

# TLP700

Industrial inverters

Inverter for air conditioners

IGBT/Power MOSFET gate drive

TLP700 consists of a GaAs light-emitting diode and an integrated photodetector. This unit is 6-lead SDIP package. The TLP700 is 50% smaller than the 8-pin DIP and meets the reinforced insulation class requirements of international safety standards. Therefore the mounting area can be reduced in equipment requiring safety standard certification. The TLP700 is suitable for gate driving circuits for IGBTs or power MOSFETs. In particular, the TLP700 is capable of "direct" gate driving of low-power IGBTs.

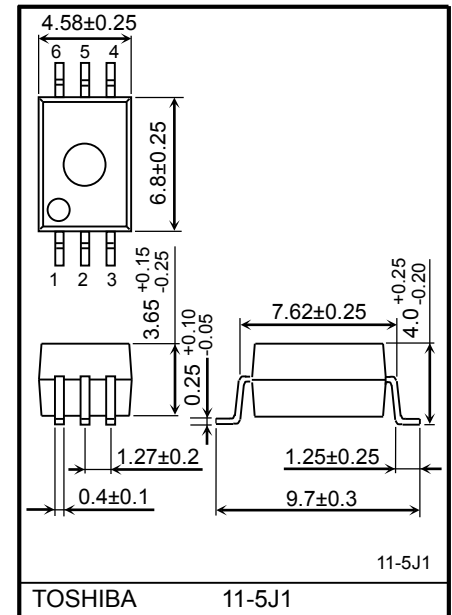
- Peak output current:  $\pm 2.0$  A (max)
- Guaranteed performance over temperature:  $-40$  to  $100^{\circ}\text{C}$
- Supply current:  $2.0$  mA (max)
- Power supply voltage:  $15$  to  $30$  V
- Threshold input current:  $I_{FLH} = 5$  mA (max)
- Switching time ( $t_{PLH} / t_{PHL}$ ):  $500$  ns (max)
- Common mode transient immunity:  $\pm 15$  kV/ $\mu\text{s}$  (min)
- Isolation voltage:  $5000$  Vrms (min)
- UL recognized: UL1577, File No. E67349
- c-UL approved : CSA Component Acceptance Service  
No. 5A, File No.E67349
- Option (D4) VDE approved :  
EN60747-5-5 EN60065 EN60950-1(Note 1)  
EN62368-1(Pending)

**Note 1: When a EN60747-5-5 approved type is needed, please designate the "Option(D4)"**

## Truth Table

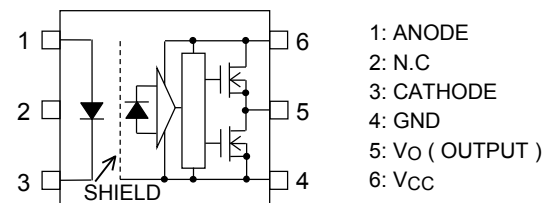
Input	LED	M1	M2	Output
H	ON	ON	OFF	H
L	OFF	OFF	ON	L

Unit: mm

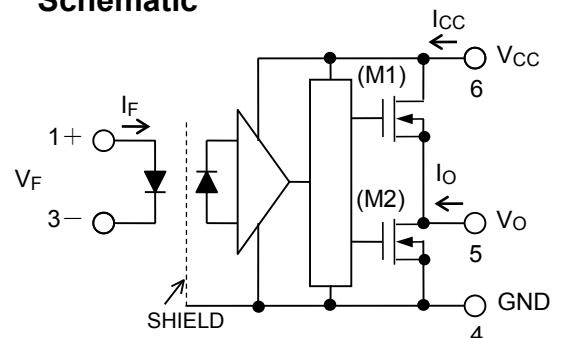


Weight: 0.26 g (typ.)

## Pin Configuration (Top View)



## Schematic



Note: A 0.1- $\mu\text{F}$  bypass capacitor must be connected between pins 6 and 4.

Start of commercial production  
2007-08

## Absolute Maximum Ratings (Ta = 25 °C)

Characteristics			Symbol	Rating	Unit
LED	Forward current		I <sub>F</sub>	20	mA
	Forward current derating (Ta ≥ 85°C)		ΔI <sub>F</sub> /ΔTa	-0.54	mA/°C
	Peak transient forward current (Note 1)		I <sub>FP</sub>	1	A
	Reverse voltage		V <sub>R</sub>	5	V
	Diode power dissipation		P <sub>D</sub>	40	mW
	Diode power dissipation derating (Ta ≥ 85 °C)		ΔP <sub>D</sub> /ΔTa	-1.0	mW/°C
	Junction temperature		T <sub>j</sub>	125	°C
Detector	"H" peak output current	Ta=-40 to 100 °C (Note 2)	I <sub>OPH</sub>	-2.0	A
	"L" peak output current		I <sub>OPL</sub>	2.0	A
	Output voltage		V <sub>O</sub>	35	V
	Supply voltage		V <sub>CC</sub>	35	V
	Power dissipation		P <sub>C</sub>	400	mW
	Junction temperature		T <sub>j</sub>	125	°C
	Operating frequency (Note 3)			f	50
Operating temperature range			T <sub>opr</sub>	-40 to 100	°C
Storage temperature range			T <sub>stg</sub>	-55 to 125	°C
Lead soldering temperature (10 s) (Note 4)			T <sub>sol</sub>	260	°C
Isolation voltage (AC, 60 s, R.H. ≤ 60%) (Note 5)			BV <sub>S</sub>	5000	V <sub>rms</sub>

Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings.

Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

Note: A ceramic capacitor (0.1 μF) should be connected from pin 6 to pin 4 to stabilize the operation of the high gain linear amplifier. Failure to provide the bypassing may impair the switching property.

The total lead length between capacitor and coupler should not exceed 1 cm.

Note 1: Pulse width P<sub>W</sub> ≤ 1 μs, 300 pps

Note 2: Exponential waveform pulse width P<sub>W</sub> ≤ 0.3 μs, f ≤ 15 kHz

Note 3: Exponential waveform I<sub>OPH</sub> ≥ -1.5 A (≤ 0.3 μs), I<sub>OPL</sub> ≤ +1.5 A (≤ 0.3 μs), Ta=100°C

Note 4: For the effective lead soldering area

Note 5: Device considered a two-terminal device: pins 1, 2 and 3 paired with pins 4, 5 and 6 respectively.

