Data Sheet

PS9331L, PS9331L2

R08DS0111EJ0200
Rev.2.00
Jun 21, 2013

2.5 A OUTPUT CURRENT, HIGH CMR, IGBT GATE DRIVE, 6-PIN SDIP PHOTOCOUPLER

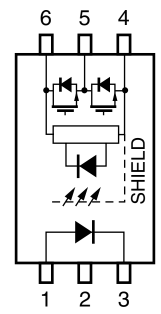
DESCRIPTION

The PS9331L and PS9331L2 are optical coupled isolators containing a GaAlAs LED on the input side and a photo diode, a signal processing circuit and power MOSFETs on the output side on one chip.
The PS9331L and PS9331L2 are in 6-pin plastic SDIP (Shrink Dual In-line Package). The PS9331L2 has 8 mm creepage distance. The mount area of 6-pin plastic SDIP is half size of 8-pin DIP.
The PS9331L and PS9331L2 are designed specifically for high common mode transient immunity (CMR) and high switching speed. It is suitable for driving IGBTs and MOS FETs.
The PS9331L is lead bending type (Gull-wing) for surface mounting.
The PS9331L2 is lead bending type for long creepage distance (Gull-wing) for surface mount.

FEATURES

- Long creepage distance (8 mm MIN.: PS9331L2)
- Half size of 8-pin DIP
- Peak output current (2.5 A MAX., 2.0 A MIN.)
- High speed switching (t_{PLH}, t_{PHL} = 175 ns MAX.)
- High common mode transient immunity (CM_H, CM_L = ±50 kV/μs MIN.)
- Operating Ambient Temperature (125 °C)
- Embossed tape product : PS9331L-E3, PS9331L2-E3: 2 000 pcs/reel
- Pb-Free product
- Safety standards
  - UL approved: No. E72422
  - CSA approved: No. CA 101391 (CA5A, CAN/CSA-C22.2 60065, 60950)
  - SEMKO approved (EN 60065, EN 60950)
  - DIN EN 60747-5-5 (VDE 0884-5) approved (Option)

PIN CONNECTION
(Top View)



