu\text{s MIN.}$ )
- Operating Ambient Temperature ( $125 \text{ }^\circ\text{C MAX.}$ )
- High isolation voltage ( $BV = 5\,000 \text{ Vr.m.s.}$ )
- Embossed tape product : PS9009-F3: 3 000 pcs/reel
- Pb-Free product
- Safety standards
  - UL approved: UL1577, Double protection
  - CSA approved: CA5A, CAN/CSA-C22.2 60065, CAN/CSA-C22.2 60950-1, Reinforced insulation)
  - VDE approval: DIN EN 60747-5-5 (Option)



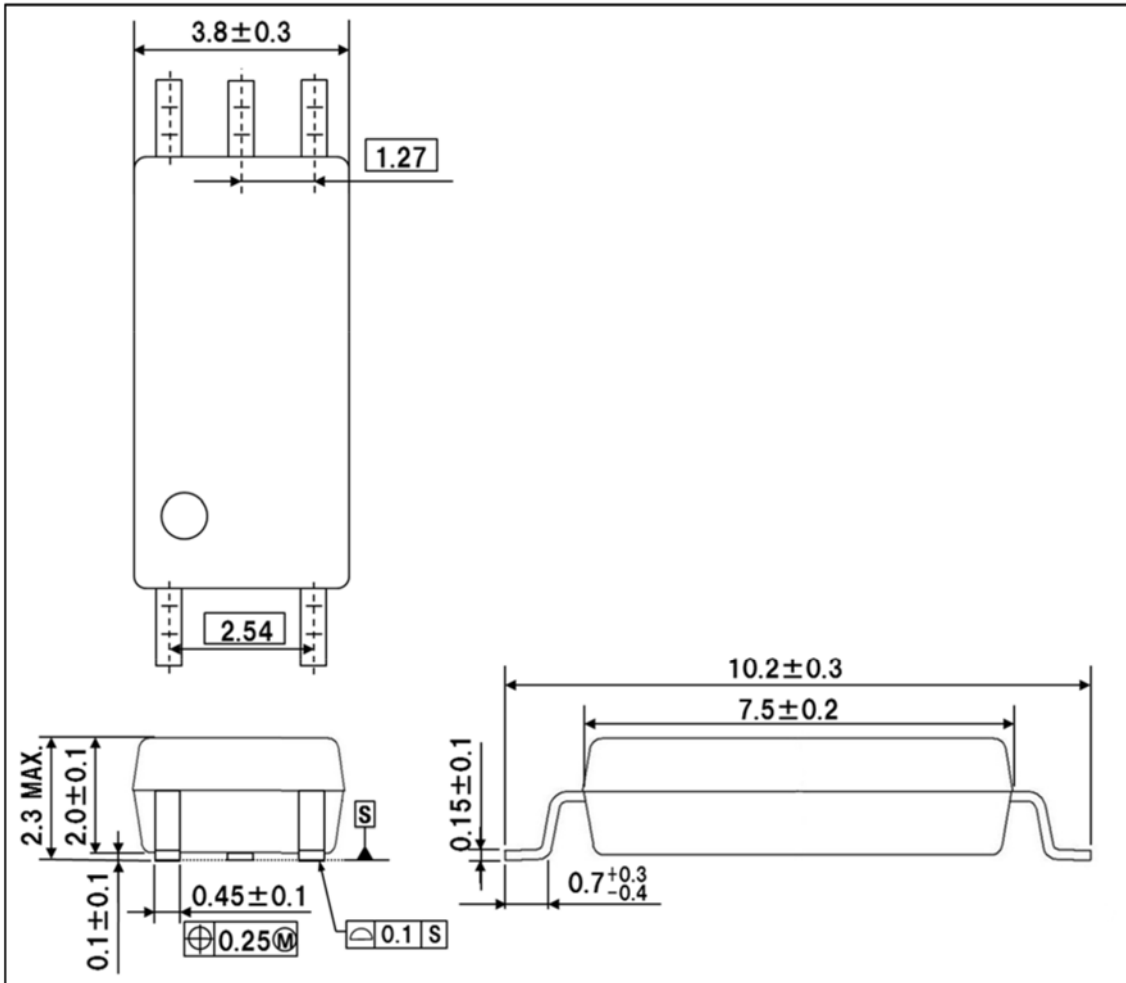
## APPLICATIONS

- IPM Driver
- General purpose inverter

Start of mass production

Oct.2015

**PACKAGE DIMENSIONS (UNIT: mm)**

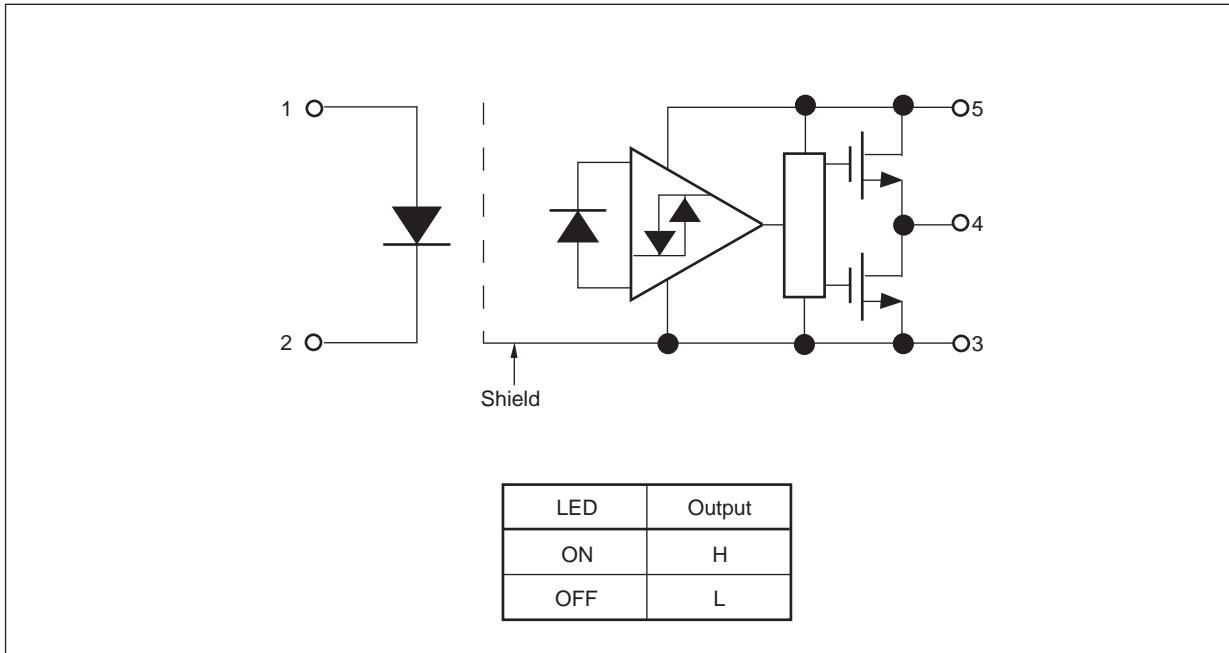


Weight : 0.119g (typ.)

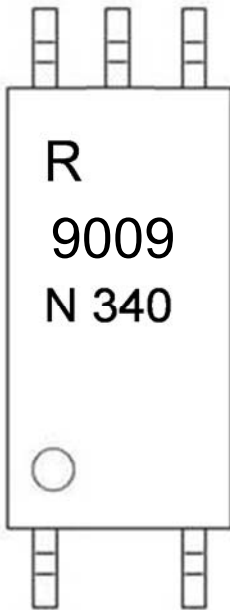
**PHOTOCOUPLER CONSTRUCTION**

Parameter	MIN.
Air Distance	8 mm
Outer Creepage Distance	8 mm
Isolation Distance	0.15 mm

**BLOCK DIAGRAM**



**MARKING EXAMPLE**



R	An initial of "Renesas"		
9009	Product Part Number		
○	No.1 pin Mark, Anode Mark		
N340	N	Rank Code	
	340	Assembly Lot	
		3	Last one-digit of Assembly Year
		40	Weekly Serial Code

## ORDERING INFORMATION

Part Number	Order Number	Solder Plating Specification	Packing Style	Safety Standard Approval	Application Part Number <sup>*1</sup>
PS9009	PS9009-Y-AX	Pb-Free and Halogen Free (Ni/Pd/Au)	20 pcs (Tape 20 pcs cut)	Standard products (UL, CSA approved)	PS9009