## Recommended Operating Conditions

Characteristics	Symbol	Min	Typ.	Max	Unit
Input current, ON (Note 1)	I <sub>F</sub> (ON)	7.5	—	10	mA
Input voltage, OFF	V <sub>F</sub> (OFF)	0	—	0.8	V
Supply voltage (Note 2)(Note 3)	V <sub>CC</sub>	15	—	30	V
Peak output current	I <sub>OPH</sub> / I <sub>OPL</sub>	—	—	±1.5	A
Operating temperature	T <sub>opr</sub>	-40	—	100	°C

Note: Recommended operating conditions are given as a design guideline to obtain expected performance of the device. Additionally, each item is an independent guideline respectively. In developing designs using this product, please confirm specified characteristics shown in this document.

Note 1: Input signal rise time (fall time) ≤ 0.5 μs.

Note 2: This item denotes operating ranges, not meaning of recommended operating conditions.

Note 3: If the V<sub>CC</sub> rise slope is sharp, an internal circuit might not operate with stability. Please design the V<sub>CC</sub> rise slope under 3.0 V/μs.

## Electrical Characteristics (Ta = -40 to 100 °C, unless otherwise specified)

Characteristics		Symbol	Test Circuit	Test Condition		Min	Typ.	Max	Unit
Forward voltage		V <sub>F</sub>	—	I <sub>F</sub> = 10 mA, Ta = 25 °C		—	1.57	1.75	V
Temperature coefficient of forward voltage		ΔV <sub>F</sub> /ΔTa	—	I <sub>F</sub> = 10 mA		—	-1.8	—	mV/°C
Input reverse current		I <sub>R</sub>	—	V <sub>R</sub> = 5 V, Ta = 25 °C		—	—	10	μA
Input capacitance		C <sub>T</sub>	—	V = 0 V, f = 1 MHz, Ta = 25 °C		—	100	—	pF
Output current (Note 1)	“H” Level	I <sub>OPH1</sub>	1	V <sub>CC</sub> = 15 V I <sub>F</sub> = 5 mA	V <sub>6-5</sub> = 3.5 V	—	-1.4	-1.0	A
		I <sub>OPH2</sub>			V <sub>6-5</sub> = 7 V	—	—	-1.5	
	“L” Level	I <sub>OPL1</sub>	2	V <sub>CC</sub> = 15 V I <sub>F</sub> = 0 mA	V <sub>5-4</sub> = 2.5 V	1.0	1.4	—	
		I <sub>OPL2</sub>			V <sub>5-4</sub> = 7 V	1.5	—	—	
Output voltage	“H” Level	V <sub>OH</sub>	3	V <sub>CC1</sub> =+15V, V <sub>EE1</sub> =-15V R <sub>L</sub> = 200Ω, I <sub>F</sub> = 5 mA		11	13.7	—	V
	“L” Level	V <sub>OL</sub>	4	V <sub>CC1</sub> =+15V, V <sub>EE1</sub> =-15V R <sub>L</sub> = 200Ω, V <sub>F</sub> = 0.8 V		—	-14.9	-12.5	
Supply current	“H” Level	I <sub>CCH</sub>	5	V <sub>CC</sub> = 30 V V <sub>O</sub> =Open	I <sub>F</sub> = 10 mA	—	1.3	2.0	mA
	“L” Level	I <sub>CCL</sub>	6		I <sub>F</sub> = 0 mA	—	1.3	2.0	
Threshold input current	L → H	I <sub>FLH</sub>	—	V <sub>CC</sub> = 15 V, V <sub>O</sub> > 1 V		—	1.8	5	mA
Threshold input voltage	H → L	V <sub>FHL</sub>	—	V <sub>CC</sub> = 15 V, V <sub>O</sub> < 1 V		0.8	—	—	V
Supply voltage		V <sub>CC</sub>	—	—		15	—	30	V
UVLO thresh hold	V <sub>UVLO+</sub>		—	V <sub>O</sub> > 2.5V, I <sub>F</sub> = 5 mA		11.0	12.5	13.5	V
	V <sub>UVLO-</sub>		—	V <sub>O</sub> < 2.5V, I <sub>F</sub> = 5 mA		9.5	11.0	12.0	V
UVLO hysteresis		UVLO <sub>HYS</sub>	—	—		—	1.5	—	V

Note: All typical values are at Ta = 25°C

Note: This product is more sensitive than conventional products to electrostatic discharge (ESD) owing to its low power consumption design. It is therefore all the more necessary to observe general precautions regarding ESD when handling this component.

Note 1: Duration of I<sub>O</sub> time ≤ 50 μs, 1 pulse

## Isolation Characteristics (Ta = 25 °C)

Characteristic	Symbol	Test Condition		Min	Typ.	Max	Unit
Capacitance input to output	C <sub>S</sub>	V <sub>S</sub> = 0 V, f = 1MHz (Note 1)		—	1.0	—	pF
Isolation resistance	R <sub>S</sub>	R.H. ≤ 60 %, V <sub>S</sub> = 500 V (Note 1)		1×10 <sup>12</sup>	10 <sup>14</sup>	—	Ω
Isolation voltage	BV <sub>S</sub>	AC, 60 s		5000	—	—	V <sub>rms</sub>
		AC, 1 s, in oil		—	10000	—	
		DC, 60 s, in oil		—	10000	—	V <sub>dc</sub>

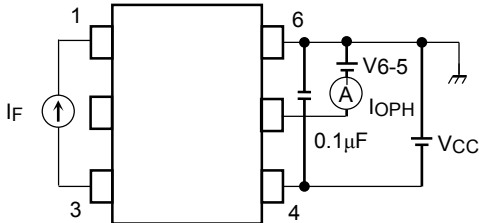
Note 1: Device considered a two-terminal device: pins 1, 2 and 3 paired with pins 4, 5 and 6 respectively.

