

PS9905

Data Sheet

R08DS0058EJ0100

Rev.1.00

Jun 11, 2012

2.5 A OUTPUT CURRENT, HIGH CMR, IGBT GATE DRIVE, 8-PIN LSDIP PHOTOCOUPLER
 FOR CREEPAGE DISTANCE OF 14.5 mm

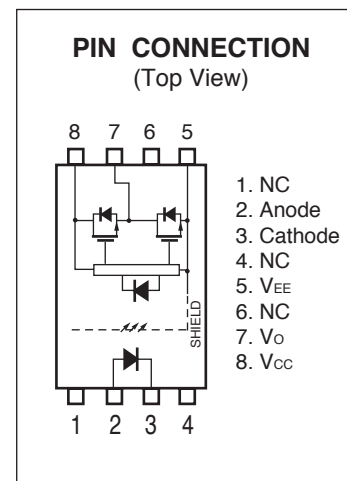
DESCRIPTION

The PS9905 is optically coupled isolator containing a GaAlAs LED on the input side and a photo diode, a signal processing circuit and a power output transistor on the output side on one chip.

FEATURES

- Long creepage distance (14.5 mm MIN.)
- Large peak output current (2.5 A MAX., 2.0 A MIN.)
- High speed switching (t_{PLH} , t_{PHL} = 0.15 μ s MAX.)
- UVLO (Under Voltage Lock Out) protection with hysteresis
- High common mode transient immunity (CM_H , CM_L = ± 25 kV/ μ s MIN.)
- 8-pin LSDIP (Long Creepage SDIP) type
- Embossed tape product: PS9905-F3: 1 000 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: No. 1122994
 - DIN EN60747-5-5 (VDE0884-5): 2011-11 approved: No. 40034588 (Option)

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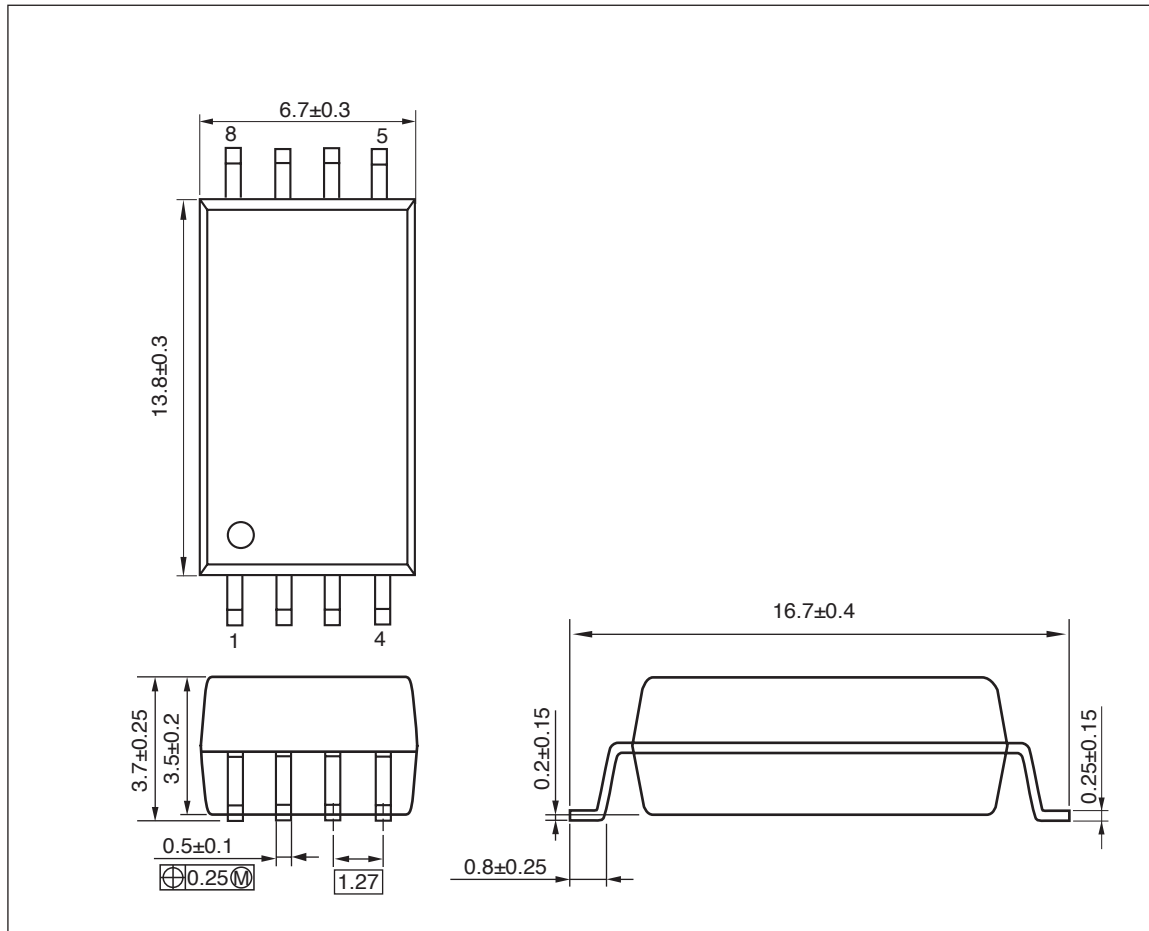


