PS9905

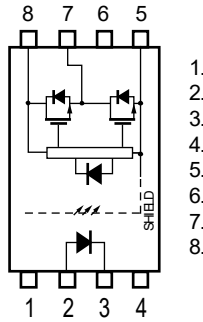
2.5 A OUTPUT CURRENT, HIGH CMR, IGBT GATE DRIVE, 8-PIN LSDIP PHOTOCOUPLER FOR CREEPAGE DISTANCE OF 15 mm

R08DS0058EJ0200
Rev.2.00
Jun. 30, 2021

DESCRIPTION

The PS9905 is optically coupled isolator containing an AlGaAs 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.

PIN CONNECTION
(Top View)



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

FEATURES

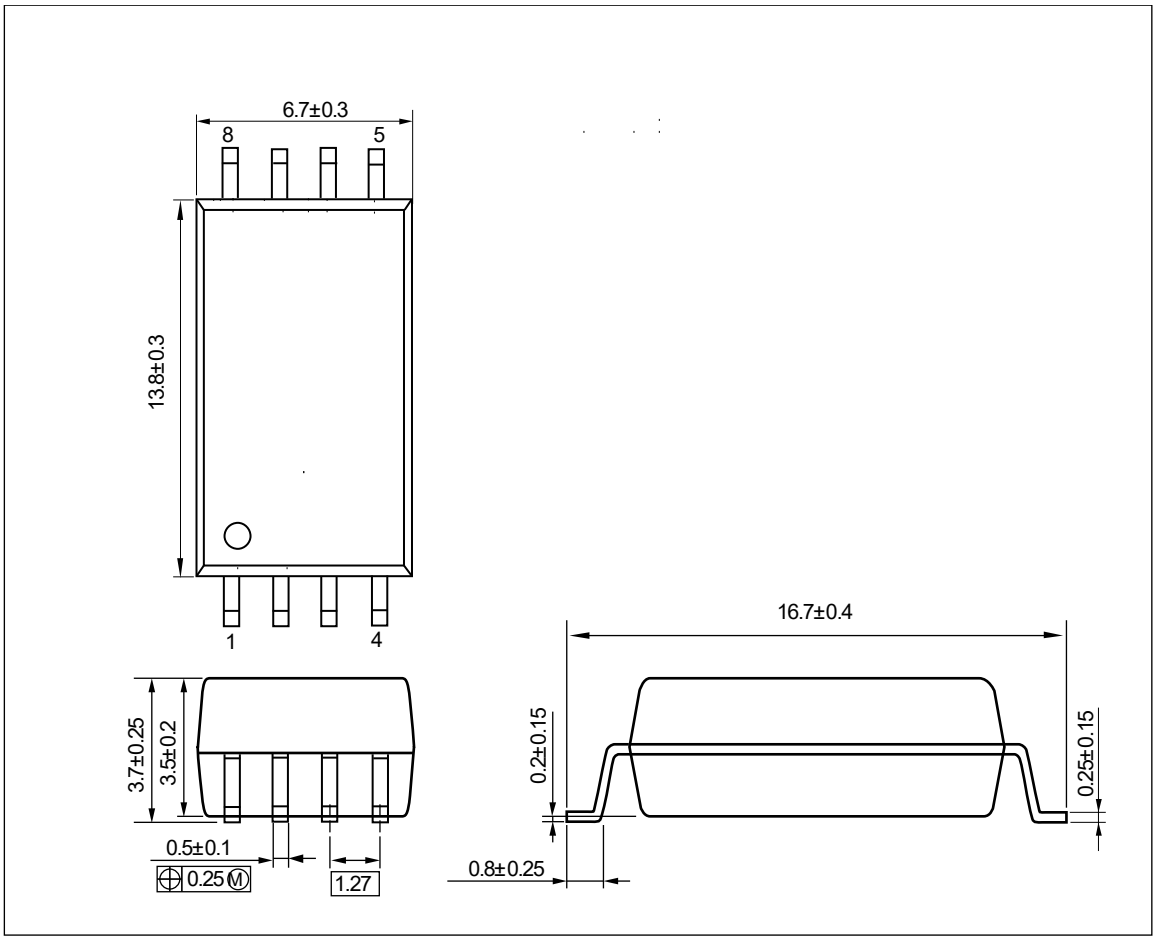
- Long creepage distance (15 mm MIN.)
- Large peak output current (2.5 A MAX., 2.0 A MIN.)
- High speed switching (t_{PLH}, t_{PHL} = 0.15 μs MAX.)
- UVLO (Under Voltage Lock Out) protection with hysteresis
- High common mode transient immunity (CM_H, CM_L = ± 25 kV/μs MIN.)
- 8-pin LSDIP (Long Creepage SDIP) type
- Embossed tape product: PS9905-F3: 1 000 pcs/reel
- Pb-Free Product
- Safety standards
  - UL approved: UL1577, Double protection
  - CSA approved: CAN/CSA-C22.2 No.62368-1, Reinforced insulation
  - SEMKO approved (Creepage Distance:14.5 mm *): EN 62368-1, IEC 62368-1, Reinforced insulation
    * Creepage Distance:15 mm – in process
  - VDE approved: DIN EN 60747-5-5 (Option)

APPLICATIONS

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

Start of mass production
Jun.2012

PACKAGE DIMENSIONS (UNIT: mm)

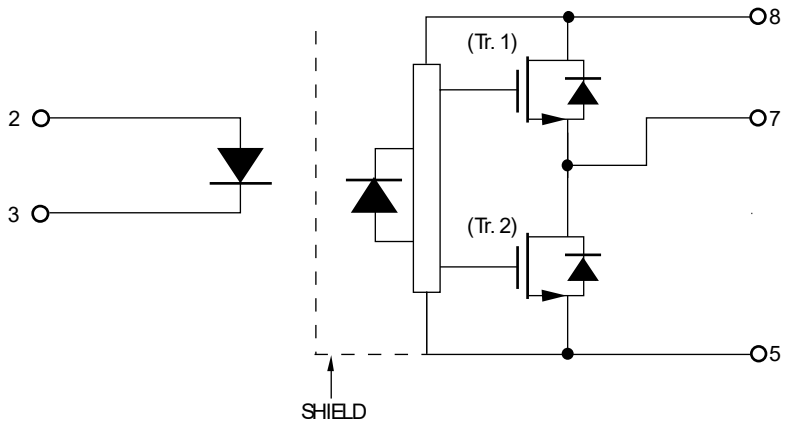


Weight: 0.642g (typ.)