1. Anode
2. NC
3. Cathode
4. V_{EE}
5. V_O
6. V_{CC}

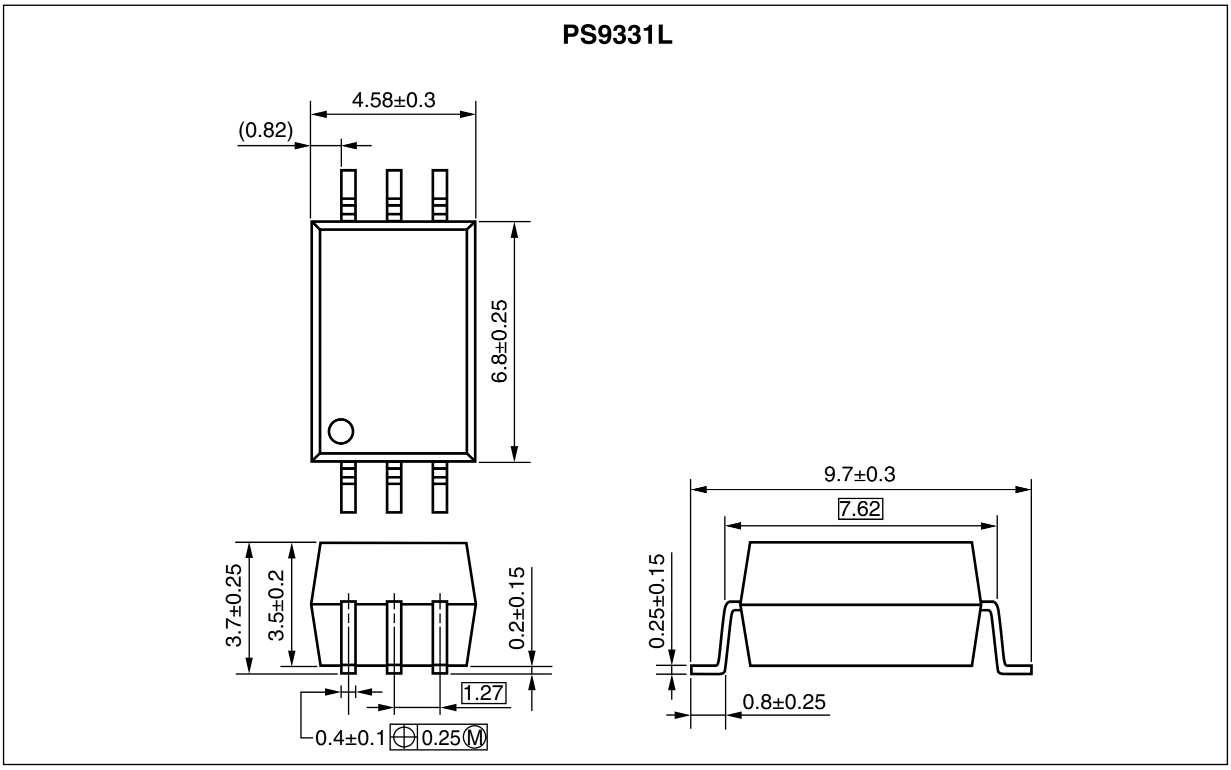
APPLICATIONS

- IGBT, Power MOS FET Gate Driver
- Industrial inverter
- AC Servo

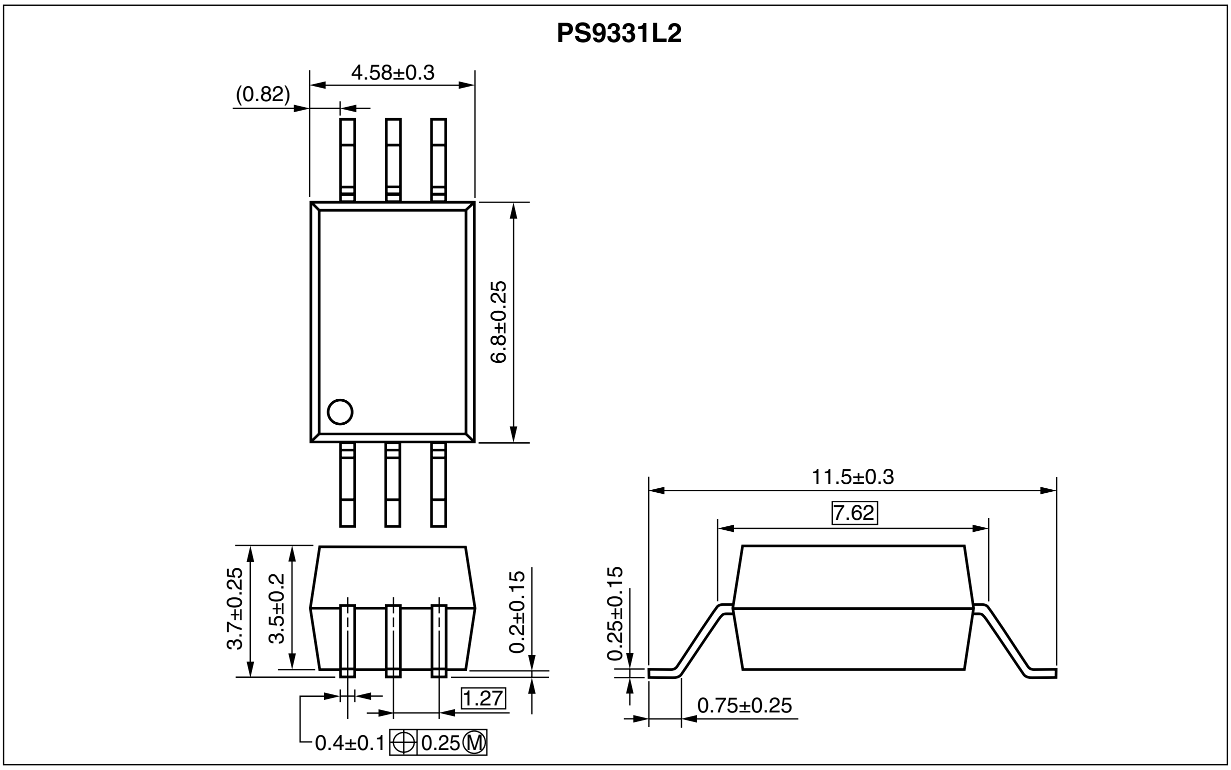
The mark <R> shows major revised points.
The revised points can be easily searched by copying an "<R>" in the PDF file and specifying it in the "Find what:" field.

PACKAGE DIMENSIONS (UNIT: mm)

Lead Bending Type (Gull-wing) For Surface Mount



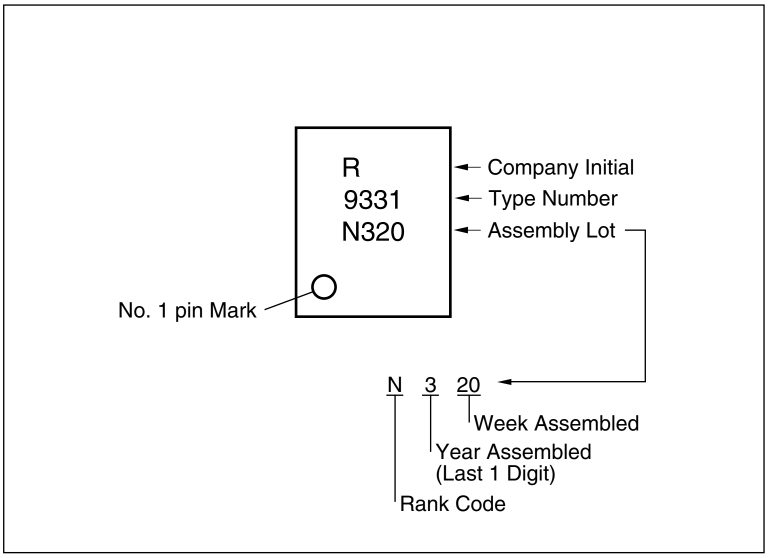
Lead Bending Type (Gull-wing) For Long Creepage Distance (Surface Mount)



PHOTOCOUPLER CONSTRUCTION

Parameter	PS9331L	PS9331L2
Air Distance (MIN.)	7 mm	8 mm
Outer Creepage Distance (MIN.)	7 mm	8 mm
Isolation Distance (MIN.)	0.4 mm	0.4 mm

MARKING EXAMPLE



ORDERING INFORMATION

Part Number	Order Number	Solder Plating Specification	Packing Style	Safety Standard Approval	Application Part Number*1
PS9331L	PS9331L-AX	Pb-Free (Ni/Pd/Au)	20 pcs (Tape 20 pcs cut)	Standard products (UL, CSA, SEMKO approved)	PS9331L
PS9331L-E3	PS9331L-E3-AX		Embossed Tape 2 000 pcs/reel		
PS9331L2	PS9331L2-AX		20 pcs (Tape 20 pcs cut)		PS9331L2
PS9331L2-E3	PS9331L2-E3-AX		Embossed Tape 2 000 pcs/reel		
PS9331L-V	PS9331L-V-AX		20 pcs (Tape 20 pcs cut)	DIN EN 60747-5-5 (VDE 0884-5) approved (Option)	PS9331L
PS9331L-V-E3	PS9331L-V-E3-AX		Embossed Tape 2 000 pcs/reel		
PS9331L2-V	PS9331L2-V-AX		20 pcs (Tape 20 pcs cut)		PS9331L2
PS9331L2-V-E3	PS9331L2-V-E3-AX		Embossed Tape 2 000 pcs/reel		

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

ABSOLUTE MAXIMUM RATINGS (T_A = 25°C, unless otherwise specified)

Parameter		Symbol	Ratings	Unit
Diode	Forward Current	I_F	25	mA
	Peak Transient Forward Current (Pulse Width < 1 μs)	$I_{F\ (TRAN)}$	1.0	A
	Reverse Voltage	V_R	5	V
	Power Dissipation *1	P_D	45	mW
Detector	High Level Peak Output Current *2	$I_{OH\ (PEAK)}$	2.5	A
	Low Level Peak Output Current *2	$I_{OL\ (PEAK)}$	2.5	A
	Supply Voltage	$(V_{CC} - V_{EE})$	0 to 35	V
	Output Voltage	V_O	0 to V_{CC}	V
	Power Dissipation *3	P_C	250	mW
Isolation Voltage *4		BV	5 000	Vr.m.s.
Operating Frequency		f	50	kHz
Operating Ambient Temperature		T_A	–40 to +125	°C
Storage Temperature		T_{stg}	–55 to +150	°C

Notes: *1. Reduced to 1.2 mW/°C at T_A = 110°C or more.

*2. Maximum pulse width = 10 μs, Maximum duty cycle = 0.2%

*3. Reduced to 3.9 mW/°C at T_A = 85°C or more.