APPLICATIONS

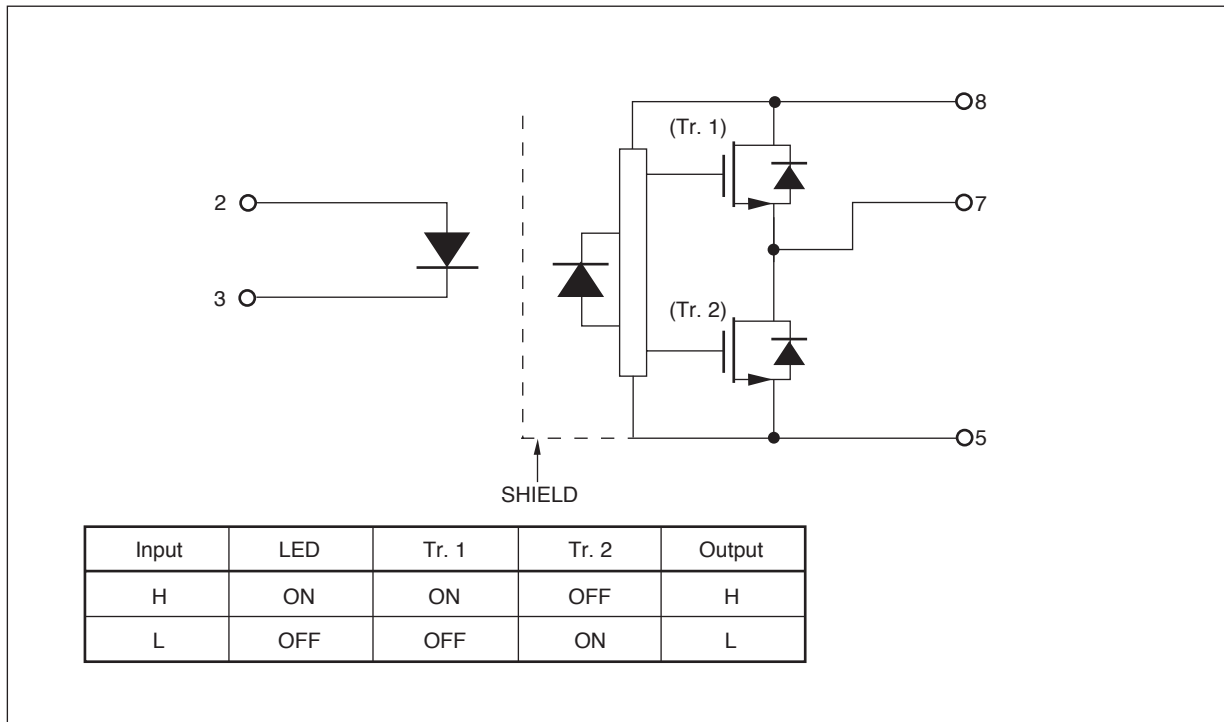
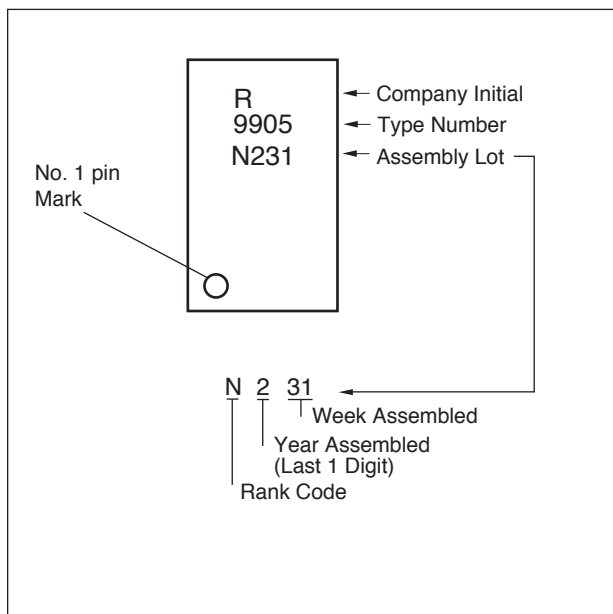
- IGBT, Power MOS FET Gate Driver
- Industrial inverter
- Solar inverter

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)**PHOTOCOUPLER CONSTRUCTION**

Parameter	Unit (MIN.)
Air Distance	14.5 mm
Outer Creepage Distance	14.5 mm
Isolation Distance	0.4 mm

FUNCTIONAL DIAGRAM**MARKING EXAMPLE**

<R> **ORDERING INFORMATION**

Part Number	Order Number	Solder Plating Specification	Packing Style	Safety Standard Approval	Application Part Number ^{*1}
PS9905	PS9905-Y-AX	Pb-Free (Ni/Pd/Au)	10 pcs (Tape 10 pcs cut)	Standard products (UL, CSA, SEMKO approved)	PS9905
PS9905-F3	PS9905-Y-F3-AX		Embossed Tape 1 000 pcs/reel		
PS9905-V	PS9905-Y-V-AX		10 pcs (Tape 10 pcs cut)	DIN EN60747-5-5 (VDE0884-5): 2011-11 approved (Option)	
PS9905-V-F3	PS9905-Y-V-F3-AX		Embossed Tape 1 000 pcs/reel		

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

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

Parameter		Symbol	Ratings	Unit
Diode	Forward Current	I_F	25	mA
	Peak Transient Forward Current (Pulse Width < 1 μs)	$I_{F(\text{TRAN})}$	1.0	A
	Reverse Voltage	V_R	5	V
	Power Dissipation ^{*1, *6}	P_D	45	mW
Detector	High Level Peak Output Current ^{*2}	$I_{OH(\text{PEAK})}$	2.5	A
	Low Level Peak Output Current ^{*2}	$I_{OL(\text{PEAK})}$	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, *6}	P_C	250	mW
Isolation Voltage ^{*4}		BV	7 500	Vr.m.s.
Operating Frequency ^{*5}		f	50	kHz
Operating Ambient Temperature		T_A	-40 to +110	$^\circ\text{C}$
Storage Temperature		T_{stg}	-55 to +125	$^\circ\text{C}$

Notes: ^{*1}. Derating to be set after 0.8 mW/ $^\circ\text{C}$ at $T_A = 85^\circ\text{C}$ or more.

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

^{*3}. Reduced to 5.2 mW/ $^\circ\text{C}$ at $T_A = 85^\circ\text{C}$ or more

^{*4}. AC voltage for 1 minute at $T_A = 25^\circ\text{C}$, RH = 60% between input and output.
Pins 1-4 shorted together, 5-8 shorted together.