PS9009-F3	PS9009-Y-F3-AX		Embossed Tape 3 000 pcs/reel		
PS9009-V	PS9009-Y-V-AX		20 pcs (Tape 20 pcs cut)	UL, CSA approved DIN EN 60747-5-5 (VDE 0884-5): 2011-11 approved (Option)	
PS9009-V-F3	PS9009-Y-V-F3-AX		Embossed Tape 3 000 pcs/reel		

Note: \*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>	25	mA
	Reverse Voltage	V <sub>R</sub>	5	V
Detector	Supply Voltage	V <sub>CC</sub>	-0.5 to +25	V
	Output Voltage	V <sub>O</sub>	-0.5 to +25	V
	Output Current	I <sub>O</sub>	25	mA
	Power Dissipation <sup>*2</sup>	P <sub>C</sub>	250	mW
Isolation Voltage <sup>*3</sup>		BV	5 000	Vr.m.s.
Operating Ambient Temperature		T <sub>A</sub>	-40 to +125	°C
Storage Temperature		T <sub>stg</sub>	-55 to +150	°C

Notes: \*1. Reduced to 0.38 mA/°C at T<sub>A</sub> = 85°C or more.

\*2. Reduced to 4.0 mW/°C at T<sub>A</sub> = 85°C or more

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

Pins 1-3 shorted together, 4-6 shorted together.

## RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	MIN.	TYP.	MAX.	Unit
Supply Voltage	V <sub>CC</sub>	4.5	15	20	V
Output Voltage	V <sub>O</sub>	0		20	V
Forward Current (ON)	I <sub>F (ON)</sub>	5		10	mA
Forward Voltage (OFF)	V <sub>F (OFF)</sub>	0		0.8	V
Operating Ambient Temperature	T <sub>A</sub>	-40		125	°C