PHOTOCOUPLER CONSTRUCTION

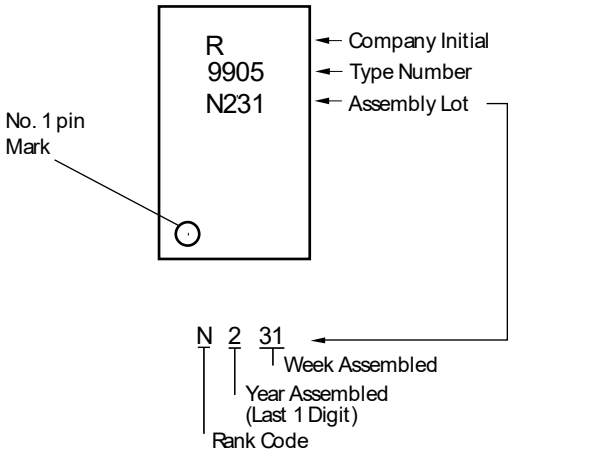
Parameter	MIN.
Air Distance	14.5 mm
Creepage Distance	15 mm
Isolation Distance	0.4 mm

FUNCTIONAL DIAGRAM



Input	LED	Tr. 1	Tr. 2	Output
H	ON	ON	OFF	H
L	OFF	OFF	ON	L

MARKING EXAMPLE



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)	UL, CSA, SEMIKO, DIN EN60747-5-5 approved	
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.

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, *6	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, *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	°C
Storage Temperature		T_{stg}	−55 to +125	°C

Notes: *1. Derating to be set after 0.8 mW/°C at T_A = 85 °C or more.
*2. Maximum pulse width = 10 μs, Maximum duty cycle = 0.2 %
*3. Reduced to 5.2 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 1-4 shorted together, 5-8 shorted together.
*5. $I_{OH\ (PEAK)} \leq$ 2.0 A (≤ 0.3 μs), $I_{OL\ (PEAK)} \leq$ 2.0 A (≤ 0.3 μs)
*6. Mounted on glass epoxy substrate of 75 mm × 115 mm × t1.5 mm

RECOMMENDED OPERATING CONDITIONS

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

ELECTRICAL CHARACTERISTICS

(V_{EE} = 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 mA, T_A = 25 °C	1.3	1.56	1.8	V
	Reverse Current	I_R	V_R = 3 V, T_A = 25 °C			10	μA
	Terminal Capacitance	C_t	f = 1 MHz, V_F = 0 V, T_A = 25 °C		30		pF
Detector	High Level Output Current	I_{OH}	V_O = (V_{CC} – 4 V) *2	0.5	2.0		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	2.0		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} – 1.5		V
	Low Level Output Voltage	V_{OL}	I_O = 100 mA		0.1	0.5	V
	High Level Supply Current	I_{CCH}	V_O = open, I_F = 12 mA		1.4	3.0	mA
	Low Level Supply Current	I_{CCL}	V_O = open, V_F = –2 to +0.8 V		1.3	3.0	mA
	UVLO Threshold	V_{UVLO+}	V_O > 5 V, I_F = 12 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 = 12 mA	0.4	1.3		V
Coupled	Threshold Input Current (L → H)	I_{FLH}	I_O = 0 mA, V_O > 5 V		2.9	6.0	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

*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

(V_{EE} = 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 Ω, C_g = 10 nF*2, f = 10 kHz, Duty Cycle = 50 %, I_F = 12 mA		0.09	0.15	μs
Propagation Delay Time (H → L)	t_{PHL}			0.1	0.15	μs
Pulse Width Distortion (PWD)	$\lvert t_{PHL}-t_{PLH}\rvert$			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 V, I_F = 12 mA		0.8		μs
UVLO (Turn Off Delay)	$t_{UVLO\ OFF}$	V_O < 5 V, I_F = 12 mA		0.6		μs
Common Mode Transient Immunity at High Level Output	$\lvert CM_H\rvert$	T_A = 25 °C, I_F = 12 mA, V_{CC} = 30 V, $V_{O\ (MIN.)}$ = 26 V, V_{CM} = 1.5 kV	25			kV/μs
Common Mode Transient Immunity at Low Level Output	$\lvert CM_L\rvert$	T_A = 25 °C, I_F = 0 mA, V_{CC} = 30 V, $V_{O\ (MAX.)}$ = 1 V, V_{CM} = 1.5 kV	25			kV/μs