**Switching Characteristics (Ta = -40 to 100 °C, unless otherwise specified)**

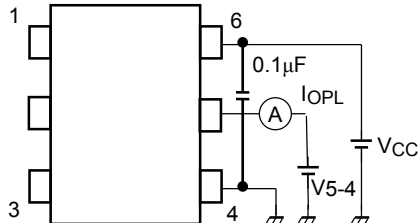
Characteristics		Symbol	Test Circuit	Test Condition		Min	Typ.	Max	Unit
Propagation delay time	L → H	tpLH	7	VCC = 30 V RG = 20 Ω CG = 10 nF	IF = 0 → 5 mA	50	—	500	ns
	H → L	tpHL			IF = 5 → 0 mA	50	—	500	
Output rise time (10-90 %)		tr			IF = 0 → 5 mA	—	50	—	
Output fall time (90-10 %)		tf			IF = 5 → 0 mA	—	50	—	
Switching time dispersion between ON and OFF		tpHL-tpLH			IF = 0 ↔ 5 mA	—	—	250	
Common mode transient immunity at HIGH level output		CMH	8	VCM =1000 Vp-p Ta = 25 °C VCC = 30 V	IF = 5 mA VO (min) = 26 V	-15	—	—	kV/μs
Common mode transient immunity at LOW level output		CM <sub>L</sub>			IF = 0 mA VO (max) = 1 V	15	—	—	

Note: All typical values are at Ta = 25 °C.

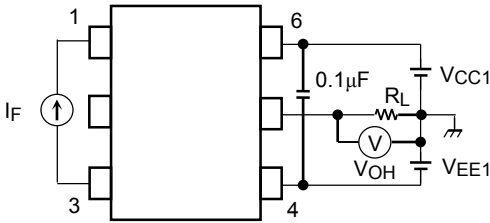
**Test Circuit 1: IOPH**



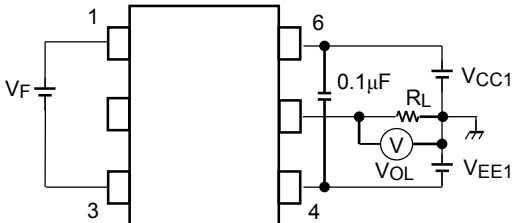
**Test Circuit 2: IOPL**



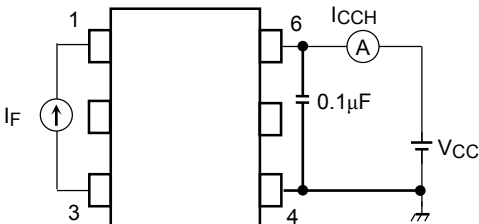
**Test Circuit 3: VOH**



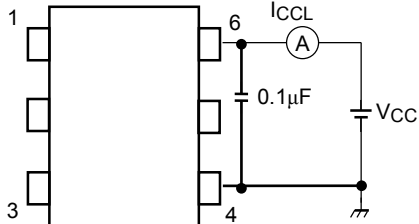
**Test Circuit 4: VOL**



**Test Circuit 5: ICCH**

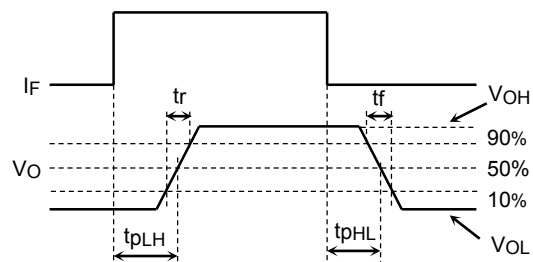
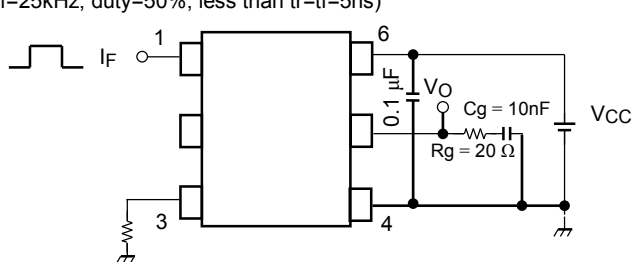


**Test Circuit 6: ICCL**

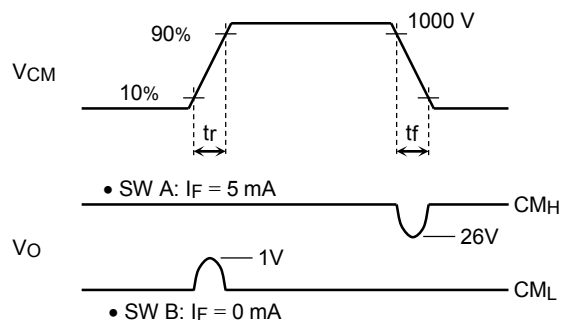
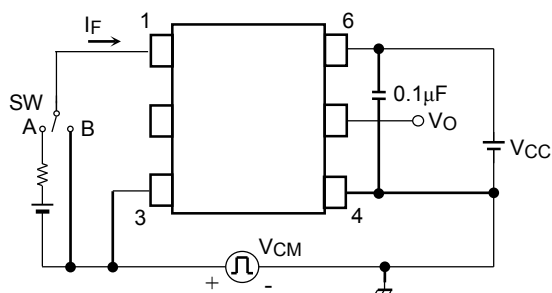


## Test Circuit 7: $t_{pLH}$ , $t_{pHL}$ , $t_r$ , $t_f$ , $|t_{pHL}-t_{pLH}|$

( $f=25\text{kHz}$ , duty=50%, less than  $t_r=t_f=5\text{ns}$ )