**ELECTRICAL CHARACTERISTICS (T<sub>A</sub> = -40 to +125°C, V<sub>CC</sub> = 4.5 to 20 V, unless otherwise specified)**

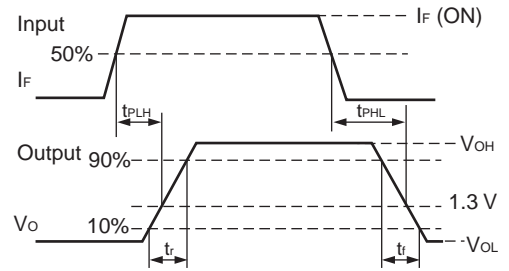
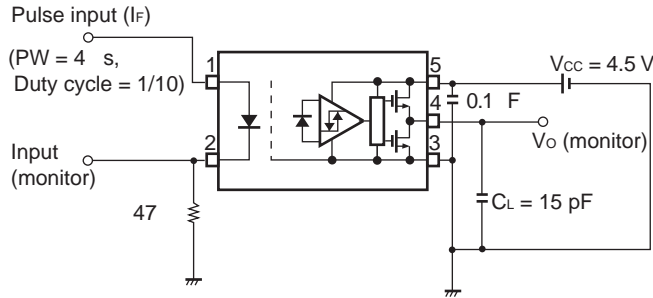
Parameter		Symbol	Conditions	MIN.	TYP.*1	MAX.	Unit
Diode	Forward Voltage	V <sub>F</sub>	I <sub>F</sub> = 10 mA, T <sub>A</sub> = 25°C	1.3	1.56	1.8	V
	Reverse Current	I <sub>R</sub>	V <sub>R</sub> = 3 V, T <sub>A</sub> = 25°C			10	μA
	Input Capacitance	C <sub>t</sub>	V <sub>F</sub> = 0 V, f = 1 MHz, T <sub>A</sub> = 25°C		30		pF
Detector	High Level Output Voltage	V <sub>OH</sub>	V <sub>CC</sub> = 4.5 V, I <sub>O</sub> = -2.6 mA, I <sub>F</sub> = 5 mA	2.7	3.2		V
			V <sub>CC</sub> = 20 V, I <sub>O</sub> = -2.6 mA, I <sub>F</sub> = 5 mA	17.4	18.7		
	Low Level Output Voltage*2	V <sub>OL</sub>	I <sub>O</sub> = 3.5 mA, I <sub>F</sub> = 0 mA		0.25	0.6	V
	High Level Supply Current	I <sub>CCH</sub>	V <sub>CC</sub> = 4.5 V, I <sub>F</sub> = 5 mA		0.98	3	mA
			V <sub>CC</sub> = 20 V, I <sub>F</sub> = 5 mA		1.32	3	
	Low Level Supply Current	I <sub>CCL</sub>	V <sub>CC</sub> = 4.5 V, I <sub>F</sub> = 0 mA		1.23	3	mA
			V <sub>CC</sub> = 20 V, I <sub>F</sub> = 0 mA		1.53	3	
	High Level Output Short*3 Circuit Current	I <sub>OSH</sub>	V <sub>CC</sub> = 4.5 V, V <sub>O</sub> = GND, I <sub>F</sub> = 5 mA	-7	-45		mA
Low Level Output Short*3 Circuit Current	I <sub>OSL</sub>	V <sub>CC</sub> = V <sub>O</sub> = 4.5 V, V <sub>F</sub> = 0 V	7	34		mA	
Coupled	Threshold Input Current	I <sub>FLH</sub>	V <sub>CC</sub> = 4.5 V, V <sub>O</sub> > 2.7 V, I <sub>O</sub> = -2.6 mA		1.52	3	mA
	Isolation Resistance	R <sub>I-O</sub>	V <sub>I-O</sub> = 1 kV <sub>DC</sub> , RH = 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)*4	t <sub>PHL</sub>	C <sub>L</sub> = 15 pF, I <sub>F</sub> = 5 → 0 mA, V <sub>THHL</sub> = 1.3 V		108	200	ns
	Propagation Delay Time (L → H)*4	t <sub>PLH</sub>	C <sub>L</sub> = 15 pF, I <sub>F</sub> = 0 → 5 mA, V <sub>THLH</sub> = 1.3 V		121	200	ns
	Pulse Width Distortion (PWD)	t <sub>PLH</sub> -t <sub>PHL</sub>	C <sub>L</sub> = 15 pF, I <sub>F</sub> = 5 ↔ 0 mA		13	80	ns
						100	
	Maximum Propagation Delays (PDD)						ns
	Rise Time (10-90%)*4	t <sub>r</sub>	C <sub>L</sub> = 15 pF, I <sub>F</sub> = 0 → 5 mA		25		ns
	Fall Time (90-10%)*4	t <sub>f</sub>	C <sub>L</sub> = 15 pF, I <sub>F</sub> = 5 → 0 mA		4.6		ns
	Common Mode Transient Immunity at High Level Output*5	CM <sub>H</sub>	V <sub>CC</sub> = 5 V, T <sub>A</sub> = 25°C, I <sub>F</sub> = 5 mA,  V <sub>CM</sub>   = 1.5 kV	50			kV/μs
	Common Mode Transient Immunity at Low Level Output*5	CM <sub>L</sub>	V <sub>CC</sub> = 5 V, T <sub>A</sub> = 25°C, I <sub>F</sub> = 0 mA,  V <sub>CM</sub>   = 1.5 kV	50			kV/μs

Notes: \*1. Typical values at T<sub>A</sub> = 25°C

\*2. Because V<sub>O</sub> of 2.4 V may be output when the LED current is not input and when output supply of V<sub>CC</sub> = 4.5 V or less, it is important to confirm the characteristics (operation with the power supply on and off) during design, before using this device.