Notes: *1. Typical values at T_A = 25 °C

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

TEST CIRCUIT

Fig. 1 I_{OH} Test Circuit

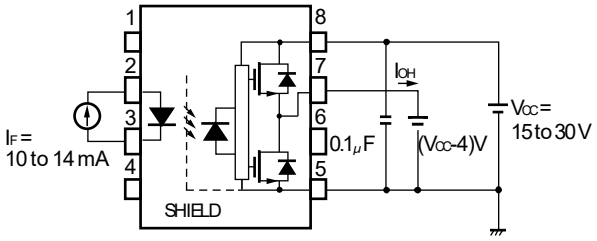


Fig. 2 I_{OL} Test Circuit

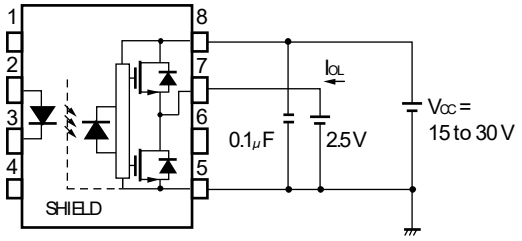


Fig. 3 V_{OH} Test Circuit

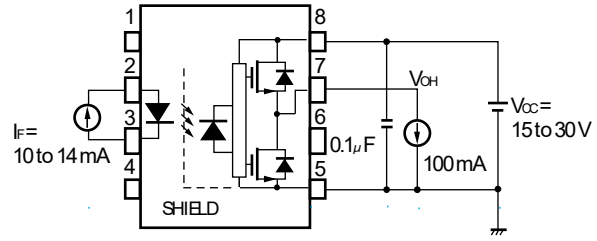


Fig. 4 V_{OL} Test Circuit

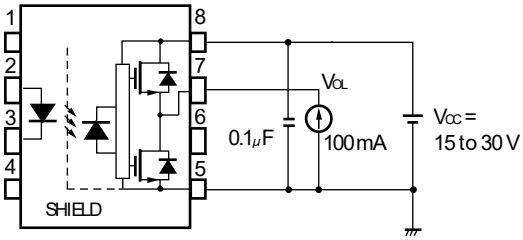


Fig. 5 I_{FLH} Test Circuit

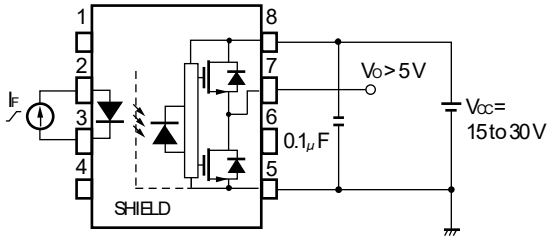


Fig. 6 UVLO Test Circuit

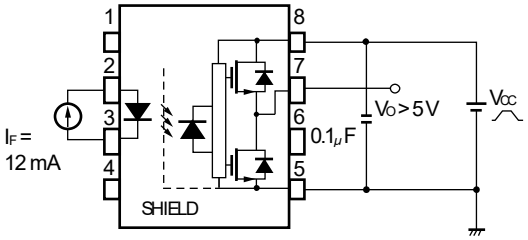


Fig. 7 t_{PLH}, t_{PHL}, t_r, t_f Test Circuit and Wave Forms

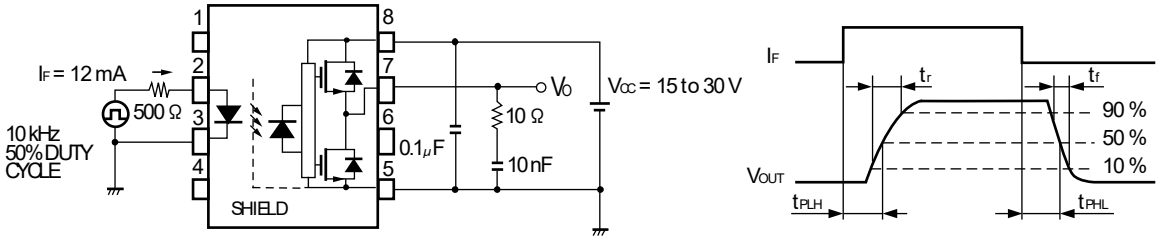
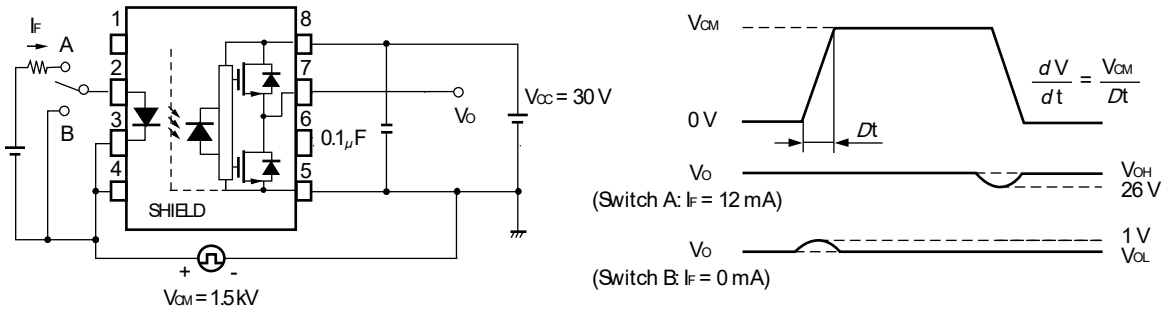
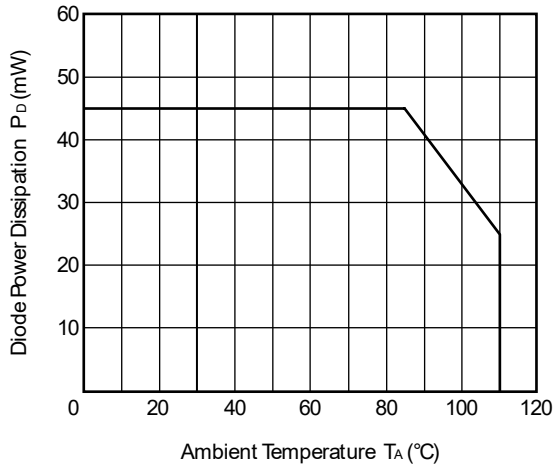


Fig. 8 CMR Test Circuit and Wave Forms

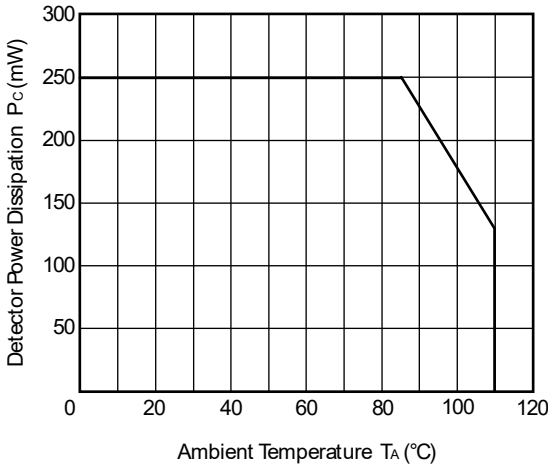


TYPICAL CHARACTERISTICS (T_A = 25 °C, unless otherwise specified)

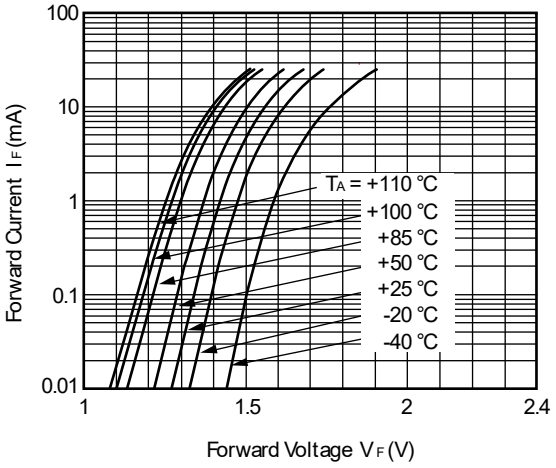
DIODE POWER DISSIPATION vs. AMBIENT TEMPERATURE