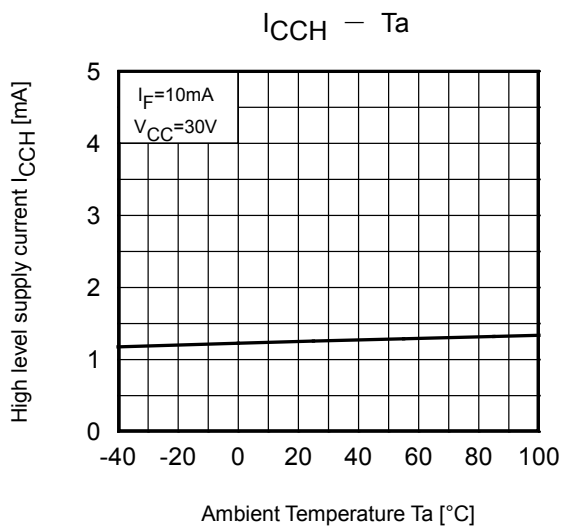
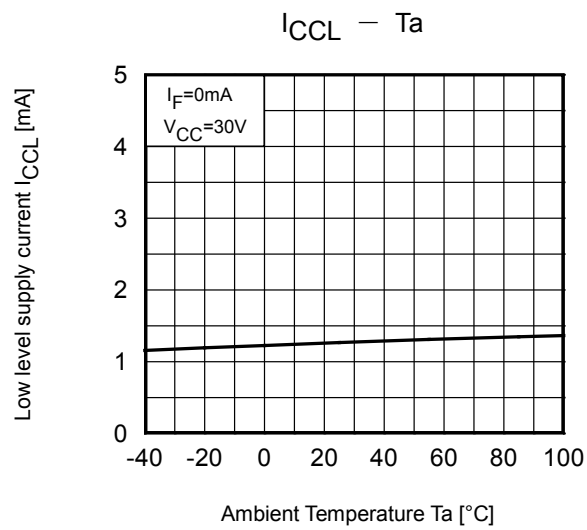
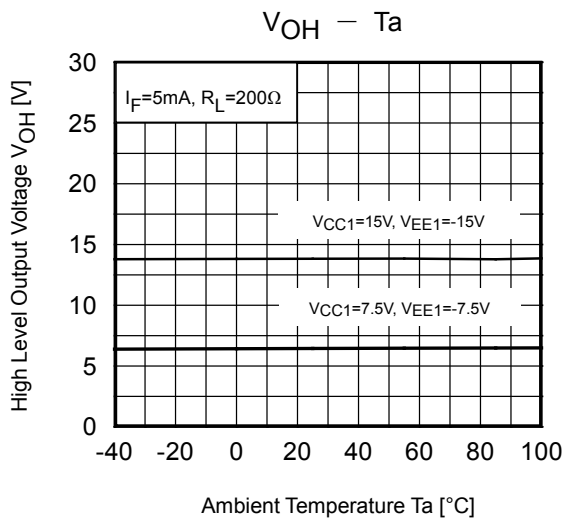
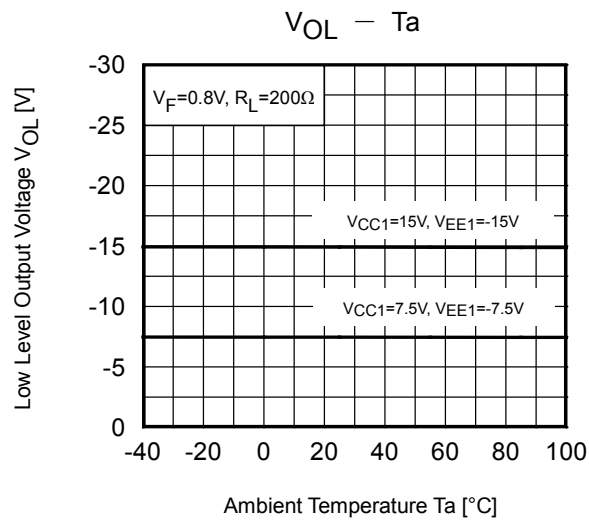
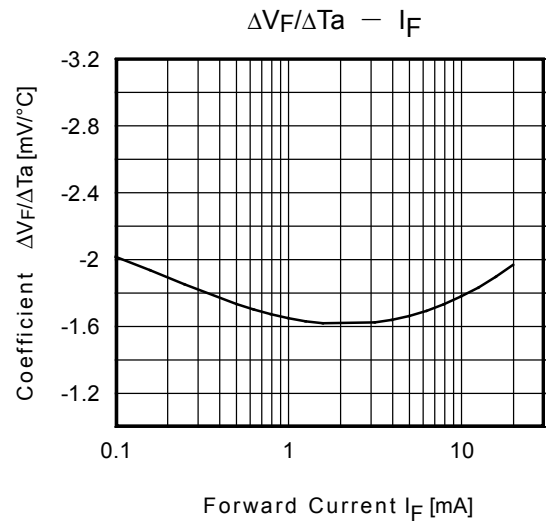
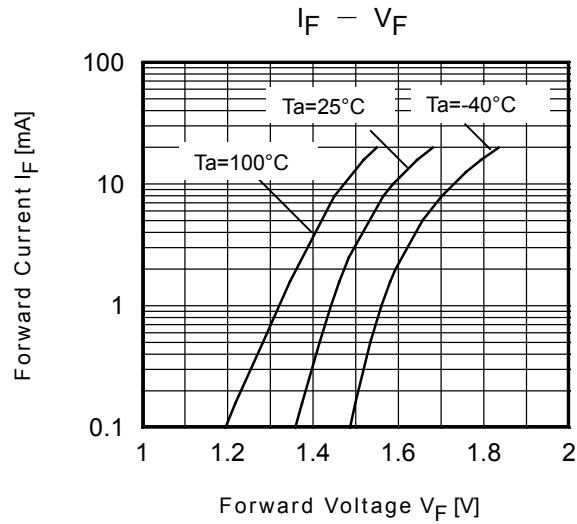
## Test Circuit 8: $CM_H$ , $CM_L$



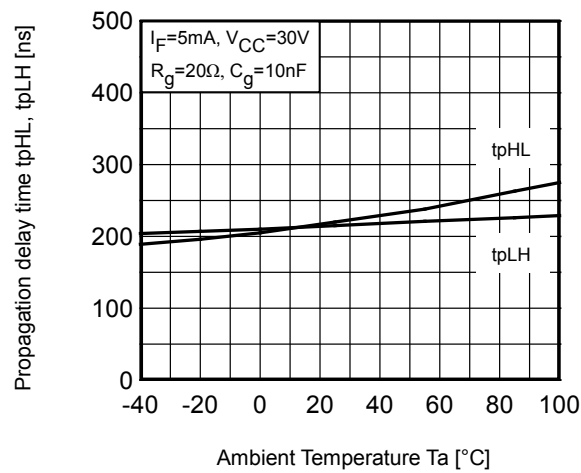
$$CM_H = - \frac{800 \text{ V}}{t_f (\mu\text{s})}$$

$$CM_L = \frac{800 \text{ V}}{t_r (\mu\text{s})}$$

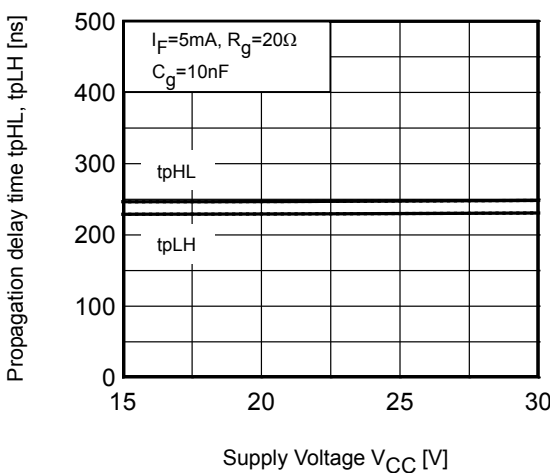
Note:  $CM_L$  ( $CM_H$ ) is the maximum rate of rise (fall) of the common mode voltage that can be sustained with the output voltage in the LOW (HIGH) state.