*4. AC voltage for 1 minute at T_A = 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	$(V_{CC} - V_{EE})$	15		30	V
Forward Current (ON)	$I_{F\ (ON)}$	8	10	12	mA
Forward Voltage (OFF)	$V_{F\ (OFF)}$	–2		0.8	V
Operating Ambient Temperature	T_A	–40		125	°C

ELECTRICAL CHARACTERISTICS (at RECOMMENDED OPERATING CONDITIONS, V_{EE} = GND, unless otherwise specified)

Parameter		Symbol	Conditions	MIN.	TYP.*1	MAX.	Unit
Diode	Forward Voltage	V_F	I_F = 10 mA, T_A = 25°C	1.35	1.56	1.75	V
	Reverse Current	I_R	V_R = 3 V, T_A = 25°C			10	μA
	Input Capacitance	C_{IN}	f = 1 MHz, V_F = 0 V		30		pF
Detector	High Level Output Current	I_{OH}	V_O = (V_{CC} – 4 V) *2	0.5	2.2		A
			V_O = (V_{CC} – 15 V) *3	2.0			
	Low Level Output Current	I_{OL}	V_O = (V_{EE} + 2.5 V) *2	0.5	2.4		A
			V_O = (V_{EE} + 15 V) *3	2.0			
	High Level Output Voltage	V_{OH}	I_O = –100 mA *4	V_{CC} – 3.0	V_{CC} – 1.3		V
	Low Level Output Voltage	V_{OL}	I_O = 100 mA		0.2	0.5	V
	High Level Supply Current	I_{CCH}	V_O = Open		1.7	2.2	mA
	Low Level Supply Current	I_{CCL}	V_O = Open		1.7	2.2	mA
	UVLO Threshold	V_{UVLO+}	V_O > 5 V, I_F = 10 mA	10.8	12.3	13.4	V
		V_{UVLO-}		9.5	11.0	12.5	
	UVLO Hysteresis	$UVLO_{HYS}$	V_O > 5 V, I_F = 10 mA	0.4	1.3		V
Coupled	Threshold Input Current (L → H)	I_{FLH}	I_O = 0 mA, V_O > 5 V		1.7	4.0	mA
	Threshold Input Voltage (H → L)	V_{FHL}	I_O = 0 mA, V_O < 5 V	0.8			V

Notes: *1. Typical values at T_A = 25°C, V_{CC} – V_{EE} = 30 V.
*2. Maximum pulse width = 50 μs, Maximum duty cycle = 0.5%.
*3. Maximum pulse width = 10 μs, Maximum duty cycle = 0.2%.
*4. V_{OH} is measured with the DC load current in this testing (Maximum pulse width = 2 ms, Maximum duty cycle = 20%).

SWITCHING CHARACTERISTICS (at RECOMMENDED OPERATING CONDITIONS, V_{EE} = GND, unless otherwise specified)

Parameter	Symbol	Conditions	MIN.	TYP.*1	MAX.	Unit
Propagation Delay Time (L → H)	t_{PLH}	R_g = 10 Ω, C_g = 10 nF, f = 10 kHz, Duty Cycle = 50%, I_F = 10 mA		80	175	ns
Propagation Delay Time (H → L)	t_{PHL}			105	175	ns
Pulse Width Distortion (PWD)	$\|t_{PHL}–t_{PLH}\|$			25	75	ns
Propagation Delay Time (Difference Between Any Two Products)	$t_{PHL}–t_{PLH}$		–90		90	ns
Rise Time	t_r			40		ns
Fall Time	t_f			40		ns
Common Mode Transient Immunity at High Level Output	$\|CM_H\|$	T_A = 25°C, I_F = 10 mA, V_{CC} = 30 V, V_{CM} = 1.5 kV	50			kV/μs
Common Mode Transient Immunity at Low Level Output	$\|CM_L\|$	T_A = 25°C, I_F = 0 mA, V_{CC} = 30 V, V_{CM} = 1.5 kV	50			kV/μs

Notes: *1. Typical values at T_A = 25°C, V_{CC}–V_{EE} = 30 V.