^{*5}. $I_{OH(\text{PEAK})} \leq 2.0 \text{ A}$ ($\leq 0.3 \mu\text{s}$), $I_{OL(\text{PEAK})} \leq 2.0 \text{ A}$ ($\leq 0.3 \mu\text{s}$)

^{*6}. Mounted on glass epoxy substrate of 75 mm $\times$ 115 mm $\times$ t1.5 mm

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	MIN.	TYP.	MAX.	Unit
Supply Voltage	$(V_{CC} - V_{EE})$	15		30	V
Forward Current (ON)	$I_{F(\text{ON})}$	10	12	14	mA
Forward Voltage (OFF)	$V_{F(\text{OFF})}$	-2		0.8	V
Operating Ambient Temperature	T_A	-40		110	$^\circ\text{C}$

ELECTRICAL CHARACTERISTICS

($V_{EE} = \text{GND}$, unless otherwise specified and refer to **RECOMMENDED OPERATING CONDITIONS**)

	Parameter	Symbol	Conditions	MIN.	TYP.*1	MAX.	Unit
Diode	Forward Voltage	V_F	$I_F = 10 \text{ mA}$, $T_A = 25^\circ\text{C}$	1.3	1.56	1.8	V
	Reverse Current	I_R	$V_R = 3 \text{ V}$, $T_A = 25^\circ\text{C}$			10	μA
	Terminal Capacitance	C_t	$f = 1 \text{ MHz}$, $V_F = 0 \text{ V}$, $T_A = 25^\circ\text{C}$		30		pF
Detector	High Level Output Current	I_{OH}	$V_O = (V_{CC} - 4 \text{ V})^{*2}$	0.5	2.0		A
			$V_O = (V_{CC} - 15 \text{ V})^{*3}$	2.0			
	Low Level Output Current	I_{OL}	$V_O = (V_{EE} + 2.5 \text{ V})^{*2}$	0.5	2.0		A
			$V_O = (V_{EE} + 15 \text{ V})^{*3}$	2.0			
	High Level Output Voltage	V_{OH}	$I_O = -100 \text{ mA}^{*4}$	$V_{CC} - 3.0$	$V_{CC} - 1.5$		V
	Low Level Output Voltage	V_{OL}	$I_O = 100 \text{ mA}$		0.1	0.5	V
	High Level Supply Current	I_{CCH}	$V_O = \text{open}$, $I_F = 12 \text{ mA}$		1.4	3.0	mA
	Low Level Supply Current	I_{CCL}	$V_O = \text{open}$, $V_F = -2 \text{ to } +0.8 \text{ V}$		1.3	3.0	mA
	UVLO Threshold	V_{UVLO+}	$V_O > 5 \text{ V}$, $I_F = 12 \text{ mA}$	10.8	12.3	13.4	V
		V_{UVLO-}		9.5	11.0	12.5	
	UVLO Hysteresis	$UVLO_{HYS}$	$V_O > 5 \text{ V}$, $I_F = 12 \text{ mA}$	0.4	1.3		V
Coupled	Threshold Input Current (L $\rightarrow$ H)	I_{FLH}	$I_O = 0 \text{ mA}$, $V_O > 5 \text{ V}$		2.9	6.0	mA
	Threshold Input Voltage (H $\rightarrow$ L)	V_{FHL}	$I_O = 0 \text{ mA}$, $V_O < 5 \text{ V}$	0.8			V

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

*2. Maximum pulse width = $50 \mu\text{s}$, Maximum duty cycle = 0.5%.

*3. Maximum pulse width = $10 \mu\text{s}$, 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%).

<R> **SWITCHING CHARACTERISTICS**

($V_{EE} = \text{GND}$, unless otherwise specified and refer to **RECOMMENDED OPERATING CONDITIONS**)

Parameter	Symbol	Conditions	MIN.	TYP.* ¹	MAX.	Unit
Propagation Delay Time (L → H)	t_{PLH}	$R_g = 10\ \Omega$, $C_g = 10\ \text{nF}$ ^{*2} , $f = 10\ \text{kHz}$, Duty Cycle = 50%, $I_F = 12\ \text{mA}$		0.09	0.15	μs
Propagation Delay Time (H → L)	t_{PHL}			0.1	0.15	μs
Pulse Width Distortion (PWD)	$ t_{PHL} - t_{PLH} $			0.01	0.075	μs
Propagation Delay Time (Difference Between Any Two Products)	$t_{PHL} - t_{PLH}$		-0.1		0.1	μs
Rise Time	t_r			50		ns
Fall Time	t_f			50		ns
UVLO (Turn On Delay)	$t_{UVLO\ ON}$	$V_O > 5\ \text{V}$, $I_F = 12\ \text{mA}$		0.8		μs
UVLO (Turn Off Delay)	$t_{UVLO\ OFF}$	$V_O < 5\ \text{V}$, $I_F = 12\ \text{mA}$		0.6		μs
Common Mode Transient Immunity at High Level Output	$ CM_H $	$T_A = 25^\circ\text{C}$, $I_F = 12\ \text{mA}$, $V_{CC} = 30\ \text{V}$, $V_{O(MIN.)} = 26\ \text{V}$, $V_{CM} = 1.5\ \text{kV}$	25			$\text{kV}/\mu\text{s}$
Common Mode Transient Immunity at Low Level Output	$ CM_L $	$T_A = 25^\circ\text{C}$, $I_F = 0\ \text{mA}$, $V_{CC} = 30\ \text{V}$, $V_{O(MAX.)} = 1\ \text{V}$, $V_{CM} = 1.5\ \text{kV}$	25			$\text{kV}/\mu\text{s}$

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

*2. This load condition is equivalent to the IGBT load at 1 200 V / 75 A.