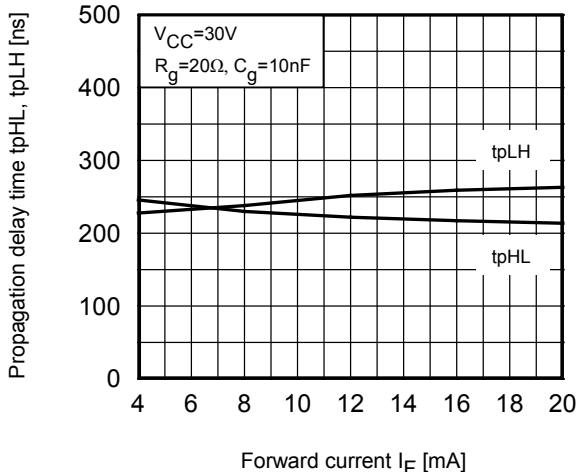
tpHL, tpLH — Ta



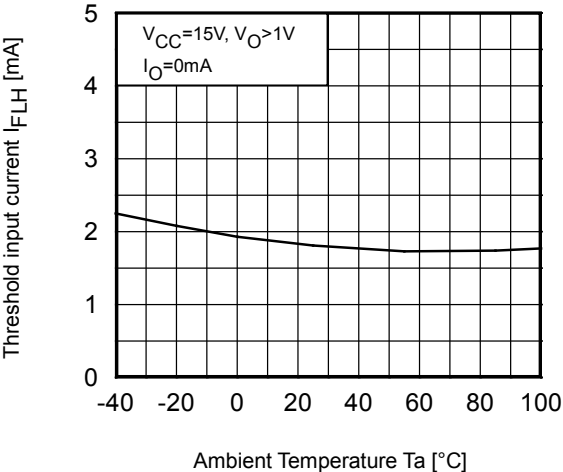
tpHL, tpLH — VCC



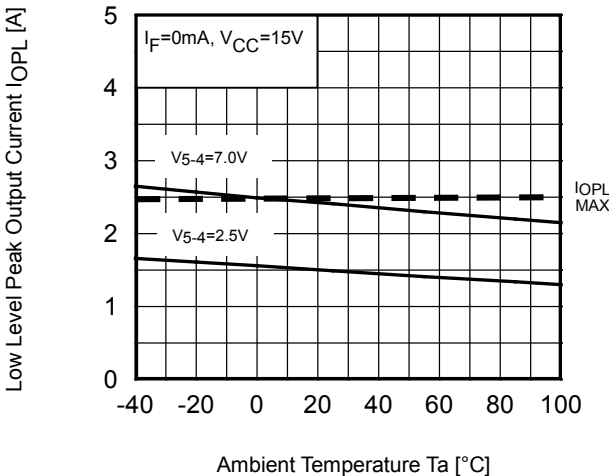
tpHL, tpLH — IF



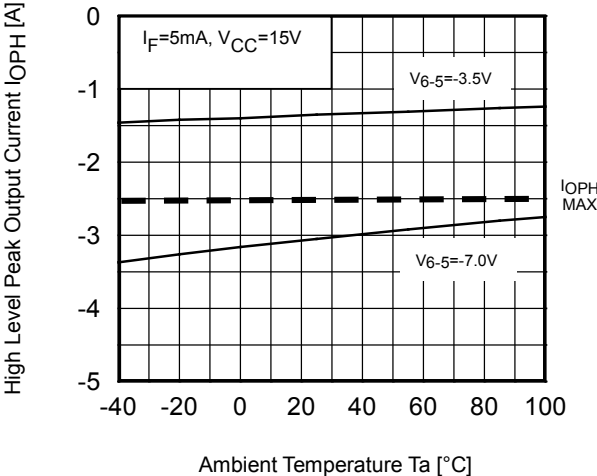
IFLH — Ta

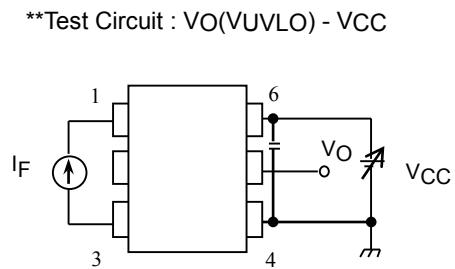
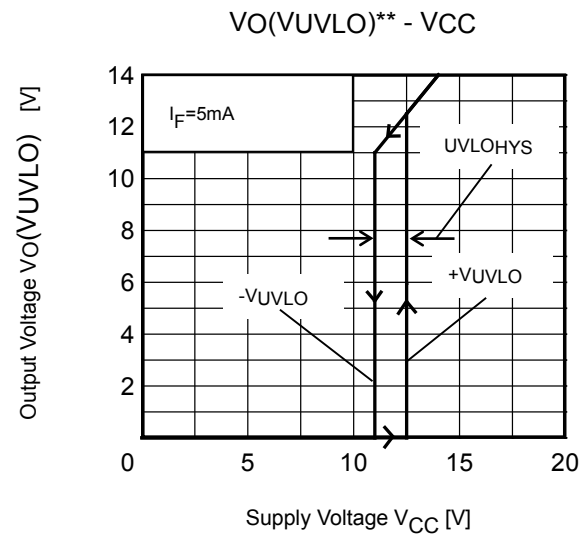
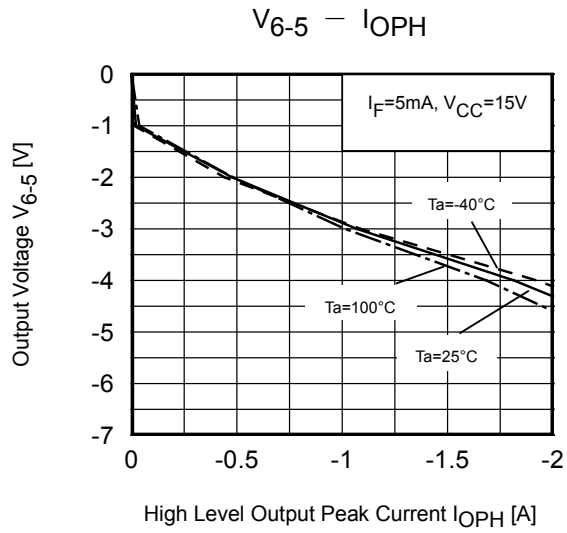
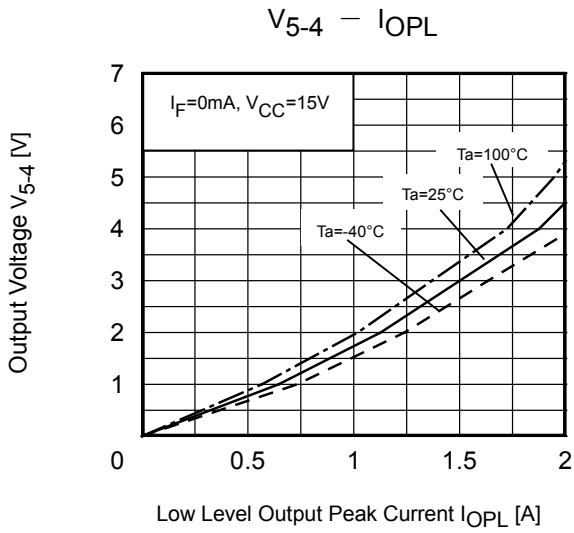