TEST CIRCUIT

Fig. 1 I_{OH} Test Circuit

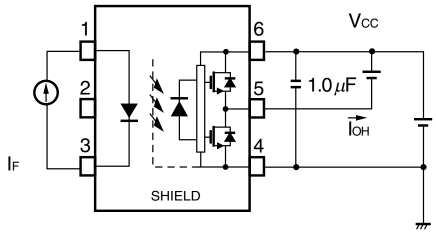


Fig. 2 I_{OL} Test Circuit

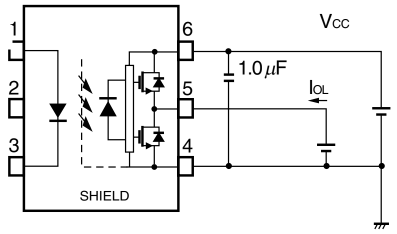


Fig. 3 V_{OH} Test Circuit

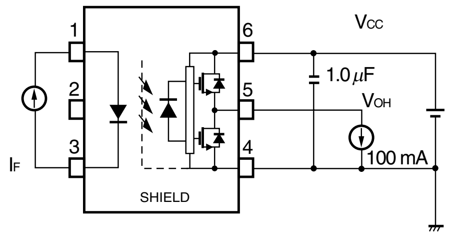


Fig. 4 V_{OL} Test Circuit

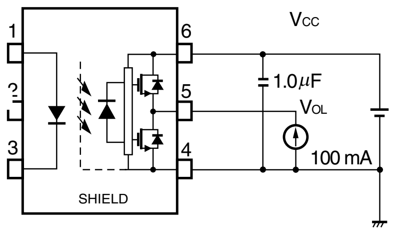


Fig. 5 I_{CCH}/I_{CCL} Test Circuit

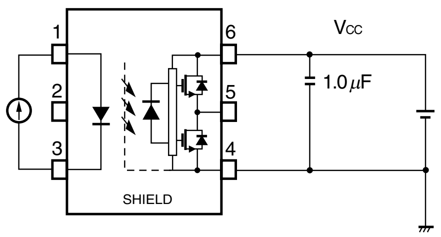


Fig. 6 UVLO Test Circuit

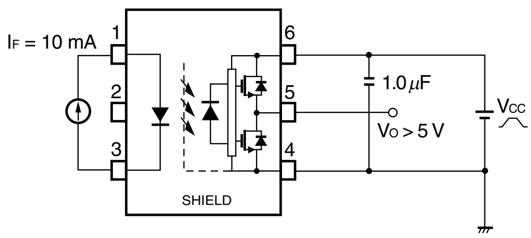


Fig. 7 I_{FLH} Test Circuit

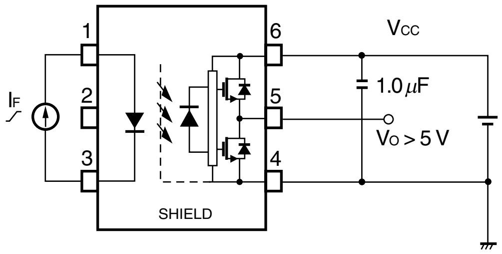


Fig. 8 t_{PLH}, t_{PHL}, t_r, t_f Test Circuit and Wave Forms

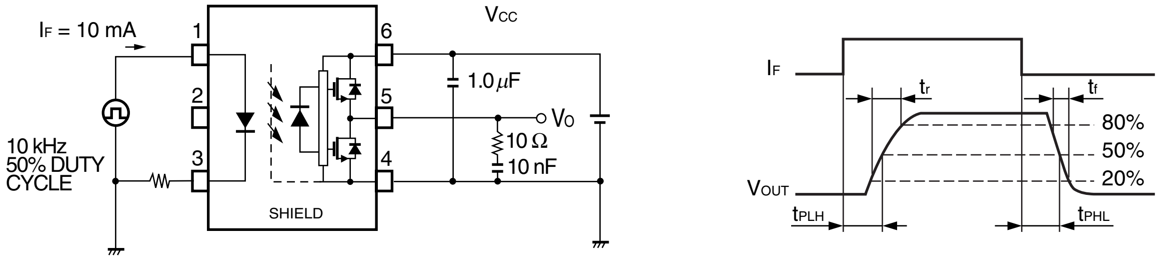
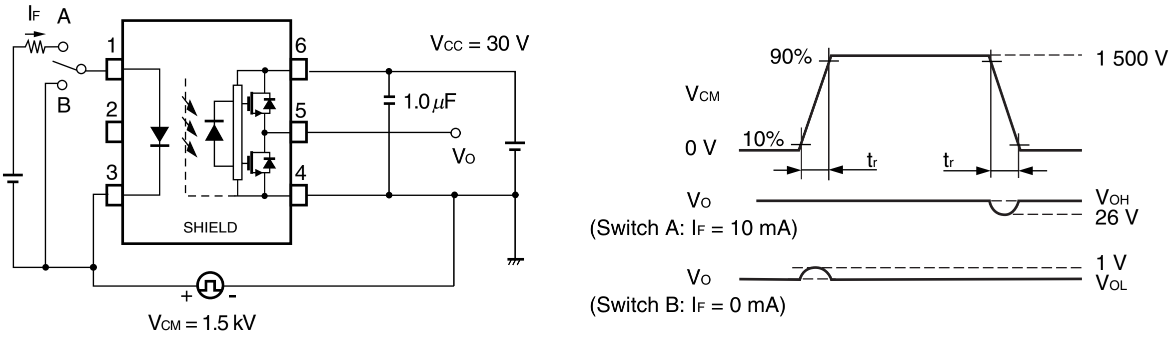
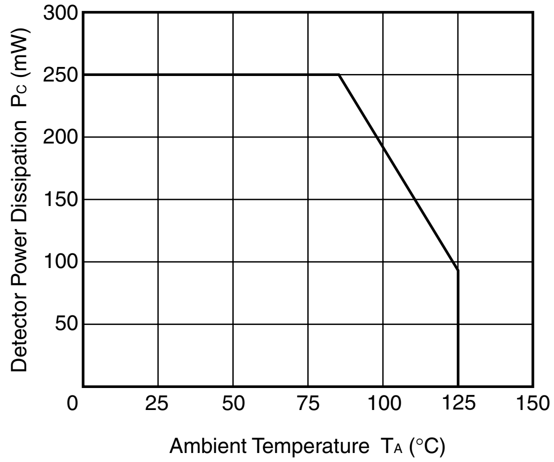


Fig. 9 CMR Test Circuit and Wave Forms

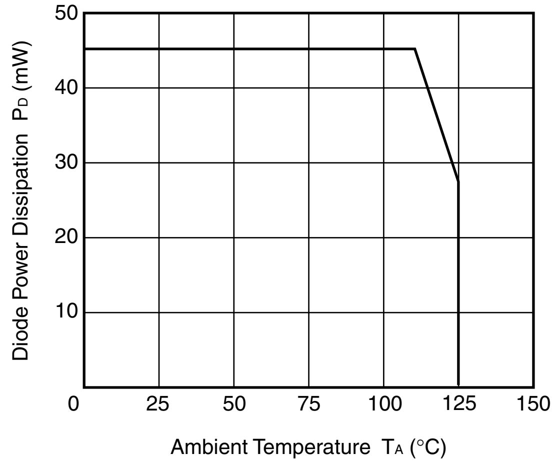


<R> TYPICAL CHARACTERISTICS (T_A = 25°C, unless otherwise specified)

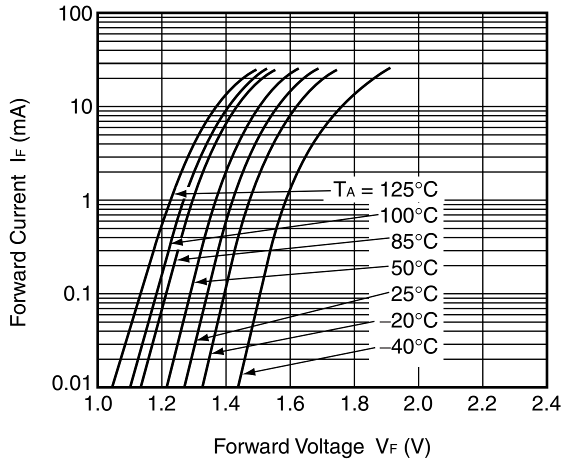
DETECTOR POWER DISSIPATION vs. AMBIENT TEMPERATURE



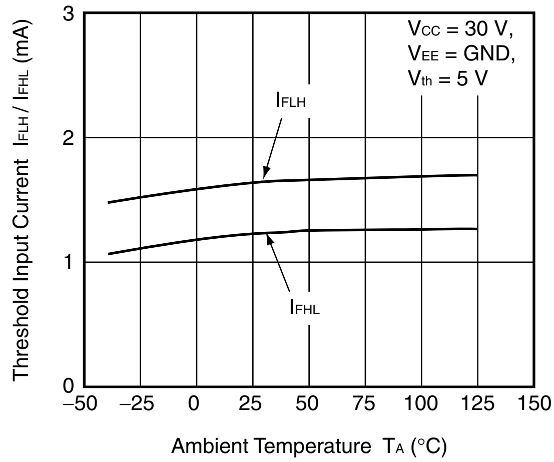
DIODE POWER DISSIPATION vs. AMBIENT TEMPERATURE



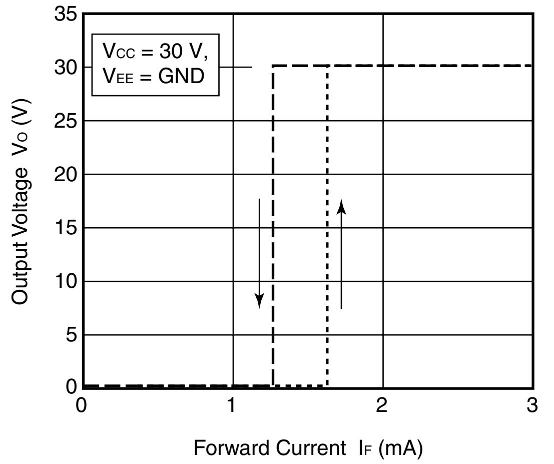
FORWARD CURRENT vs. FORWARD VOLTAGE



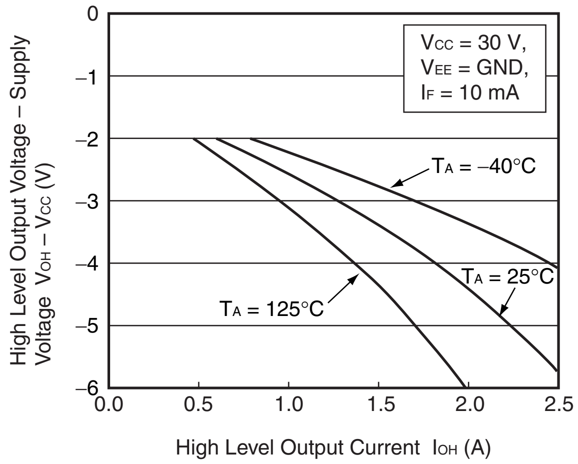
THRESHOLD INPUT CURRENT vs. AMBIENT TEMPERATURE