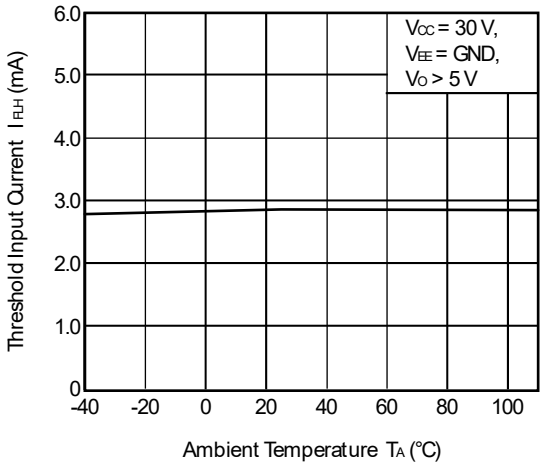
DETECTOR POWER DISSIPATION vs. AMBIENT TEMPERATURE



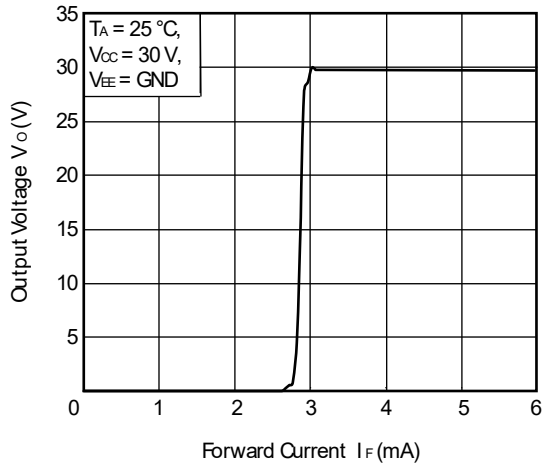
FORWARD CURRENT vs. FORWARD VOLTAGE



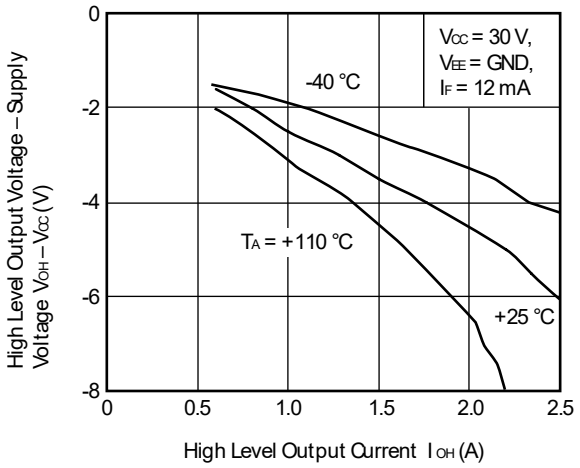
THRESHOLD INPUT CURRENT vs. AMBIENT TEMPERATURE



OUTPUT VOLTAGE vs. FORWARD CURRENT

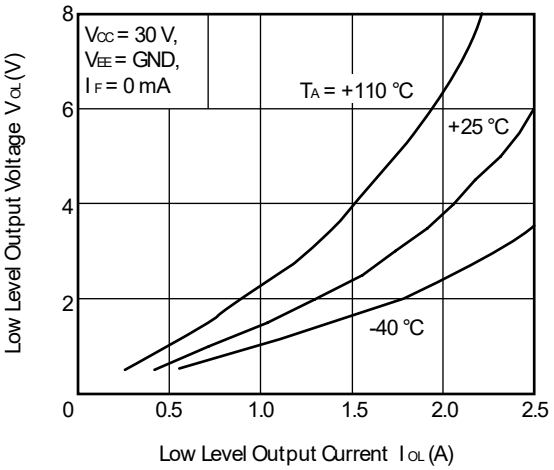


HIGH LEVEL OUTPUT VOLTAGE – SUPPLY VOLTAGE vs. HIGH LEVEL OUTPUT CURRENT

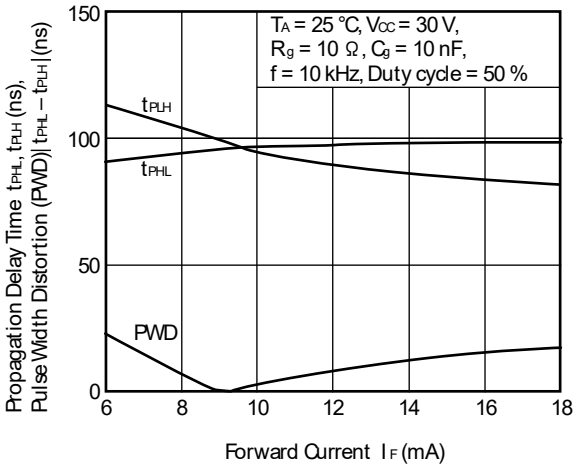


Remark The graphs indicate nominal characteristics.

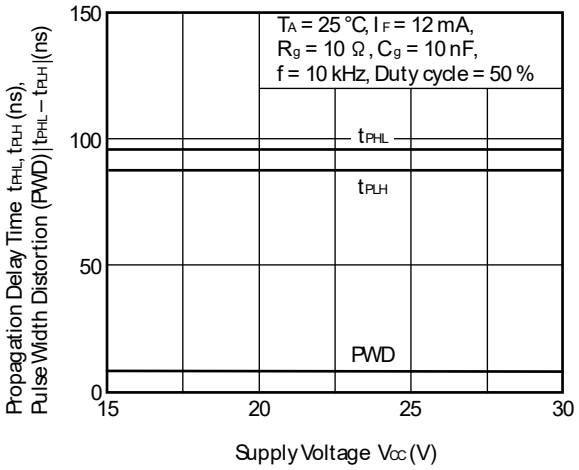
LOW LEVEL OUTPUT VOLTAGE vs.
LOW LEVEL OUTPUT CURRENT