IOPL — Ta



IOPH — Ta





\*: The above graphs show typical characteristics.



## Soldering and Storage

### (1) Precautions for Soldering

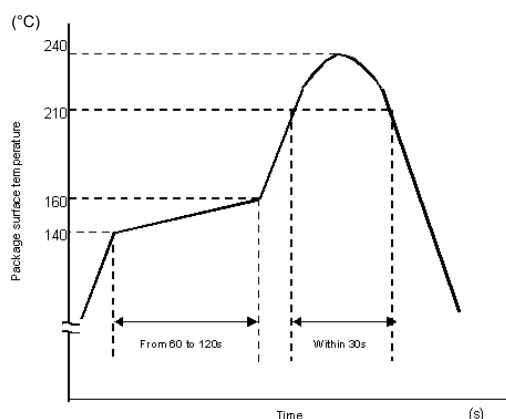
The soldering temperature should be controlled as closely as possible to the conditions shown below, irrespective of whether a soldering iron or a reflow soldering method is used.

#### 1) When Using Soldering Reflow

The soldering temperature profile is based on the package surface temperature.

(See the figure shown below, which is based on the package surface temperature.)

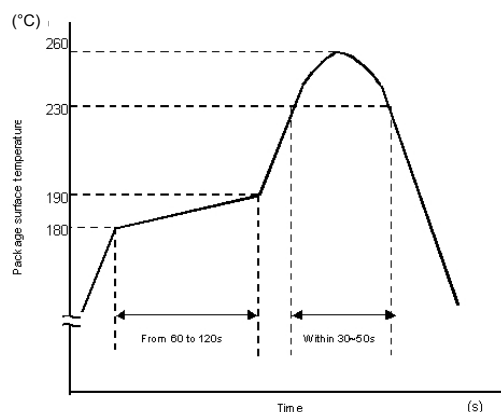
- An example of a temperature profile when Sn-Pb eutectic solder is used:



This profile is based on the device's maximum heat resistance guaranteed value.

Set the preheat temperature/heating temperature to the optimum temperature corresponding to the solder paste type used by the customer within the described profile.

- An example of a temperature profile when lead(Pb)-free solder is used:



This profile is based on the device's maximum heat resistance guaranteed value.

Set the preheat temperature/heating temperature to the optimum temperature corresponding to the solder paste type used by the customer within the described profile.

- Reflow soldering must be performed once or twice.
- The mounting should be completed with the interval from the first to the last mountings being 2 weeks.

#### 2) When using soldering Flow (Applicable to both eutectic solder and Lead(Pb)-Free solder)

- Apply preheating of 150 °C (package surface temperature) for 60 to 120 seconds.
- Mounting condition of 260 °C or less within 10 seconds is recommended.
- Flow soldering must be performed once

#### 3) When using soldering Iron (Applicable to both eutectic solder and Lead(Pb)-Free solder)

- Complete soldering within 10 seconds for lead temperature not exceeding 260 °C or within 3 seconds not exceeding 350 °C.
- Heating by soldering iron must be only once per 1 lead

**(2) Precautions for General Storage**

- 1) Do not store devices at any place where they will be exposed to moisture or direct sunlight.
- 2) When transportation or storage of devices, follow the cautions indicated on the carton box.
- 3) The storage area temperature should be kept within a temperature range of 5 °C to 35 °C, and relative humidity should be maintained at between 45% and 75%.
- 4) Do not store devices in the presence of harmful (especially corrosive) gases, or in dusty conditions.
- 5) Use storage areas where there is minimal temperature fluctuation. Because rapid temperature changes can cause condensation to occur on stored devices, resulting in lead oxidation or corrosion, as a result, the solderability of the leads will be degraded.
- 6) When repacking devices, use anti-static containers.
- 7) Do not apply any external force or load directly to devices while they are in storage.
- 8) If devices have been stored for more than two years, even though the above conditions have been followed, it is recommended that solderability of them should be tested before they are used.

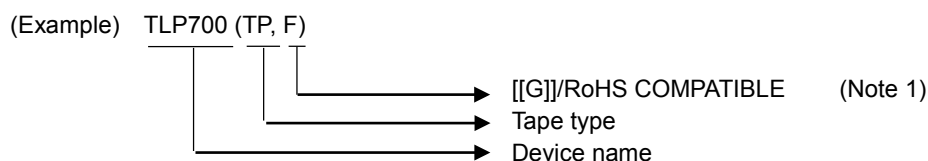
## Embossed-Tape Packing (TP) Specifications for SDIP6 Type Photocouplers

### 1. Applicable Package

Package Name	Product Type
SDIP6	Photocouplers

### 2. Product Naming System

Type of package used for shipment is denoted by a symbol suffix after a product number. The method of classification is as below.



Note 1: Please contact your TOSHIBA sales representative for details as to environmental matters such as the RoHS compatibility of Product.