OUTPUT VOLTAGE vs. FORWARD CURRENT

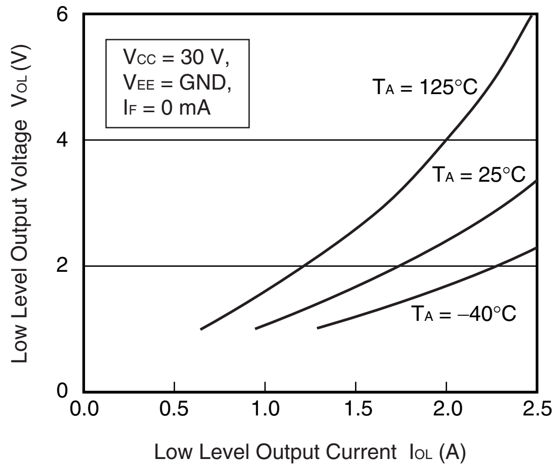


HIGH LEVEL OUTPUT VOLTAGE – SUPPLY VOLTAGE vs. HIGH LEVEL OUTPUT CURRENT

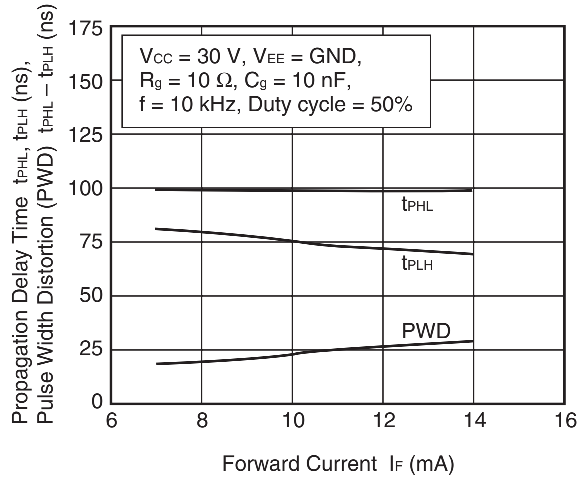


Remark The graphs indicate nominal characteristics.

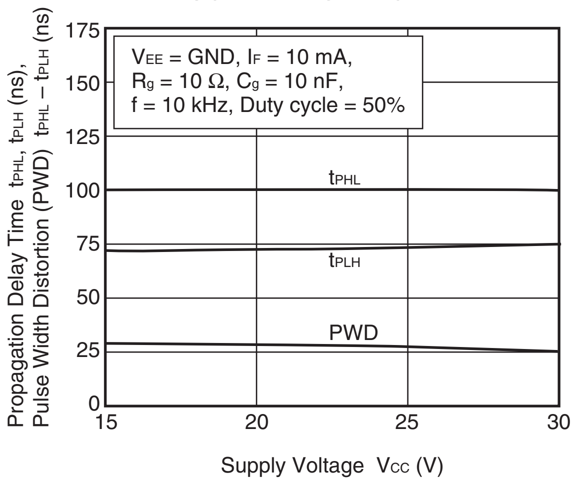
LOW LEVEL OUTPUT VOLTAGE vs.
LOW LEVEL OUTPUT CURRENT