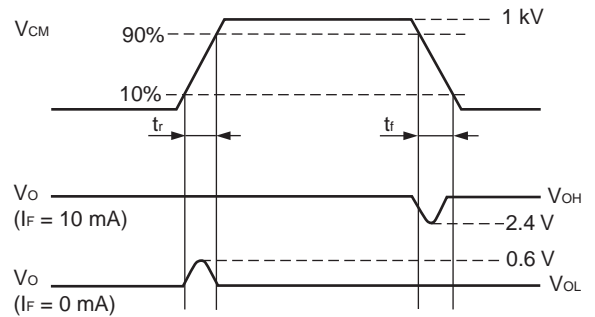
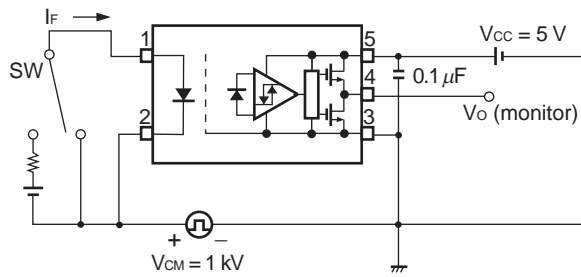
\*3. Duration of output short circuit time should not exceed 10 ms.

\*4. Test circuit for propagation delay time



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

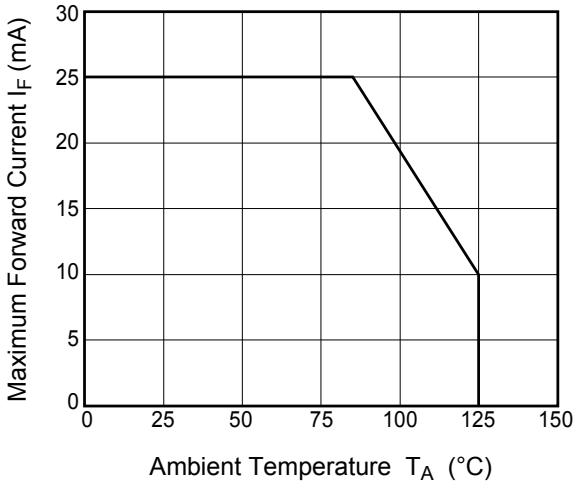
\*5. Test circuit for common mode transient immunity



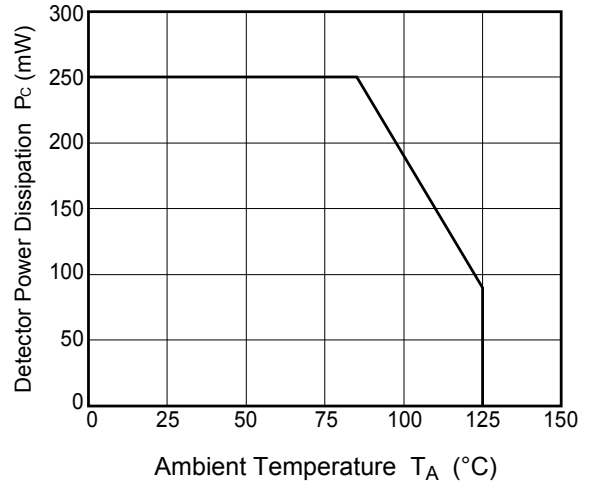
**Remark**  $C_L$  includes probe and stray wiring capacitance.

**TYPICAL CHARACTERISTICS (T<sub>A</sub> = 25°C, unless otherwise specified)**

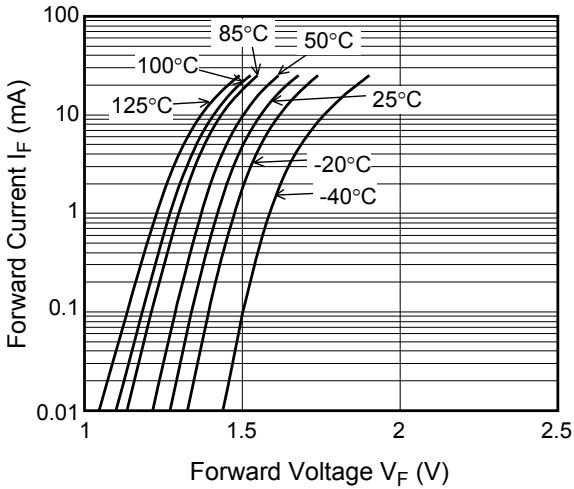
MAXIMUM FORWARD CURRENT vs. AMBIENT TEMPERATURE



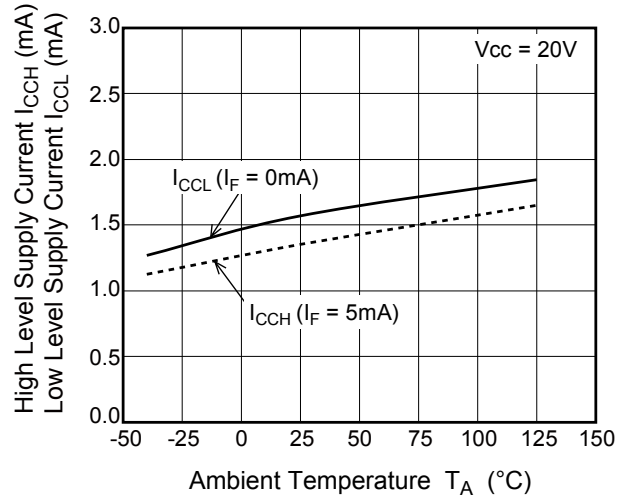
DETECTOR POWER DISSIPATION vs. AMBIENT TEMPERATURE