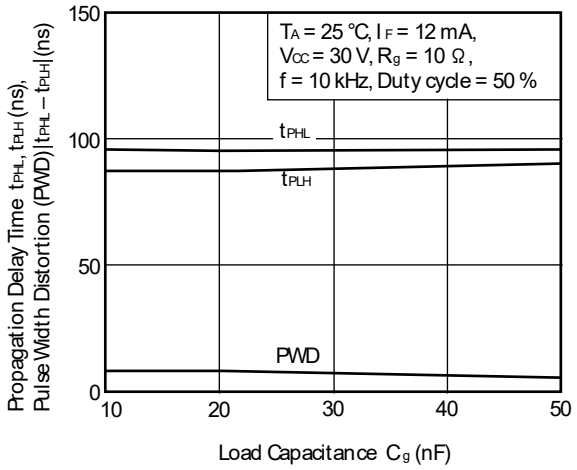
PROPAGATION DELAY TIME,
PULSE WIDTH DISTORTION
vs. FORWARD CURRENT



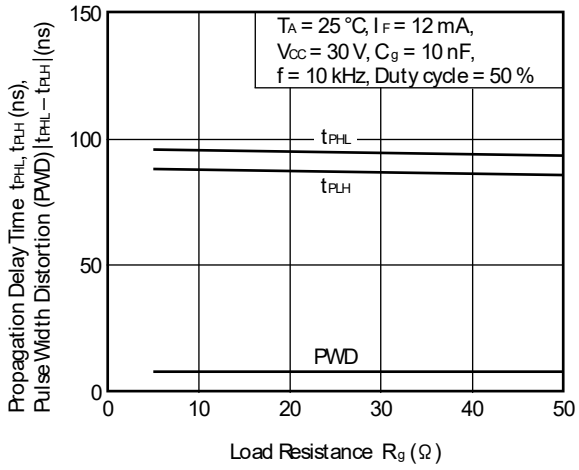
PROPAGATION DELAY TIME,
PULSE WIDTH DISTORTION
vs. SUPPLY VOLTAGE



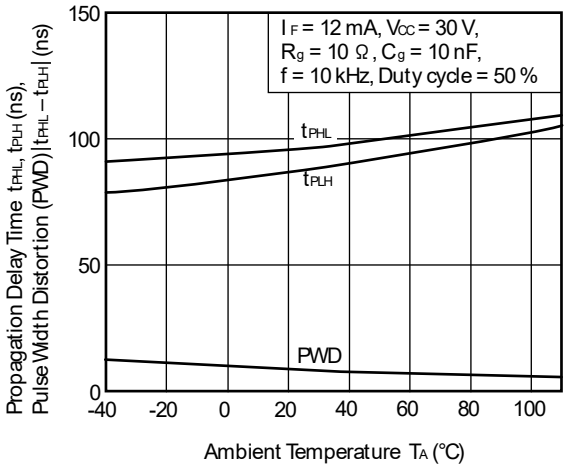
PROPAGATION DELAY TIME,
PULSE WIDTH DISTORTION
vs. LOAD CAPACITANCE



PROPAGATION DELAY TIME,
PULSE WIDTH DISTORTION
vs. LOAD RESISTANCE

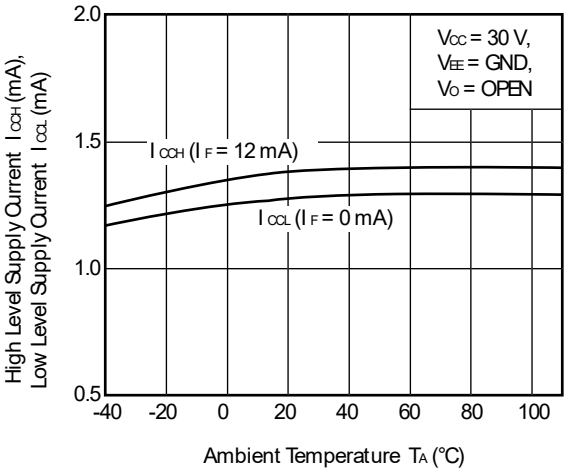


PROPAGATION DELAY TIME,
PULSE WIDTH DISTORTION
vs. AMBIENT TEMPERATURE

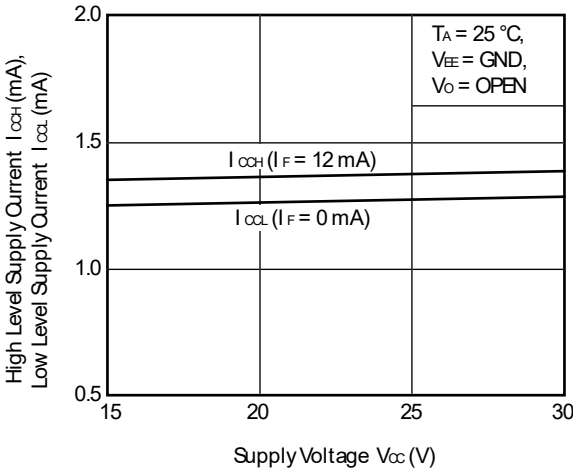


Remark The graphs indicate nominal characteristics.