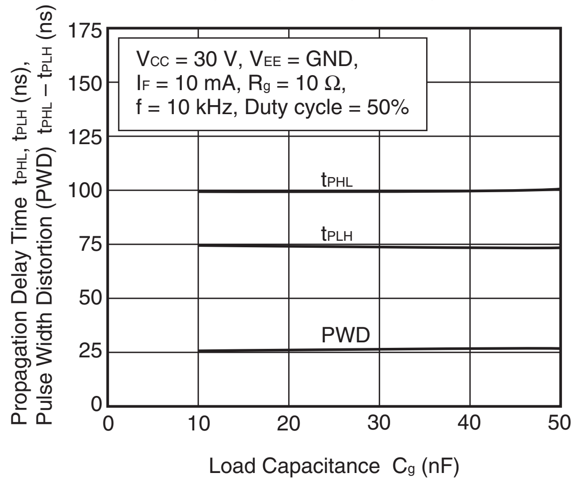
PROPAGATION DELAY TIME,
PULSE WIDTH DISTORTION
vs. FORWARD CURRENT



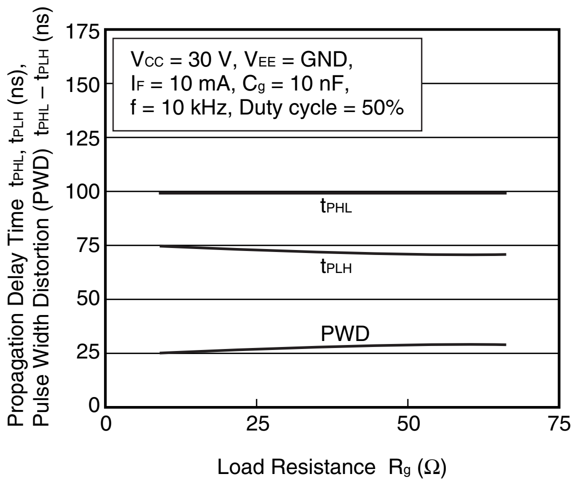
PROPAGATION DELAY TIME,
PULSE WIDTH DISTORTION
vs. SUPPLY VOLTAGE



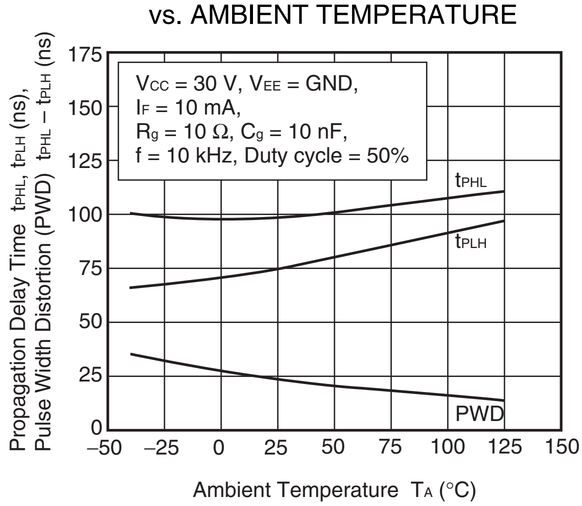
PROPAGATION DELAY TIME,
PULSE WIDTH DISTORTION
vs. LOAD CAPACITANCE



PROPAGATION DELAY TIME,
PULSE WIDTH DISTORTION
vs. LOAD RESISTANCE

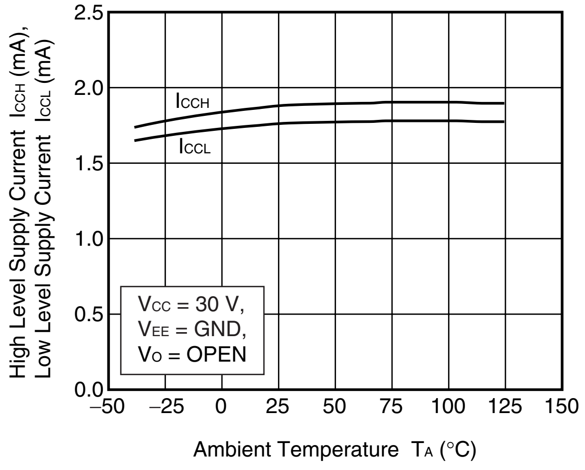


PROPAGATION DELAY TIME,
PULSE WIDTH DISTORTION
vs. AMBIENT TEMPERATURE

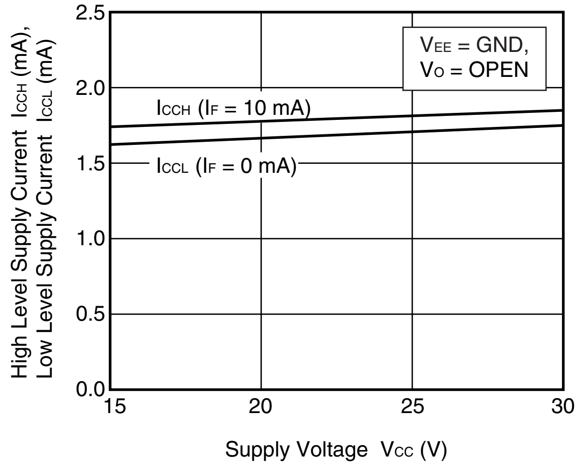


Remark The graphs indicate nominal characteristics.

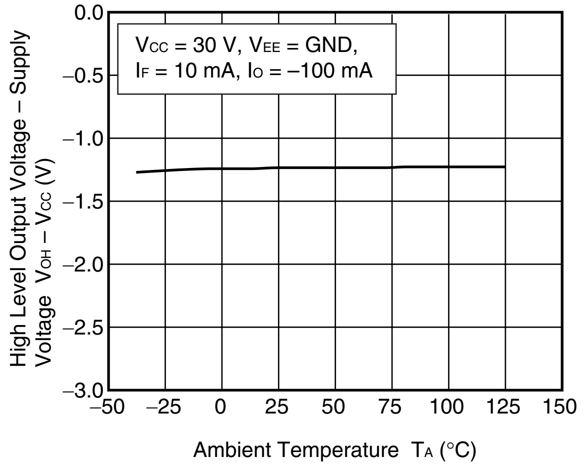
SUPPLY CURRENT vs.
AMBIENT TEMPERATURE



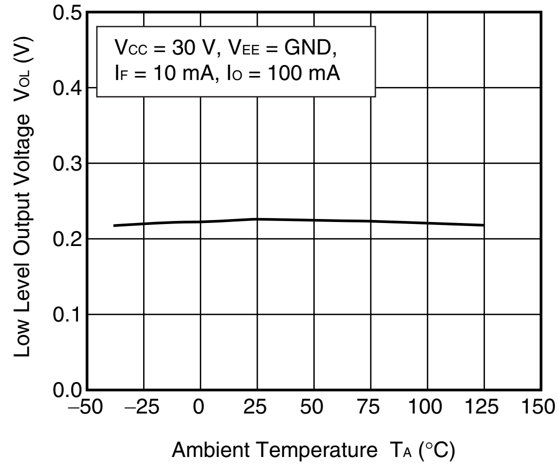
SUPPLY CURRENT vs.
SUPPLY VOLTAGE



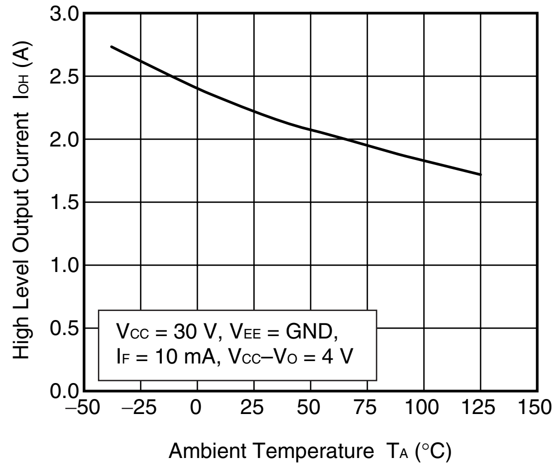
HIGH LEVEL OUTPUT VOLTAGE – SUPPLY
VOLTAGE vs. AMBIENT TEMPERATURE



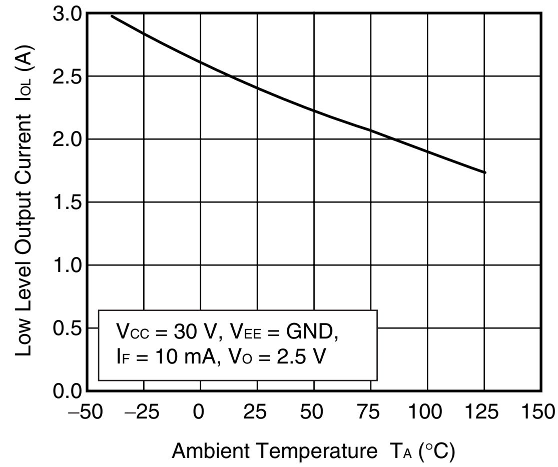
LOW LEVEL OUTPUT VOLTAGE vs.
AMBIENT TEMPERATURE



HIGH LEVEL OUTPUT CURRENT vs.
AMBIENT TEMPERATURE

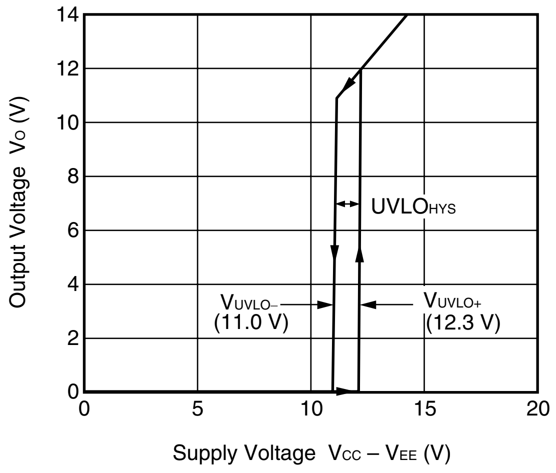


LOW LEVEL OUTPUT CURRENT vs.
AMBIENT TEMPERATURE



Remark The graphs indicate nominal characteristics.