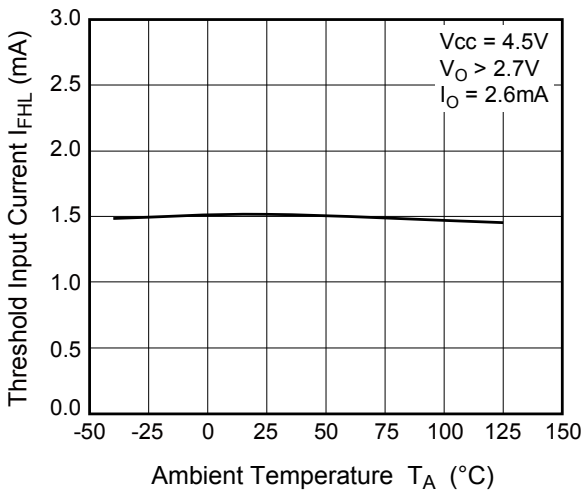
FORWARD CURRENT vs. FORWARD VOLTAGE



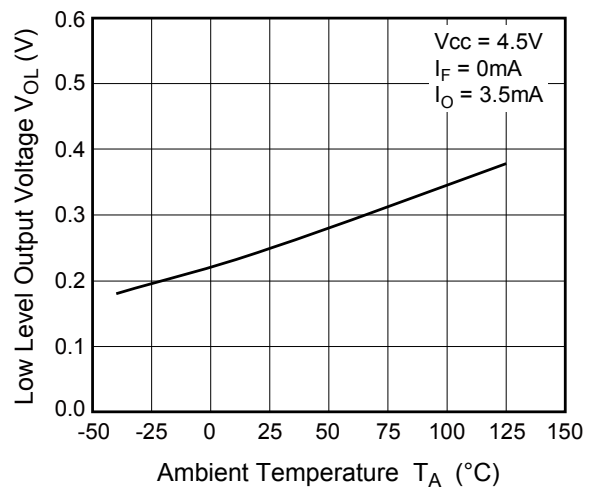
SUPPLY CURRENT vs. AMBIENT TEMPERATURE



THRESHOLD INPUT CURRENT vs. AMBIENT TEMPERATURE

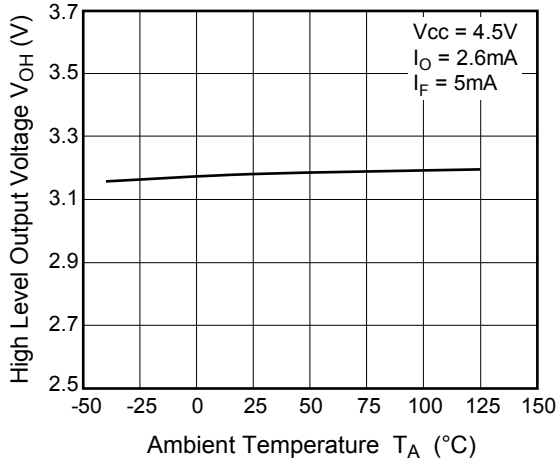


LOW LEVEL OUTPUT VOLTAGE vs. AMBIENT TEMPERATURE

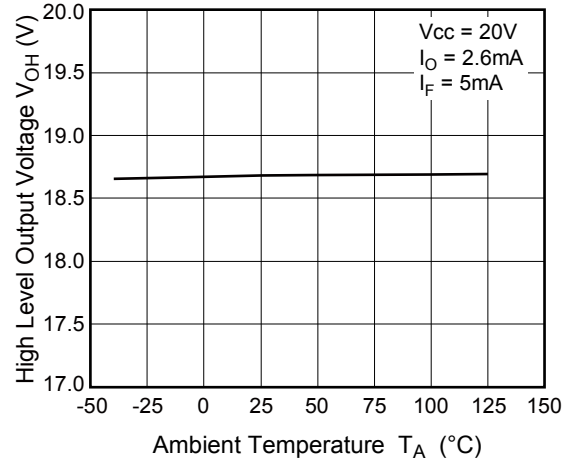


**Remark** The graphs indicate nominal characteristics.

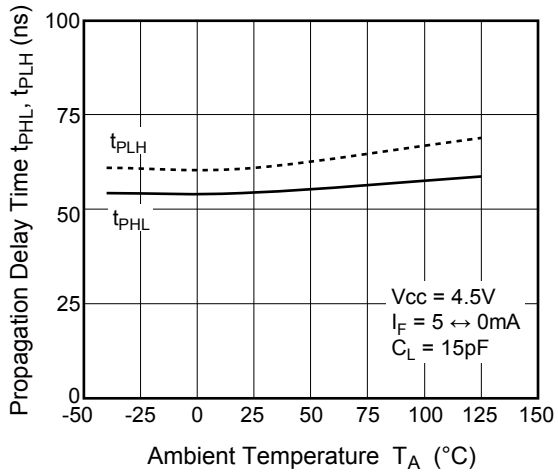
HIGH LEVEL OUTPUT VOLTAGE vs. AMBIENT TEMPERATURE



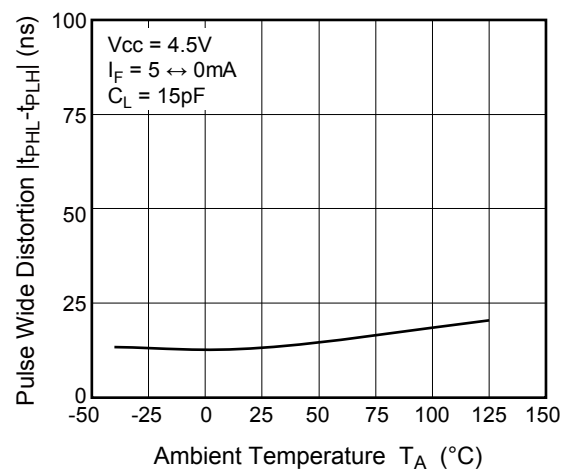
HIGH LEVEL OUTPUT VOLTAGE vs. AMBIENT TEMPERATURE