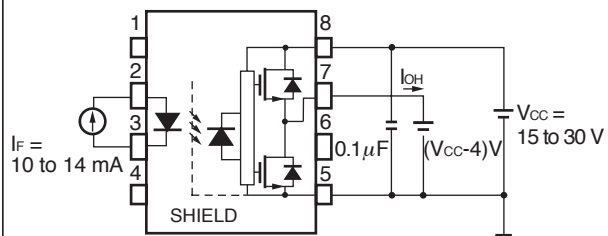
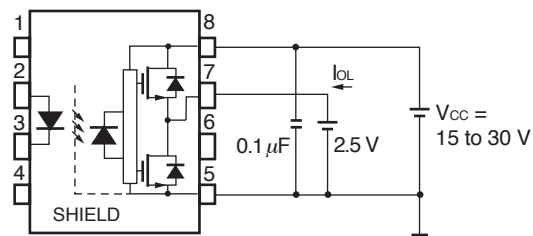
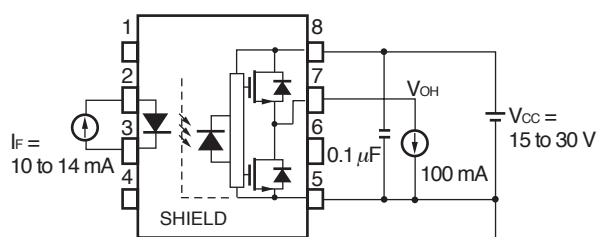
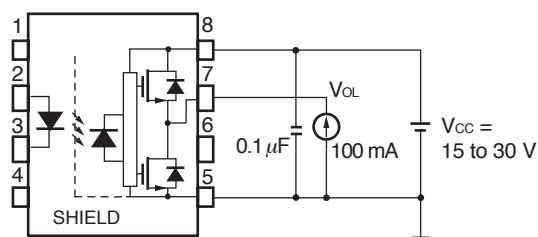
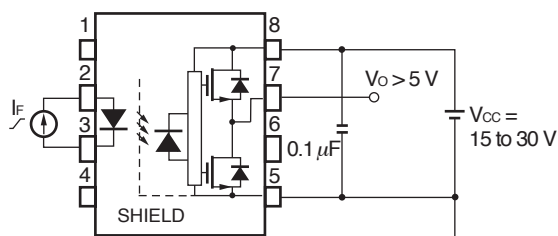
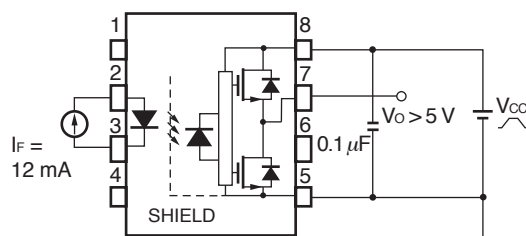
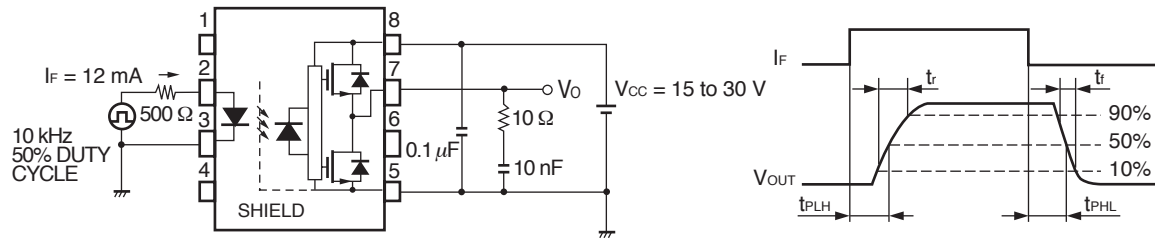
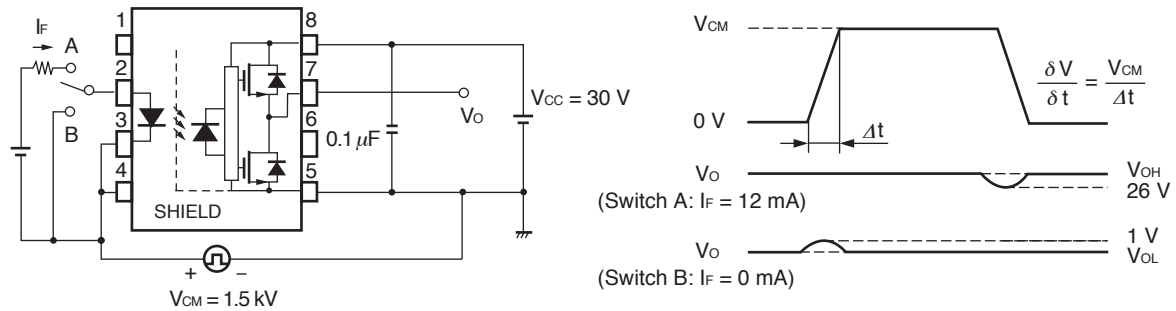
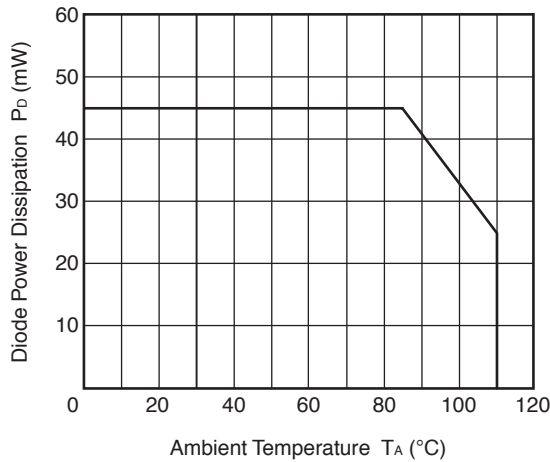
<R> **TEST CIRCUIT****Fig. 1 I_{OH} Test Circuit****Fig. 2 I_{OL} Test Circuit****Fig. 3 V_{OH} Test Circuit****Fig. 4 V_{OL} Test Circuit****Fig. 5 I_{FLH} Test Circuit****Fig. 6 UVLO Test Circuit**

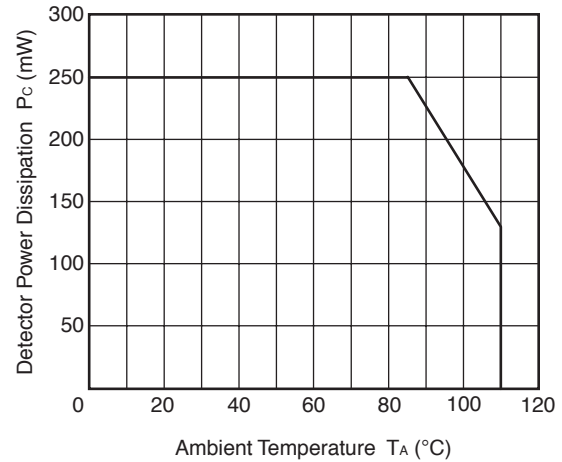
Fig. 7 t_{PLH} , t_{PHL} , t_r , t_f Test Circuit and Wave Forms

Fig. 8 CMR Test Circuit and Wave Forms


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

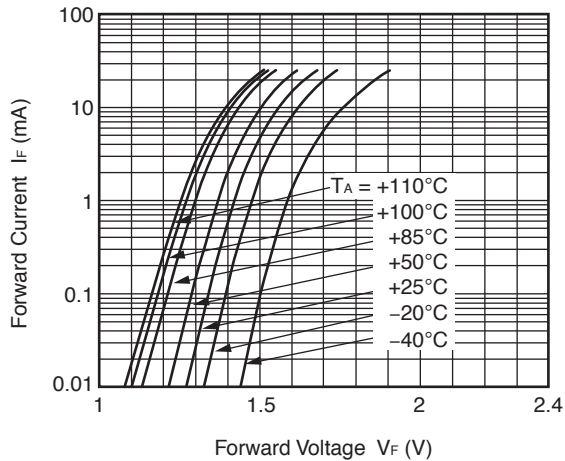
**DIODE POWER DISSIPATION
vs. AMBIENT TEMPERATURE**