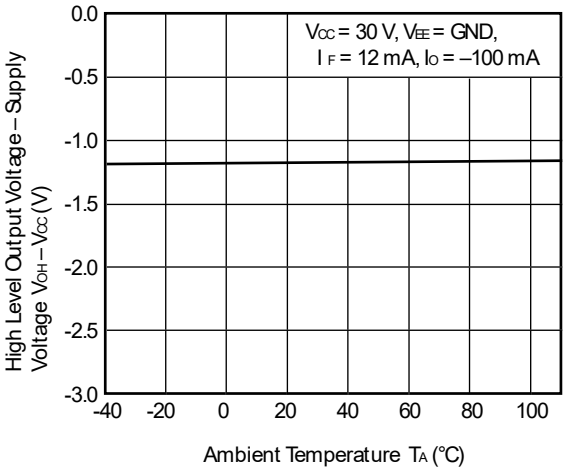
SUPPLY CURRENT vs.
AMBIENT TEMPERATURE



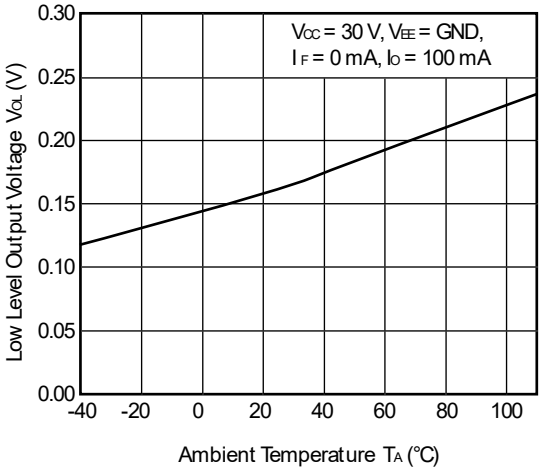
SUPPLY CURRENT vs.
SUPPLY VOLTAGE



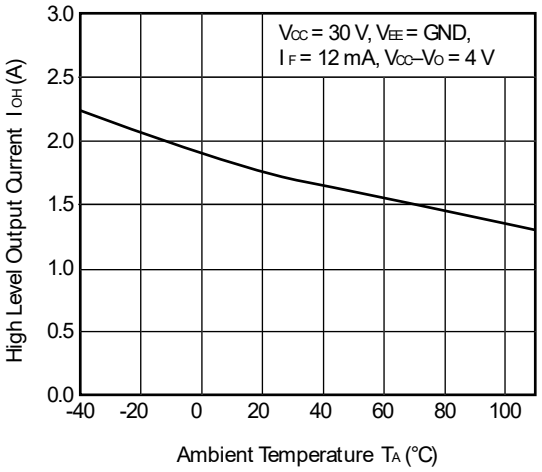
HIGH LEVEL OUTPUT VOLTAGE – SUPPLY
VOLTAGE vs. AMBIENT TEMPERATURE



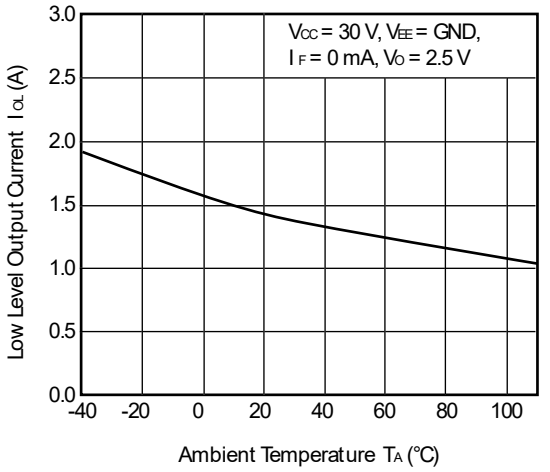
LOW LEVEL OUTPUT VOLTAGE vs.
AMBIENT TEMPERATURE



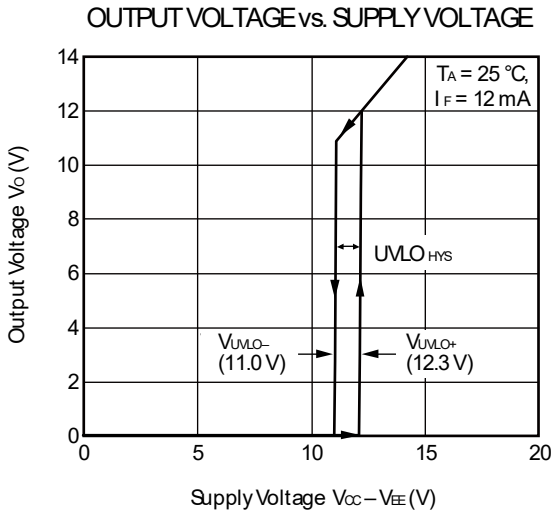
HIGH LEVEL OUTPUT CURRENT vs.
AMBIENT TEMPERATURE



LOW LEVEL OUTPUT CURRENT vs.
AMBIENT TEMPERATURE



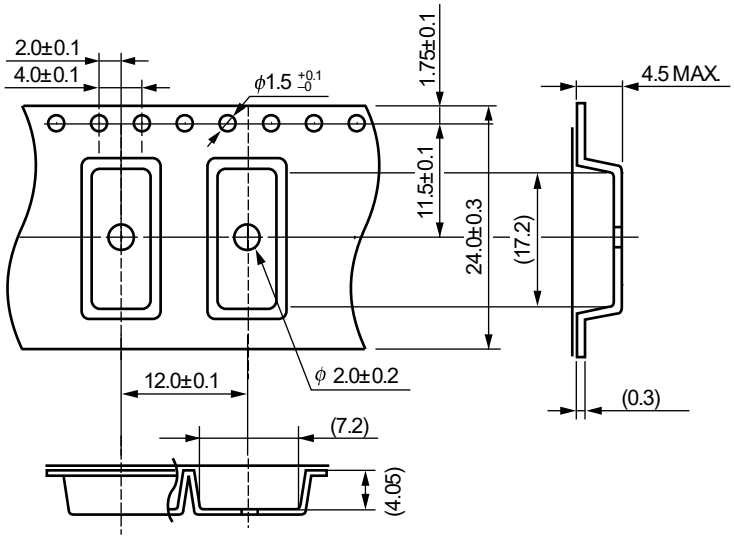
Remark The graphs indicate nominal characteristics.



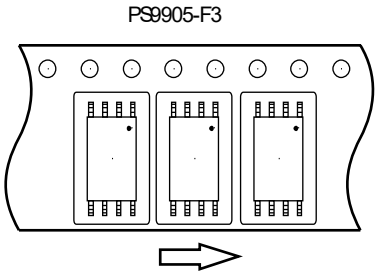
Remark The graphs indicate nominal characteristics.

TAPING SPECIFICATIONS (UNIT: mm)

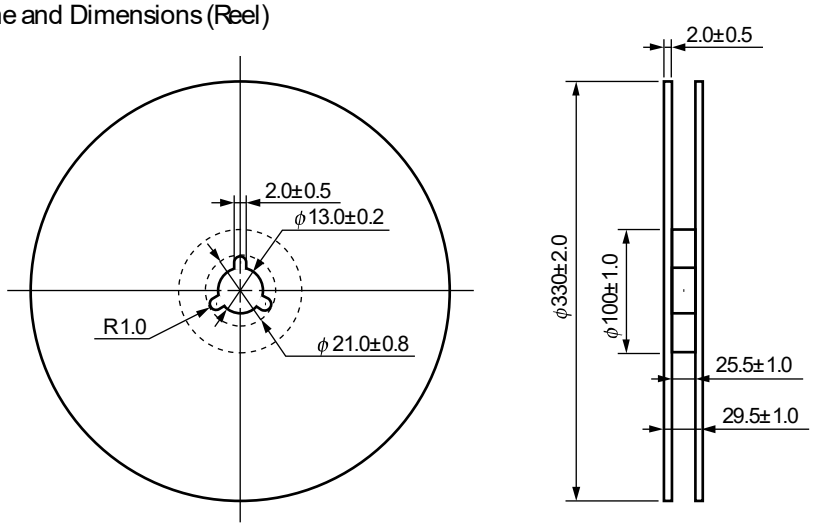
Outline and Dimensions (Tape)