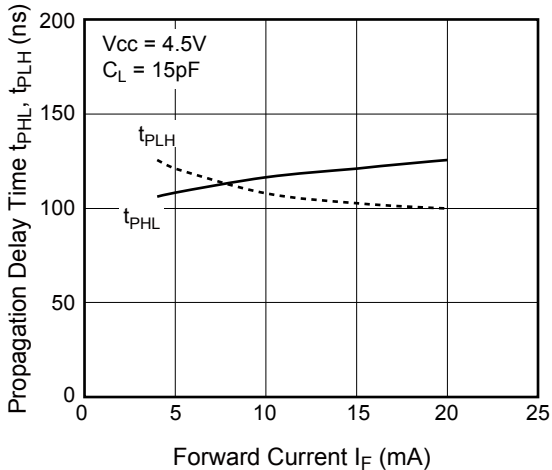
PROPAGATION DELAY TIME vs. AMBIENT TEMPERATURE



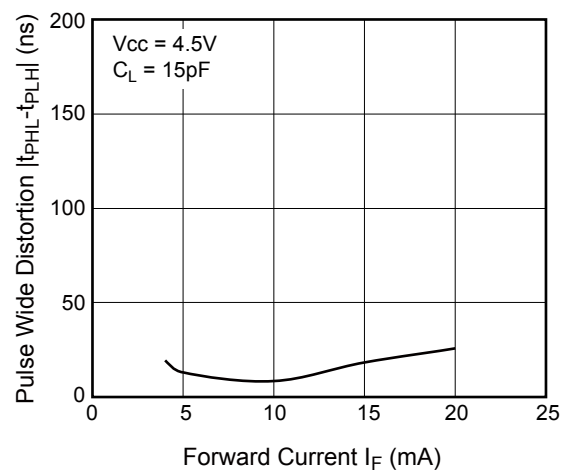
PULSE WIDE DISTORTION vs. AMBIENT TEMPERATURE



PROPAGATION DELAY TIME vs. FORWARD CURRENT



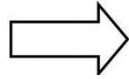
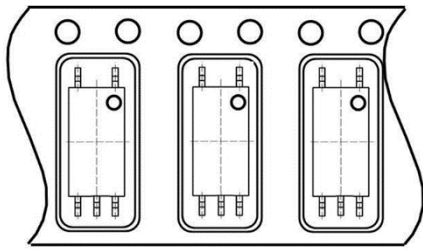
PULSE WIDE DISTORTION vs. FORWARD CURRENT



**Remark** The graphs indicate nominal characteristics.

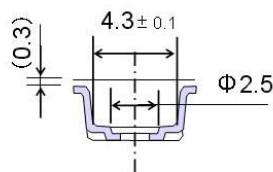
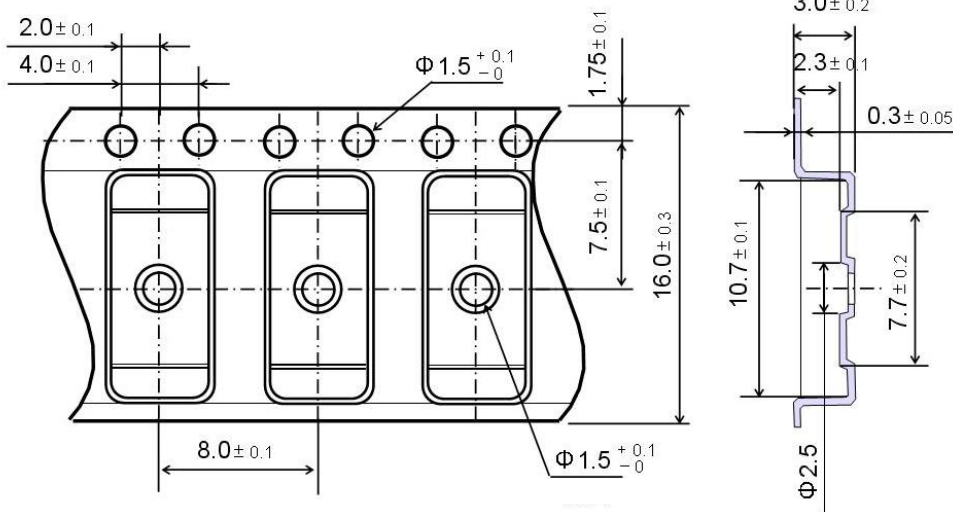


TAPING SPECIFICATIONS (UNIT: mm)

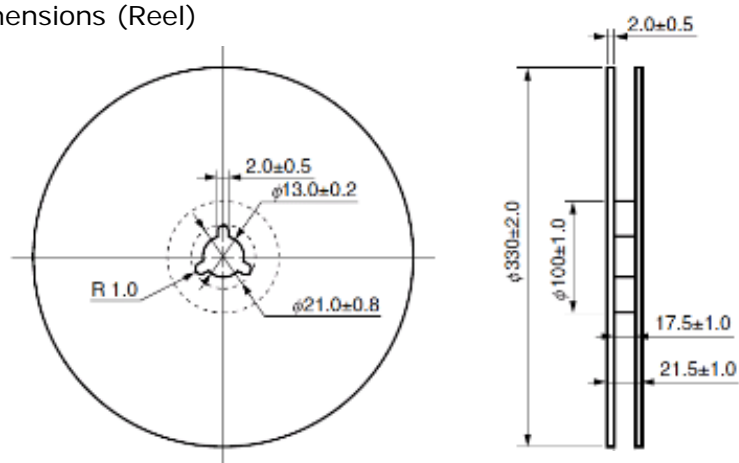


Tape Direction

Outline and Dimensions (Taps)