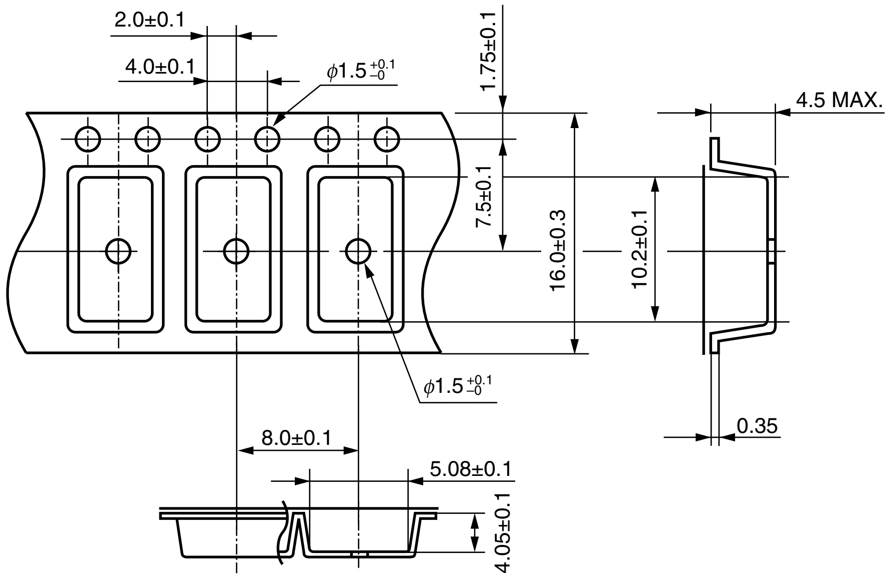
OUTPUT VOLTAGE vs. SUPPLY VOLTAGE



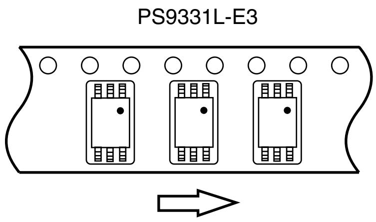
Remark The graphs indicate nominal characteristics.

TAPING SPECIFICATIONS (UNIT: mm)

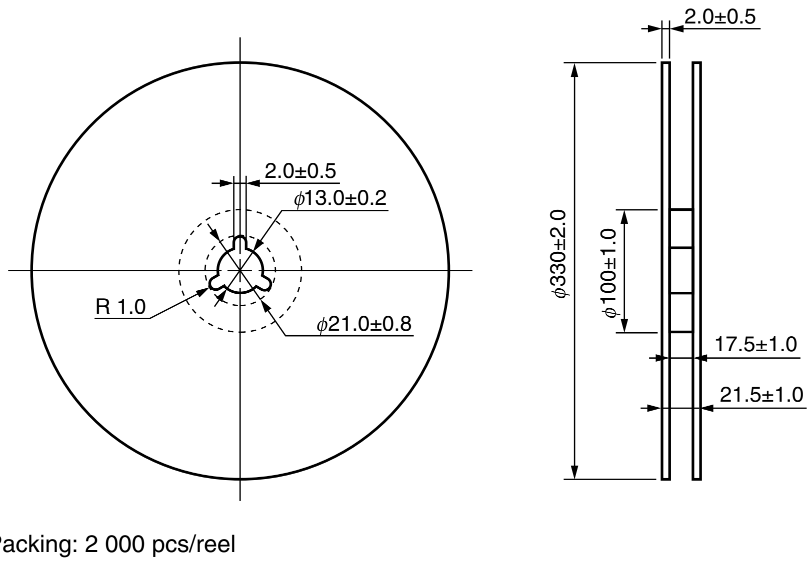
Outline and Dimensions (Tape)



Tape Direction

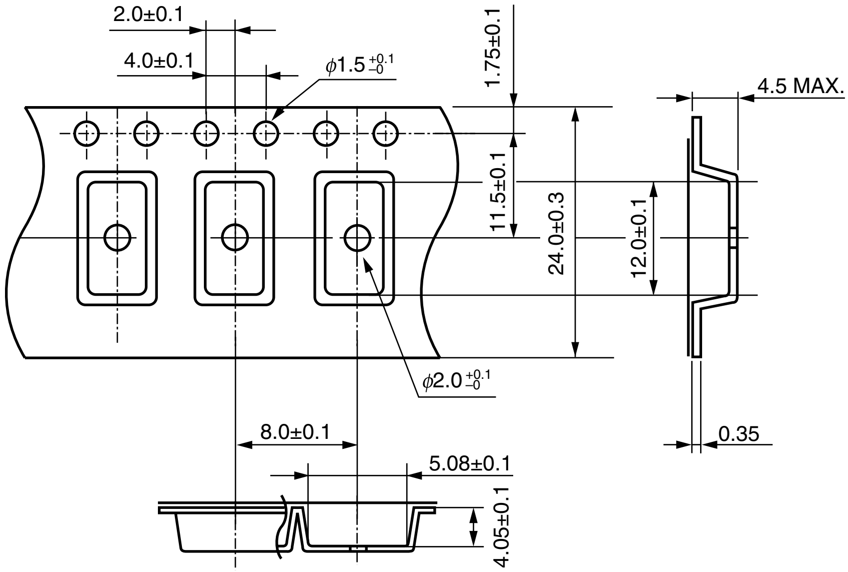


Outline and Dimensions (Reel)



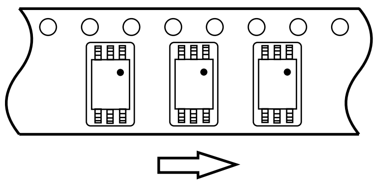
Packing: 2 000 pcs/reel

Outline and Dimensions (Tape)