RoHS is the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

### 3. Tape Dimensions

#### 3.1 Orientation of Devices in Relation to Direction of Tape Movement

Device orientation in the recesses is as shown in Figure 1.

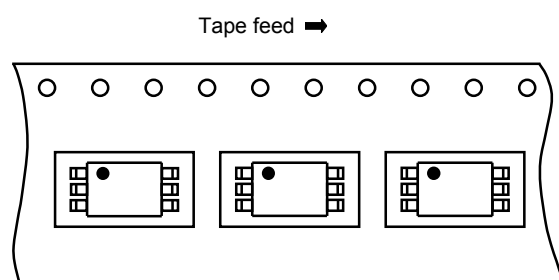


Figure 1 Device Orientation

#### 3.2 Tape Packing Quantity: 1500 devices per reel

#### 3.3 Empty Device Recesses Are as Shown in Table 1.

Table 1 Empty Device Recesses

	Standard	Remarks
Occurrences of 2 or more successive empty device recesses	0 device	Within any given 40-mm section of tape, not including leader and trailer
Single empty device recesses	6 devices (max) per reel	Not including leader and trailer

#### 3.4 Start and End of Tape:

The start of the tape has 30 or more empty holes. The end of the tape has 30 or more empty holes and two empty turns only for a cover tape.

### 3.5 Tape Specification

- (1) Tape material: Plastic (protection against electrostatics)
- (2) Dimensions: The tape dimensions are as shown in Figure 2 and Table 2.

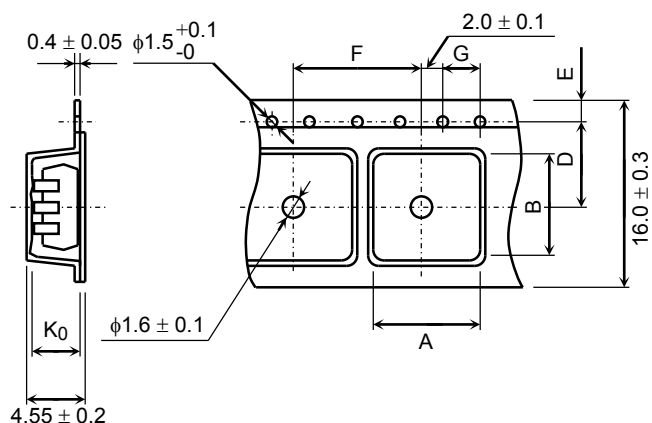


Figure 2 Tape Forms

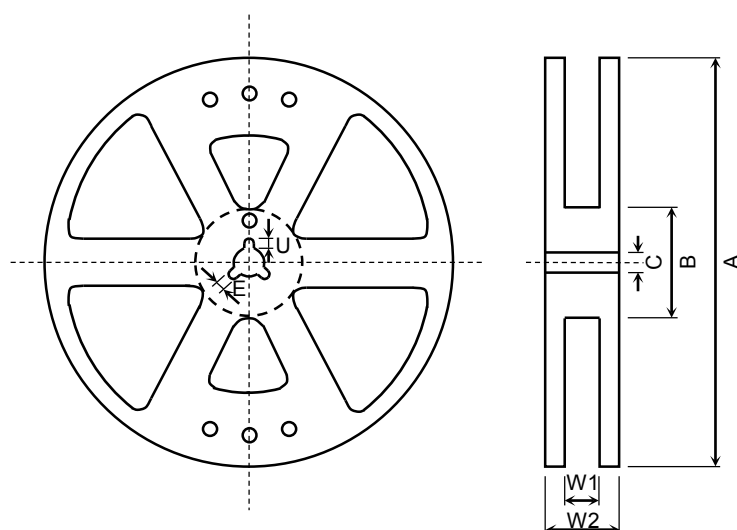
Table 2 Tape Dimension

Unit: mm  
Unless otherwise specified:  $\pm 0.1$

Symbol	Dimension	Remark
A	10.4	—
B	5.1	—
D	7.5	Center line of indented square hole and sprocket hole
E	1.75	Distance between tape edge and hole center
F	12.0	Cumulative error $^{+0.1}_{-0.3}$ per 10 feed holes
G	4.0	Cumulative error $^{+0.1}_{-0.3}$ per 10 feed holes
$K_0$	4.1	Internal space

## 3.6 Reel

- (1) Material: Plastic
- (2) Dimensions: The reel dimensions are as shown in Figure 3 and Table 3.



**Figure 3 Reel Forms**

**Table 3 Reel Dimension**

Unit: mm

記 号	寸 法
A	$\phi 380 \pm 2$
B	$\phi 80 \pm 1$
C	$\phi 13 \pm 0.5$
E	$2.0 \pm 0.5$
U	$4.0 \pm 0.5$
W1	$17.5 \pm 0.5$
W2	$21.5 \pm 1.0$

## 4. Packing

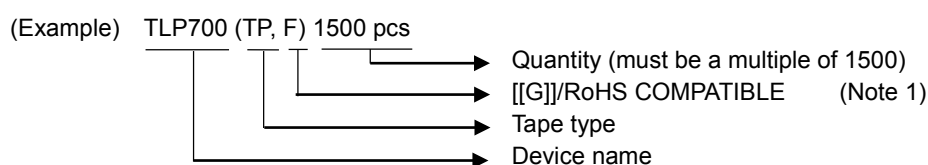
Either one reel or five reels of photocouplers are packed in a shipping carton.

## 5. Label Indication

The carton bears a label indicating the product number, the symbol representing classification of standard, the quantity, the lot number and the Toshiba company name.

## 6. Ordering Method

When placing an order, please specify the product number, the tape type and the quantity as shown in the following example.



Note 1: Please contact your TOSHIBA sales representative for details as to environmental matters such as the RoHS compatibility of Product.

RoHS is the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

## EN60747-5-5 Option (D4) Specification

Types : TLP700

Type designations for “option: (D4)”, which are tested under EN60747 requirements.

Ex.: TLP700 (D4-TP,F)

D4 : EN60747 option

TP : Standard tape & reel type

F : [[G]]/RoHS COMPATIBLE (Note 1)

Note: Use TOSHIBA standard type number for safety standard application.

Ex.: TLP700 (D4-TP,F) → TLP700



Note 1: Please contact your TOSHIBA sales representative for details as to environmental matters such as the RoHS compatibility of Product.