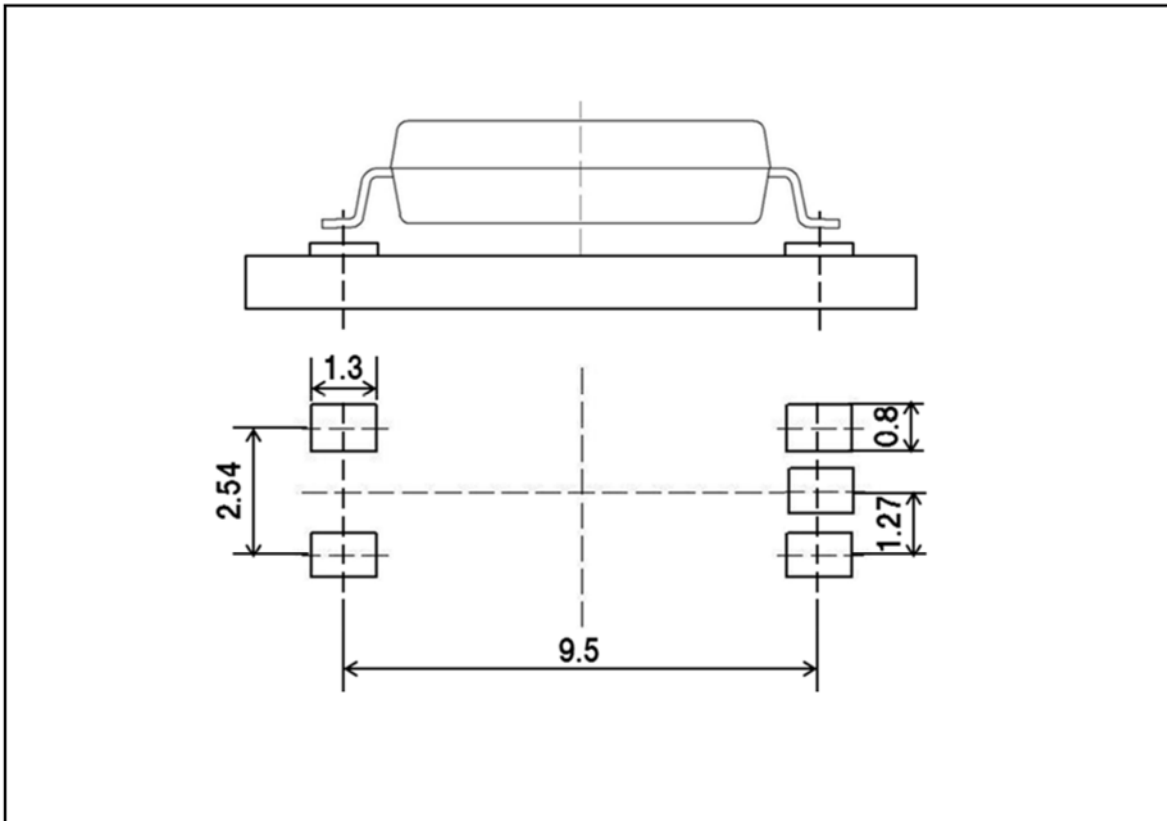


Outline and Dimensions (Reel)



Packing: 3000 pcs/reel

## RECOMMENDED MOUNT PAD DIMENSIONS (UNIT: mm)



**Remark** All dimensions in this figure must be evaluated before use.

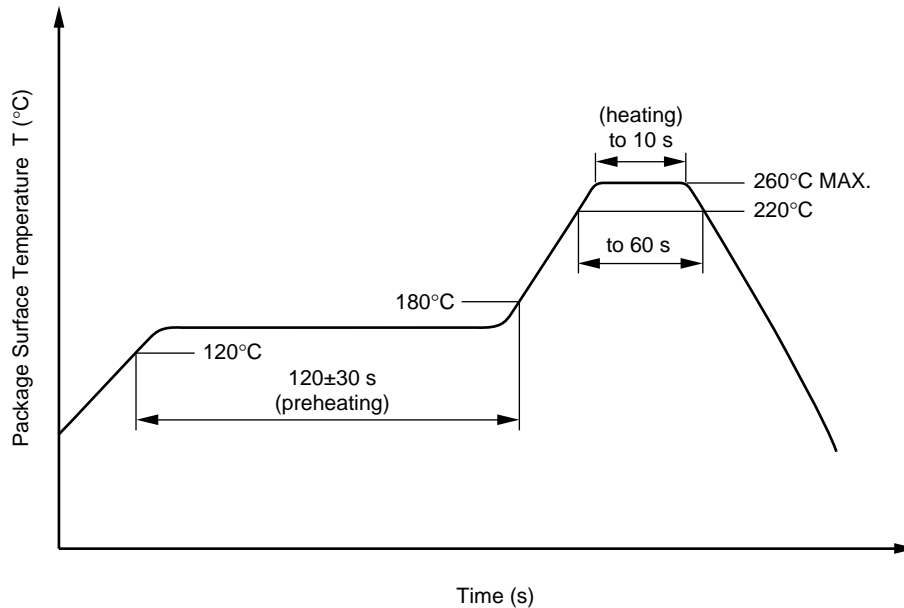
## NOTES ON HANDLING

### 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

#### (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 at startup, the output transistor may enter the on state, even if the voltage is within the absolute maximum ratings.