Tape Direction

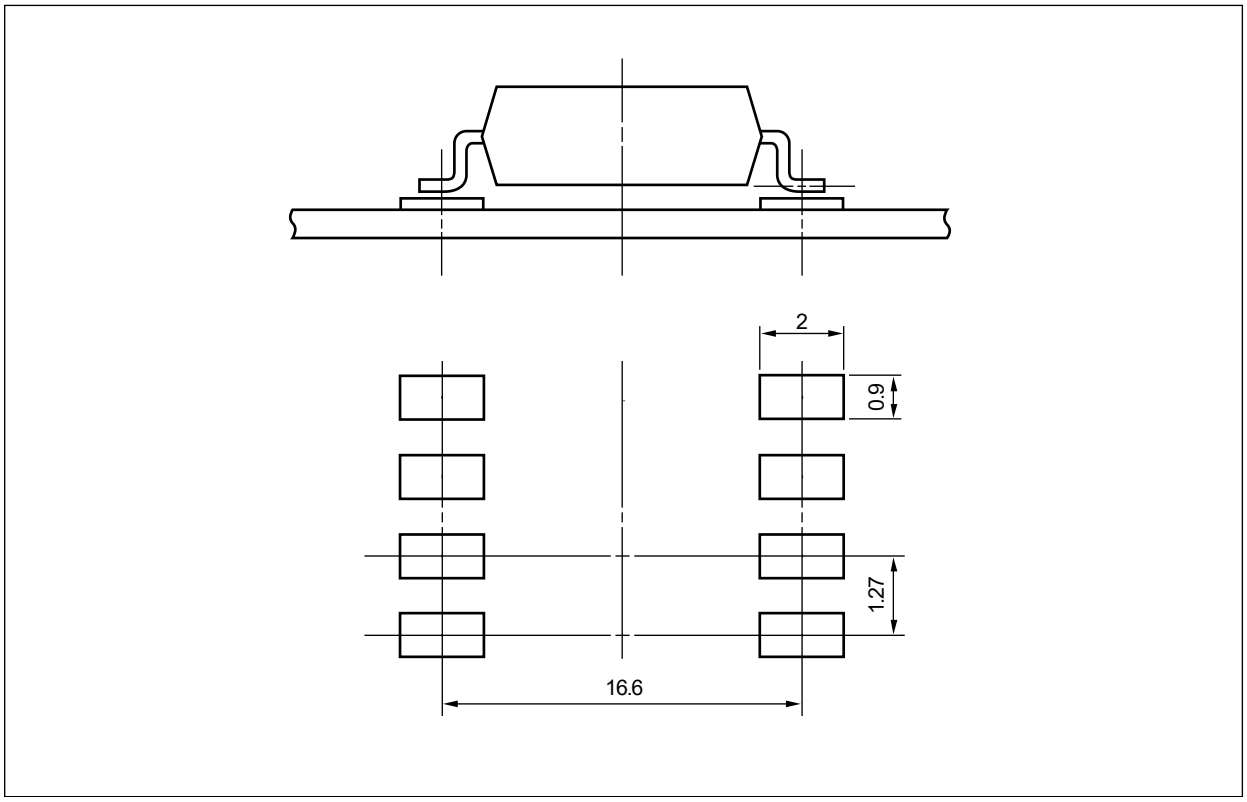


Outline and Dimensions (Reel)



Packing: 1 000 pcs/reel

RECOMMENDED MOUNT PAD DIMENSIONS (UNIT: mm)



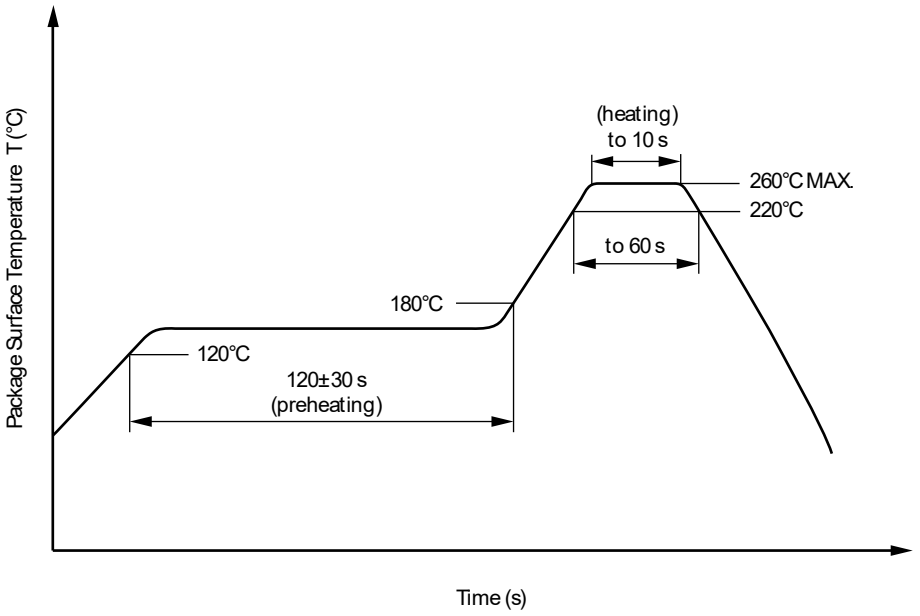
【8pin LSDIP】

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
(b) Please be sure that the temperature of the package would not be heated over 110 °C

(4) Cautions
- Flux Cleaning
  Avoid cleaning with Freon based or halogen-based (chlorinated etc.) solvents.
- Do not use fixing agents or coatings containing halogen-based substances.

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.