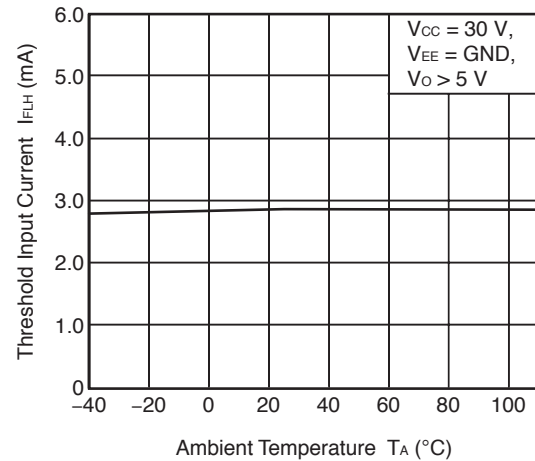
**DETECTOR POWER DISSIPATION
vs. AMBIENT TEMPERATURE**



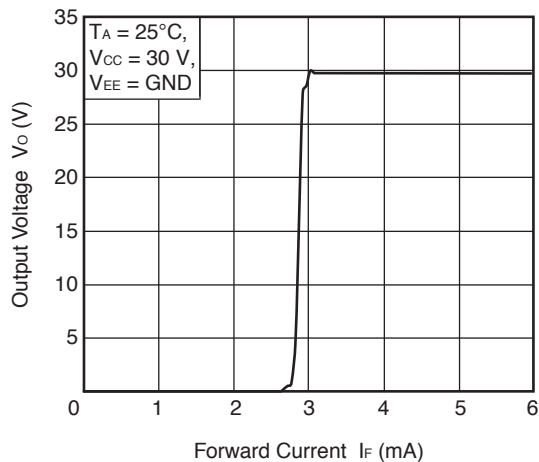
**FORWARD CURRENT vs.
FORWARD VOLTAGE**



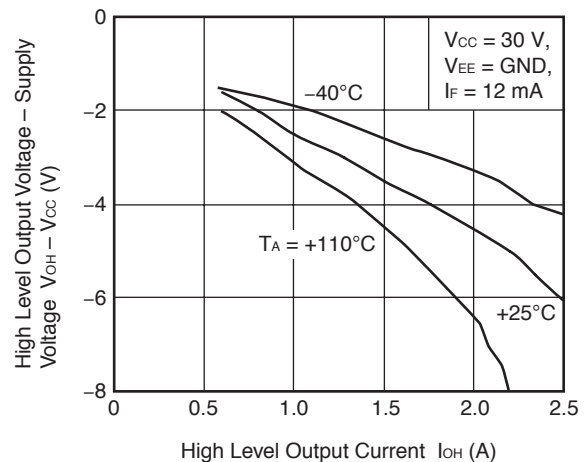
**THRESHOLD INPUT CURRENT vs.
AMBIENT TEMPERATURE**



**OUTPUT VOLTAGE vs.
FORWARD CURRENT**

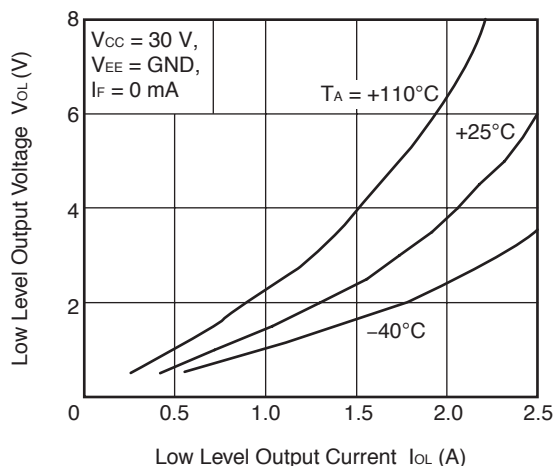


**HIGH LEVEL OUTPUT VOLTAGE – SUPPLY
VOLTAGE vs. HIGH LEVEL OUTPUT CURRENT**

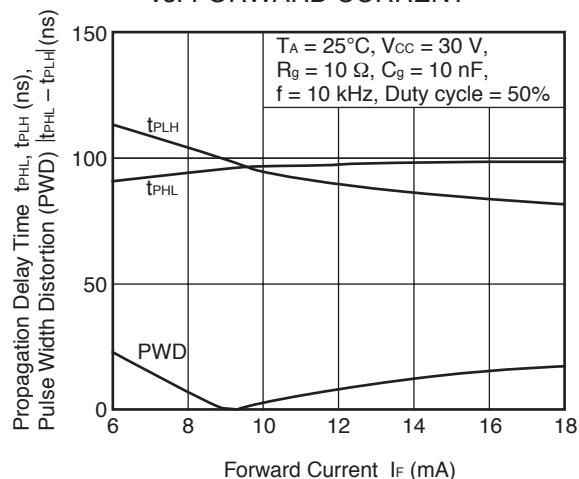


Remark The graphs indicate nominal characteristics.

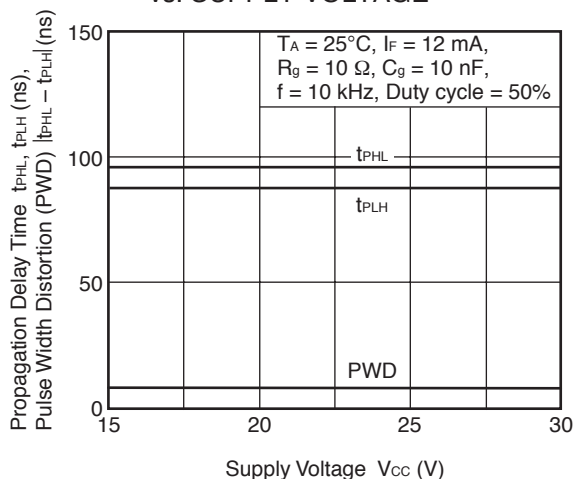
LOW LEVEL OUTPUT VOLTAGE vs.
LOW LEVEL OUTPUT CURRENT