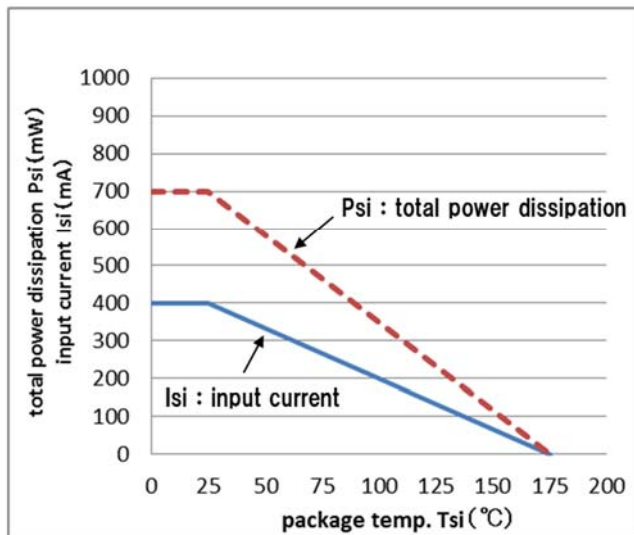
## USAGE CAUTIONS

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.

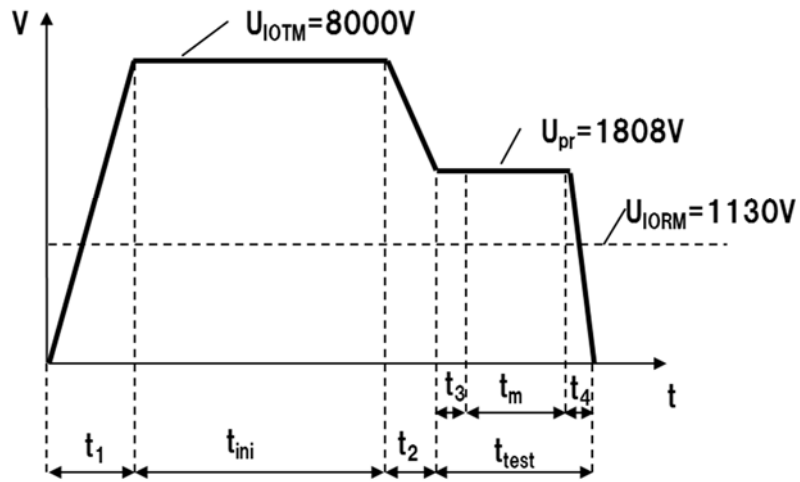
## SPECIFICATION OF VDE MARKS LICENSE DOCUMENT

Parameter	Symbol	Spec.	Unit
Climatic test class (IEC 60068-1/DIN EN 60068-1)		40/125/21	
Dielectric strength maximum operating isolation voltage Test voltage (partial discharge test, procedure a for type test and random test) $U_{pr} = 1.6 \times U_{IORM}, P_d < 5 \text{ pC}$	$U_{IORM}$ $U_{pr}$	1 130 1 808	$V_{peak}$ $V_{peak}$
Test voltage (partial discharge test, procedure b for all devices) $U_{pr} = 1.875 \times U_{IORM}, P_d < 5 \text{ pC}$	$U_{pr}$	2 119	$V_{peak}$
Highest permissible overvoltage	$U_{IOTM}$	8 000	$V_{peak}$
Degree of pollution (DIN EN 60664-1 VDE0110 Part 1)		2	
Comparative tracking index (IEC 60112/DIN EN 60112 (VDE 0303 Part 11))	CTI	400	
Material group (DIN EN 60664-1 VDE0110 Part 1)		II	
Storage temperature range	$T_{stg}$	-55 to +150	°C
Operating temperature range	$T_A$	-40 to +125	°C
Isolation resistance, minimum value $V_{IO} = 500 \text{ V dc at } T_A = 25^\circ\text{C}$ $V_{IO} = 500 \text{ V dc at } T_A \text{ MAX. at least } 100^\circ\text{C}$	Ris MIN. Ris 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 $V_{IO} = 500 \text{ V dc at } T_A = T_{si}$	$T_{si}$ $I_{si}$ $P_{si}$ Ris MIN.	175 400 700 $10^9$	°C mA mW $\Omega$

## Dependence of maximum safety ratings with package temperature

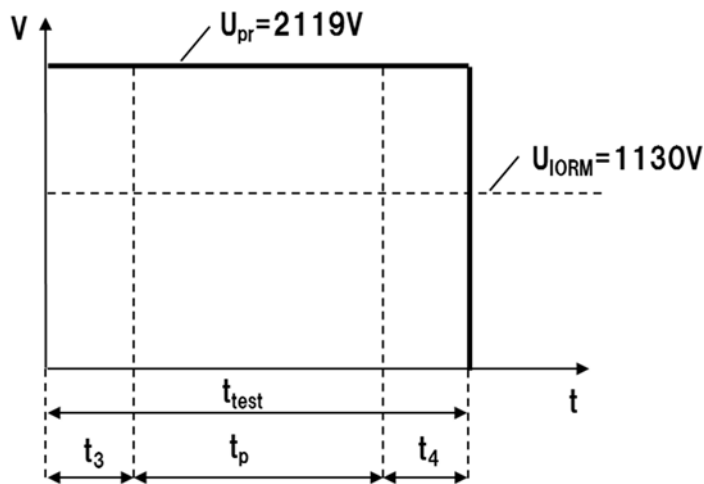


Method A Destructive Test, Type and Sample test



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

Method b Non-destructive Test, 100% Production Test



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

<b>Caution</b>	GaAs Products	<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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