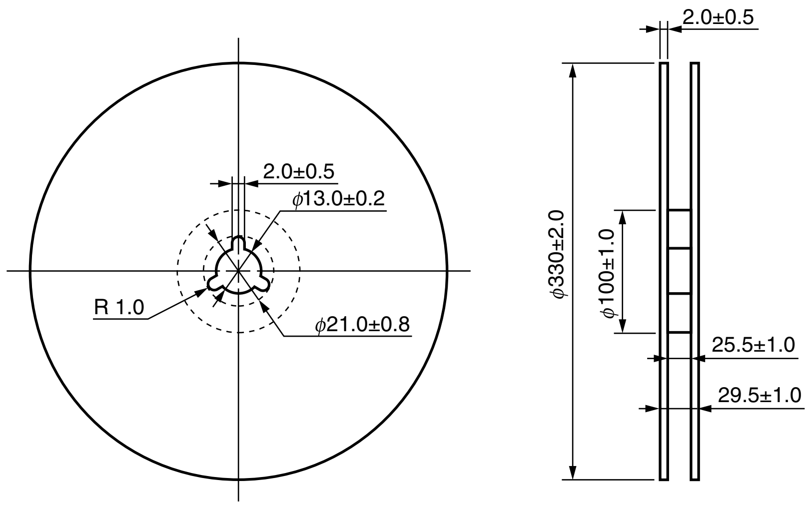


Tape Direction

PS9331L2-E3

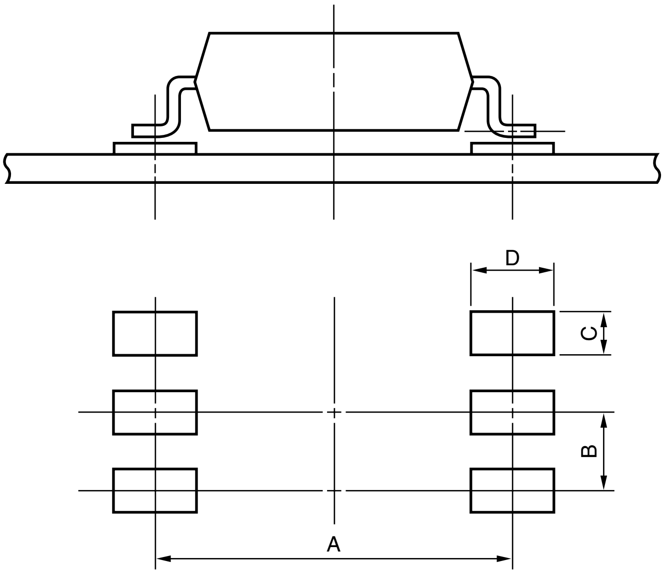


Outline and Dimensions (Reel)



Packing: 2 000 pcs/reel

RECOMMENDED MOUNT PAD DIMENSIONS (UNIT: mm)



Part Number	Lead Bending	A	B	C	D
PS9331L	lead bending type (Gull-wing) for surface mount	9.2	1.27	0.8	2.2
PS9331L2	lead bending type (Gull-wing) for long creepage distance (surface mount)	10.2	1.27	0.8	2.2

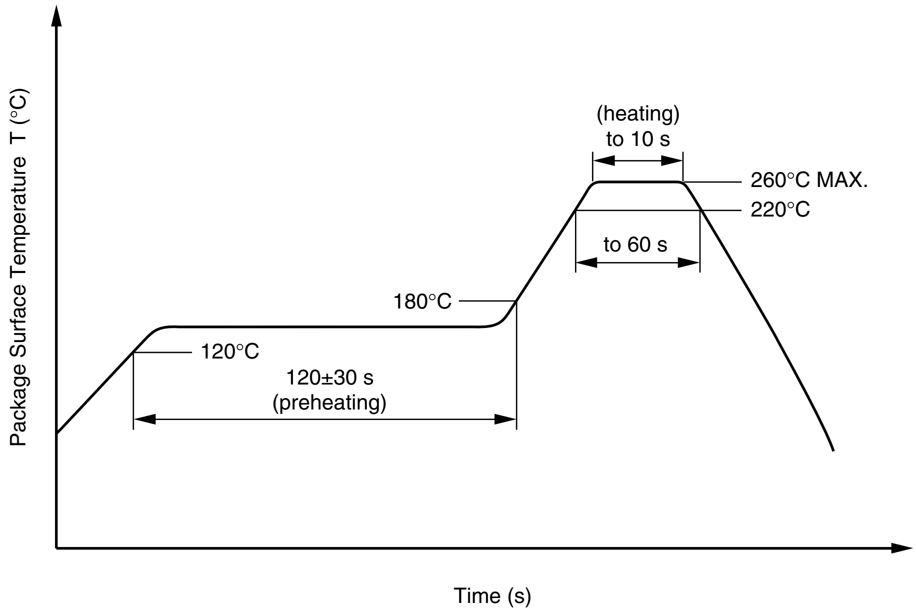
NOTES ON HANDLING

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. Board designing
   (1) By-pass capacitor of more than 1.0 μF 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.
   (2) When designing the printed wiring board, ensure that the pattern of the IGBT collectors/emitters is not too close to the input block pattern of the photocoupler.
   If the pattern is too close to the input block and coupling occurs, a sudden fluctuation in the voltage on the IGBT output side might affect the photocoupler's LED input, leading to malfunction or degradation of characteristics. (If the pattern needs to be close to the input block, to prevent the LED from lighting during the off state due to the abovementioned coupling, design the input-side circuit so that the bias of the LED is reversed, within the range of the recommended operating conditions, and be sure to thoroughly evaluate operation.)
   (3) Pin 2 (which is an NC*1 pin) can either be connected directly to the GND pin on the LED side or left open. Unconnected pins should not be used as a bypass for signals or for any other similar purpose because this may degrade the internal noise environment of the device.
   Note: *1. NC: Non-Connection (No Connection).
3. Make sure the rise/fall time of the forward current is 0.5 μs or less.
4. In order to avoid malfunctions, make sure the rise/fall slope of the supply voltage is 3 V/μs or less.
5. 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) $U_{pr} = 1.6 \times U_{IORM.}$, $P_d < 5$ pC	 U_{IORM} U_{pr}	 1 130 1 808	 V_{peak} V_{peak}
Test voltage (partial discharge test, procedure b for all devices) $U_{pr} = 1.875 \times U_{IORM.}$, $P_d < 5$ pC	U_{pr}	2 119	V_{peak}
Highest permissible overvoltage	U_{TR}	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	175	
Material group (DIN EN 60664-1 VDE0110 Part 1)		III a	
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 V dc at T_A = 25°C V_{IO} = 500 V dc at T_A MAX. at least 100°C	 Ris MIN. Ris MIN.	 10^{12} 10^{11}	 Ω Ω
Safety maximum ratings (maximum permissible in case of fault, see thermal derating curve) Package temperature Current (input current I_F, Psi = 0) Power (output or total power dissipation) Isolation resistance V_{IO} = 500 V dc at T_A = Tsi	 Tsi Isi Psi Ris MIN.	 175 400 700 10^9	 °C mA mW Ω

Caution	GaAs Products	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. • 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. 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. 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. • Do not burn, destroy, cut, crush, or chemically dissolve the product. • Do not lick the product or in any way allow it to enter the mouth.

Revision History	PS9331L, PS9331L2 Data Sheet

Rev.	Date	Description	
		Page	Summary
1.00	May 24, 2013	–	First edition issued
2.00	Jun 21, 2013	pp.8 to 11	Addition of **TYPICAL CHARACTERISTICS**

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[Colophon 2.2]