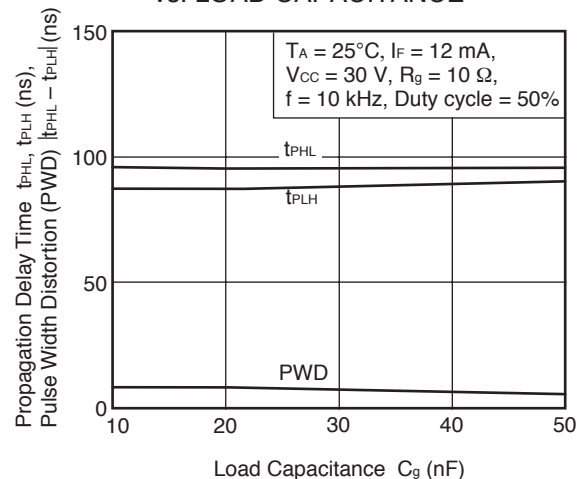
PROPAGATION DELAY TIME,
PULSE WIDTH DISTORTION
vs. FORWARD CURRENT



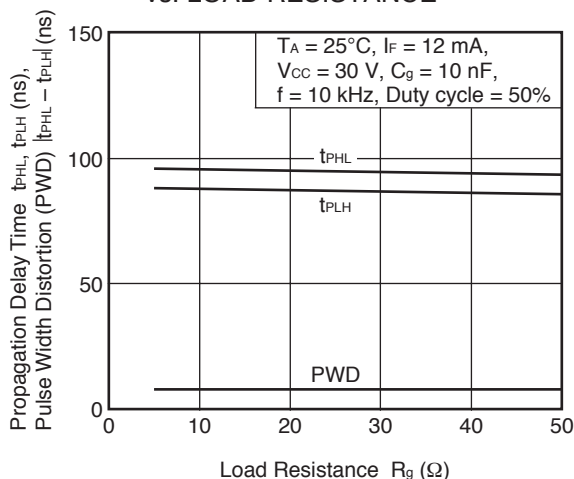
PROPAGATION DELAY TIME,
PULSE WIDTH DISTORTION
vs. SUPPLY VOLTAGE



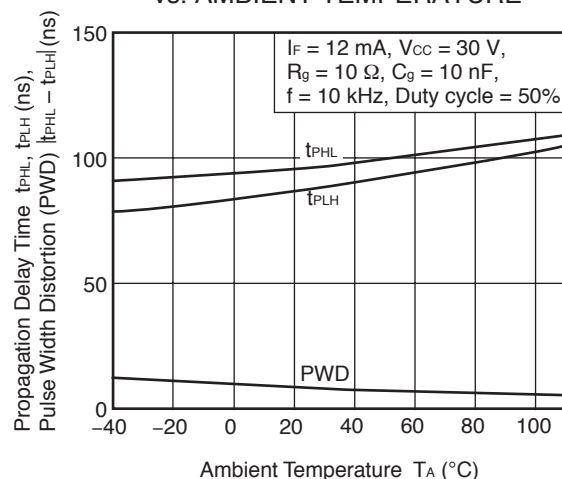
PROPAGATION DELAY TIME,
PULSE WIDTH DISTORTION
vs. LOAD CAPACITANCE



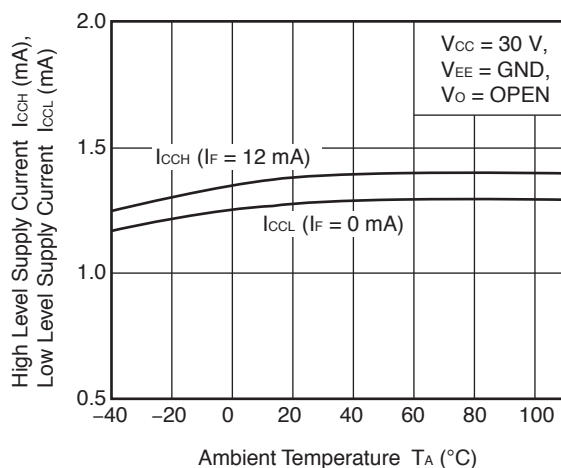
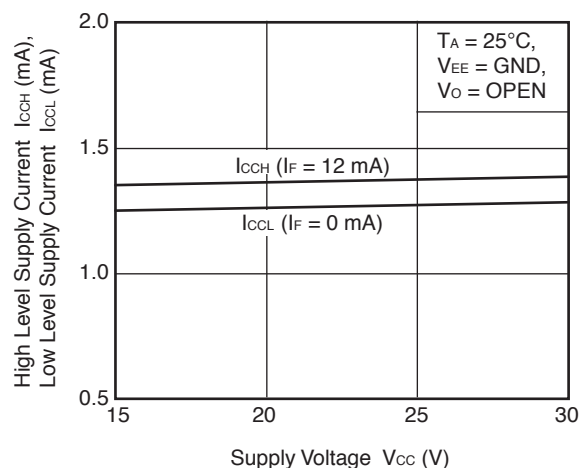
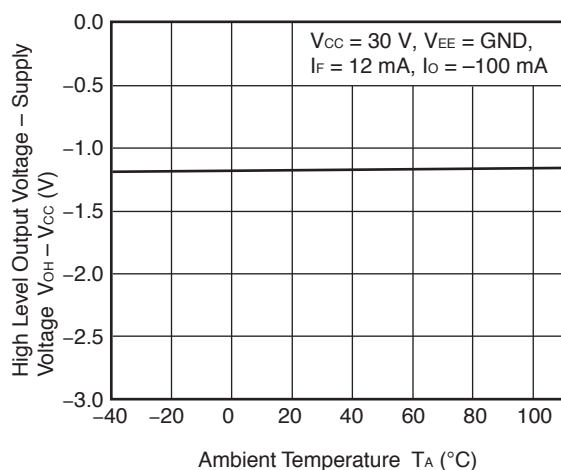
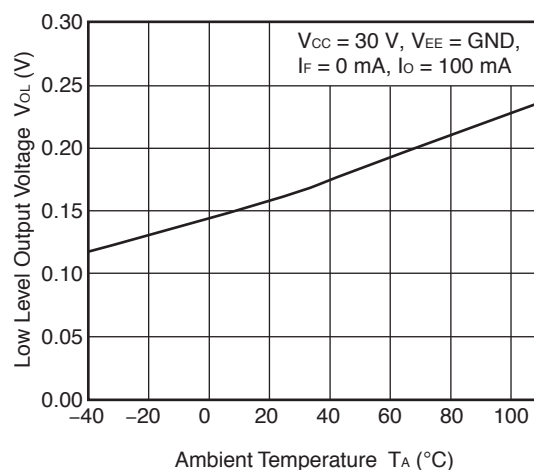
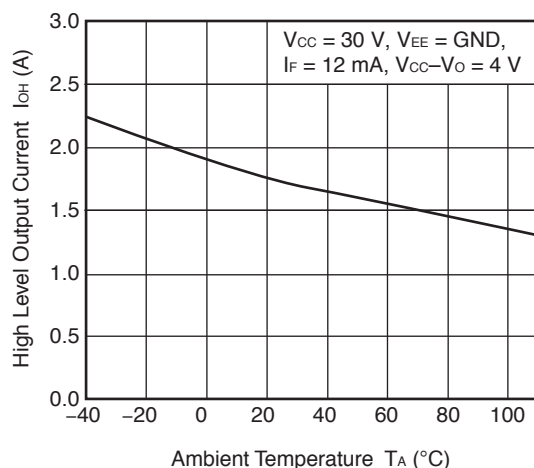
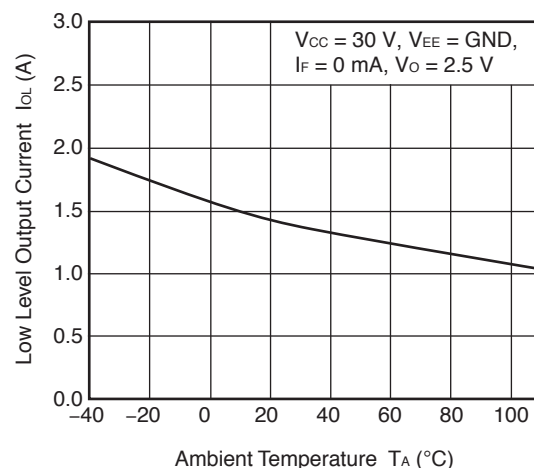
PROPAGATION DELAY TIME,
PULSE WIDTH DISTORTION
vs. LOAD RESISTANCE