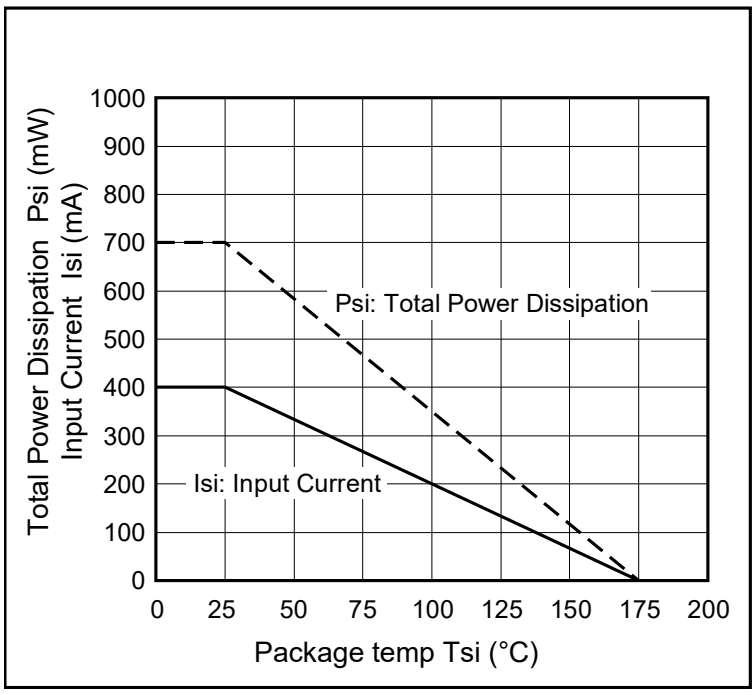
USAGE CAUTIONS

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 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 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 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.

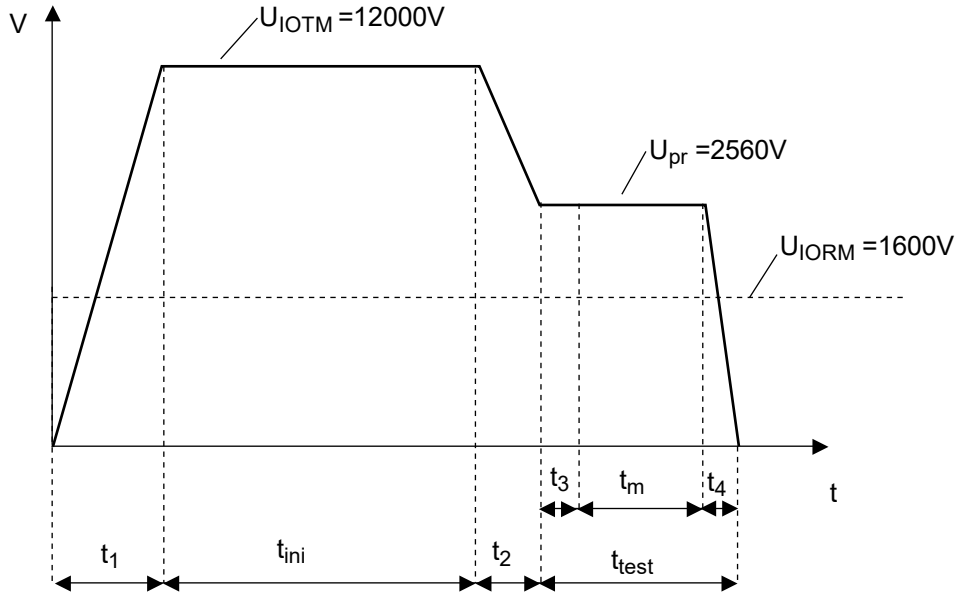
SPECIFICATION OF VDE MARKS LICENSE DOCUMENT

Parameter	Symbol	Rating	Unit
Climatic test class (IEC 60068-1/DIN EN 60068-1)		40/110/21	
Dielectric strength maximum operating isolation voltage Test voltage (partial discharge test, procedure a for type test and random test) U_{pr} = 1.6 × $U_{IORM.}$, P_d < 5 pC	 U_{IORM} U_{pr}	 1 600 2 560	 V_{peak} V_{peak}
Test voltage (partial discharge test, procedure b for all devices) U_{pr} = 1.875 × $U_{IORM.}$, P_d < 5 pC	U_{pr}	3 000	V_{peak}
Highest permissible overvoltage	U_{IOTM}	12 000	V_{peak}
Degree of pollution (IEC 60664-1/DIN EN 60664-1 (VDE 0110-1))		2	
Comparative tracking index (IEC 60112/DIN EN 60112 (VDE 0303 Part 11))	CTI	175	
Material group (IEC 60664-1/DIN EN 60664-1 (VDE 0110-1))		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 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

Dependence of maximum safety ratings with package temperature

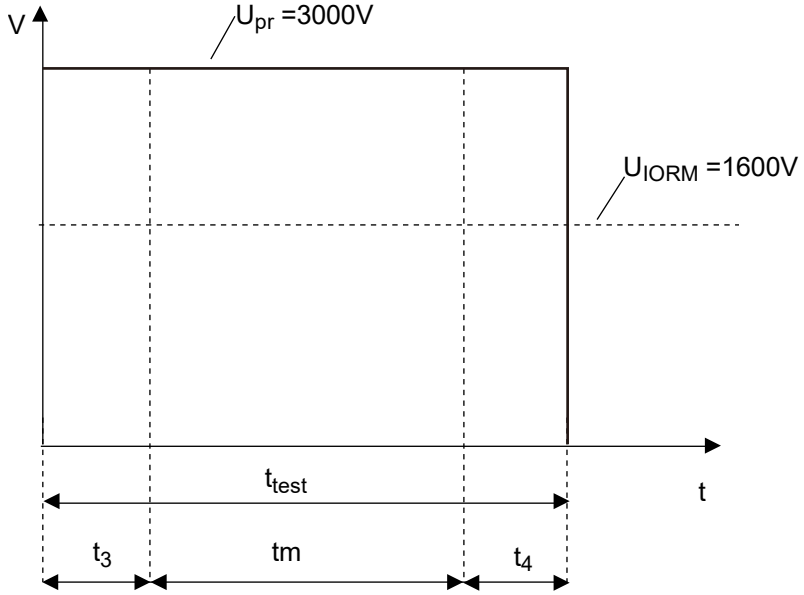


Method a Destructive Test, Type and Sample Test



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

Method b Non-destructive Test, 100% Production Test



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

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