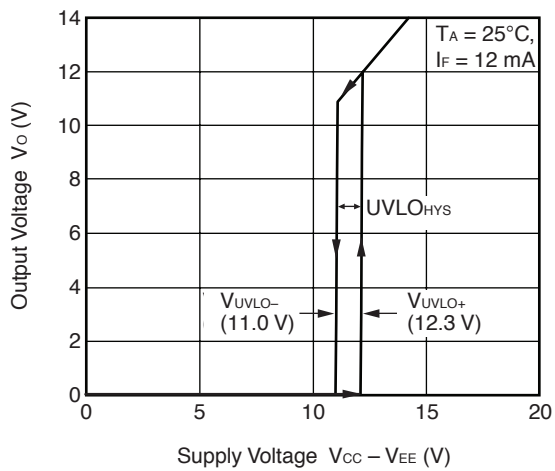
PROPAGATION DELAY TIME,
PULSE WIDTH DISTORTION
vs. AMBIENT TEMPERATURE



Remark The graphs indicate nominal characteristics.

SUPPLY CURRENT vs.
AMBIENT TEMPERATURESUPPLY CURRENT vs.
SUPPLY VOLTAGEHIGH LEVEL OUTPUT VOLTAGE – SUPPLY
VOLTAGE vs. AMBIENT TEMPERATURELOW LEVEL OUTPUT VOLTAGE vs.
AMBIENT TEMPERATUREHIGH LEVEL OUTPUT CURRENT vs.
AMBIENT TEMPERATURELOW LEVEL OUTPUT CURRENT vs.
AMBIENT TEMPERATURE

Remark The graphs indicate nominal characteristics.

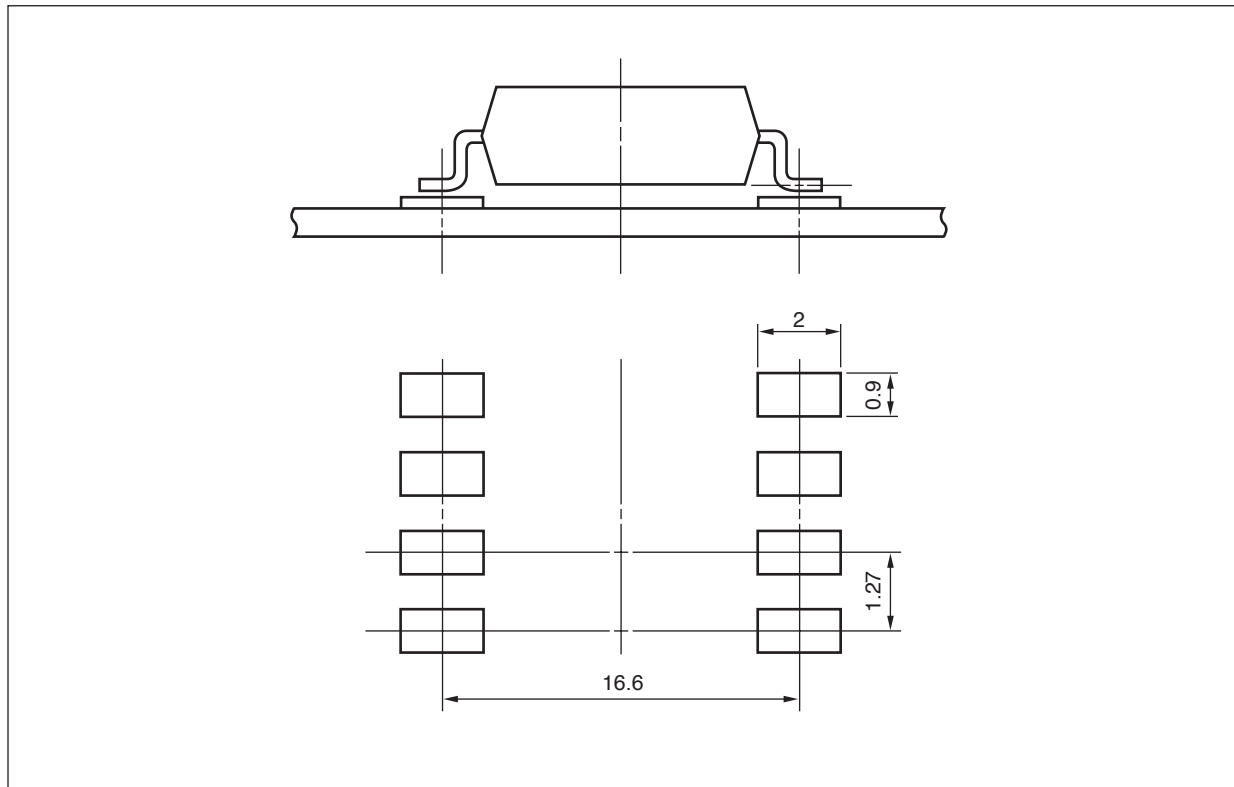
OUTPUT VOLTAGE vs. SUPPLY VOLTAGE

Remark The graphs indicate nominal characteristics.

Technical drawing of a mechanical part, showing a top view and a side view. The top view includes dimensions: 2.0 ± 0.1 , 4.0 ± 0.1 , 1.75 ± 0.1 , 11.5 ± 0.1 , 24.0 ± 0.3 , (17.2) , 12.0 ± 0.1 , (7.2) , (4.05) , (0.3) , 4.5 MAX. , $\phi 1.5^{+0.1}_0$, and $\phi 2.0 \pm 0.2$. The side view shows a cross-section of the part with a width of 4.5 MAX. and a height of (0.3) . The part has a complex shape with rounded corners and a central rectangular feature.

Technical drawing of a circular component. The front view (left) shows a circle with a central hole. The hole has a diameter of $\phi 13.0 \pm 0.2$ and a depth of 2.0 ± 0.5 . The hole is surrounded by a circular feature with a radius of $R 1.0$ and a diameter of $\phi 21.0 \pm 0.8$. The side view (right) shows the component's profile with a total height of $\phi 330 \pm 2.0$ and a central section height of $\phi 100 \pm 1.0$. The side view also shows two horizontal dimensions: 25.5 ± 1.0 and 29.5 ± 1.0 .

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RECOMMENDED MOUNT PAD DIMENSIONS (UNIT: mm)

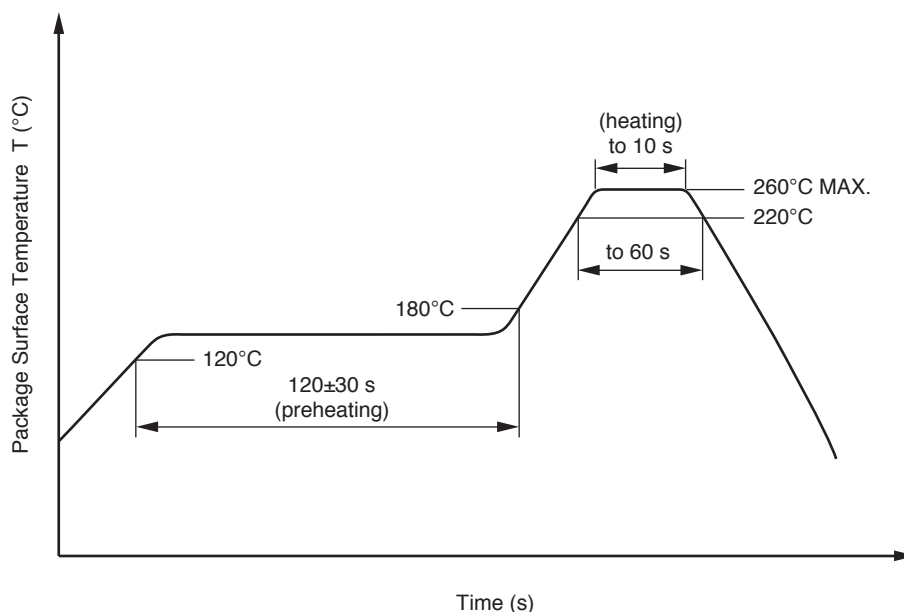
NOTES ON HANDLING

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

(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 0.1 μ 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.
 - (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 1, 4 (which is an NC^{*1} pin) can either be connected directly to the GND pin on the LED side or left open. Also, Pin 6 (which is an NC^{*1} pin) can either be connected directly to the GND pin on the detector 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 μ s or less.
4. In order to avoid malfunctions, make sure the rise/fall slope of the supply voltage is 3 V/ μ s or less.
5. Avoid storage at a high temperature and high humidity.

<R> SPECIFICATION OF VDE MARKS LICENSE DOCUMENT

Parameter	Symbol	Spec.	Unit
Climatic test class (IEC 60068-1/DIN EN 60068-1)		40/110/21	
Dielectric strength			
maximum operating isolation voltage	U_{IORM}	1 600	V_{peak}
Test voltage (partial discharge test, procedure a for type test and random test)	U_{pr}	2 560	V_{peak}
$U_{pr} = 1.6 \times U_{IORM.}, P_d < 5 \text{ pC}$			
Test voltage (partial discharge test, procedure b for all devices)	U_{pr}	3 000	V_{peak}
$U_{pr} = 1.875 \times U_{IORM.}, P_d < 5 \text{ pC}$			
Highest permissible overvoltage	U_{TR}	12 000	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 +110	°C
Isolation resistance, minimum value			
$V_{IO} = 500 \text{ V dc at } T_A = 25^\circ\text{C}$	Ris MIN.	10^{12}	Ω
$V_{IO} = 500 \text{ V dc at } T_A \text{ MAX. at least } 100^\circ\text{C}$	Ris MIN.	10^{11}	Ω
Safety maximum ratings (maximum permissible in case of fault, see thermal derating curve)			
Package temperature	T_{si}	175	°C
Current (input current I_F , $P_{si} = 0$)	I_{si}	400	mA
Power (output or total power dissipation)	P_{si}	700	mW
Isolation resistance			
$V_{IO} = 500 \text{ V dc at } T_A = T_{si}$	Ris MIN.	10^9	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	PS9905 Data Sheet
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Rev.	Date	Description	
		Page	Summary
0.01	Apr 06, 2012	–	First edition issued
1.00	Jun 11, 2012	Throughout	Preliminary Data Sheet → Data Sheet
		p.1	Modification of FEATURES
		p.4	Modification of ORDERING INFORMATION
		p.5	Modification of ABSOLUTE MAXIMUM RATINGS
		p.6	Modification of SWITCHING CHARACTERISTICS
		pp.7, 8	Modification of TEST CIRCUIT
		pp.9 to 12	Addition of TYPICAL CHARACTERISTICS
		p.17	Addition of SPECIFICATION OF VDE MARKS LICENSE DOCUMENT

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