RoHS is the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

### EN60747 Isolation Characteristics

Description		Symbol	Rating	Unit
Application classification				
for rated mains voltage $\leq 300V_{rms}$			I-IV	—
for rated mains voltage $\leq 600V_{rms}$			I-III	
Climatic classification			40/ 100 / 21	—
Pollution degree			2	—
Maximum operating insulation voltage	TLPxxx type	$V_{IORM}$	890	Vpk
	TLPxxxFtype		1140	
Input to output test voltage, method A $V_{pr}=1.6 \times V_{IORM}$ , type and sample test $t_p=10$ s, partial discharge $<5$ pC	TLPxxx type	$V_{pr}$	1424	Vpk
	TLPxxxFtype		1824	
Input to output test voltage, method B $V_{pr}=1.875 \times V_{IORM}$ , 100 % production test $t_p=1$ s, partial discharge $< 5$ pC	TLPxxx type	$V_{pr}$	1670	Vpk
	TLPxxxFtype		2140	
Highest permissible overvoltage (transient overvoltage, $t_{pr} = 60$ s)		$V_{TR}$	8000	Vpk
Safety limiting values (max. permissible ratings in case of fault, also refer to thermal derating curve)				
current (input current $I_F$ , $P_{Si} = 0$ )		$I_{Si}$	300	mA
power (output or total power dissipation)		$P_{Si}$	700	mW
temperature		$T_s$	150	°C
Insulation resistance, $V_{IO}=500$ V, $T_a = 25$ °C $V_{IO}=500$ V, $T_a = 100$ °C $V_{IO}=500$ V, $T_a = T_s$		$R_{Si}$	$\geq 10^{12}$ $\geq 10^{11}$ $\geq 10^9$	$\Omega$

Insulation Related Specifications

		 7.62mm pitch TLPxxx type	 10.16mm pitch TLPxxxF type
Minimum creepage distance	Cr	7.0mm	8.0mm
Minimum clearance	Cl	7.0mm	8.0mm
Minimum insulation thickness	ti	0.4mm	
Comperative tracking index	CTI	175	

- 1. If a printed circuit is incorporated, the creepage distance and clearance may be reduced below this value.  
If this is not permissible, the user shall take suitable measures.
- 2. This photocoupler is suitable for ‘safe electrical isolation’ only within the safety limit data.  
Maintenance of the safety data shall be ensured by means of protective circuits.

Marking on product for EN60747 : 4

Marking Example:

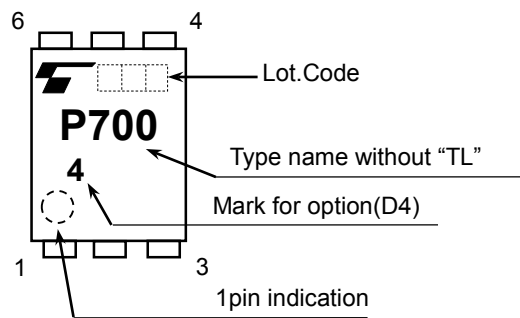


Figure 1 Partial discharge measurement procedure according to EN60747  
Destructive test for qualification and sampling tests.

Method A

(for type and sampling tests,  
destructive tests)

t1, t2	= 1 to 10 s
t3, t4	= 1 s
tp(Measuring time for partial discharge)	= 10 s
tb	= 12 s
tini	= 60 s

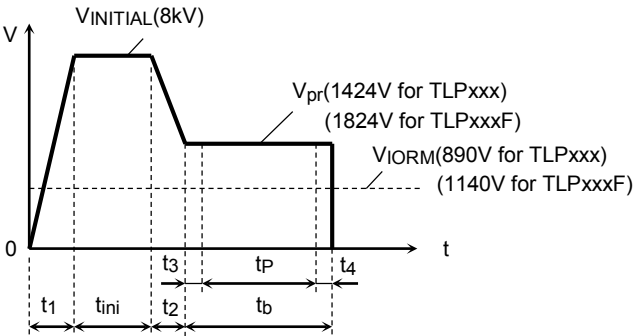


Figure 2 Partial discharge measurement procedure according to EN60747  
Non-destructive test for 100% inspection.

Method B

(for sample test, non-  
destructive test)

t3, t4	= 0.1 s
tp(Measuring time for partial discharge)	= 1 s
tb	= 1.2 s

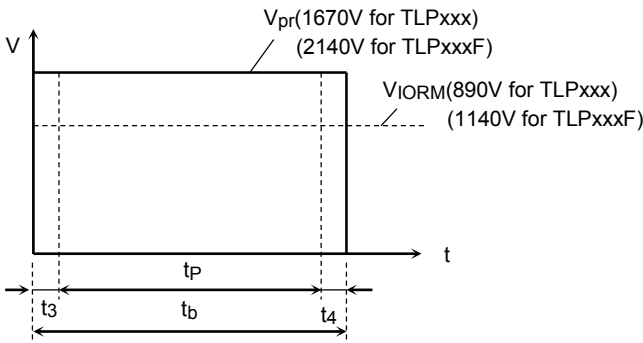
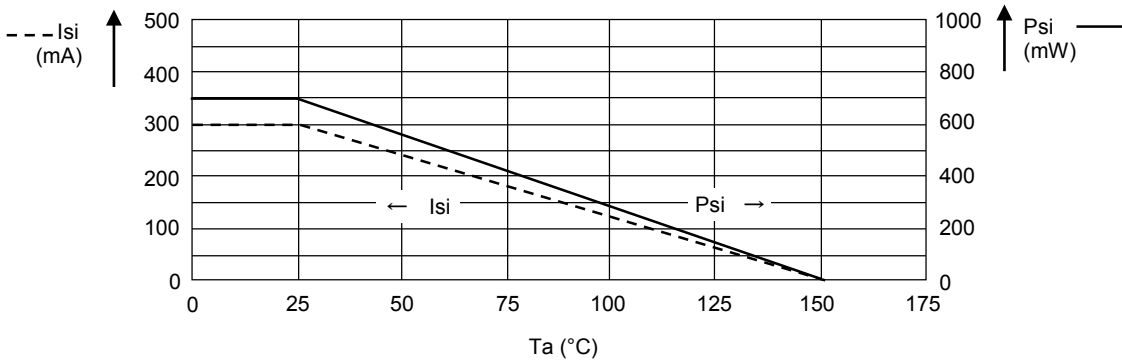


Figure 3 Dependency of maximum safety ratings on ambient temperature





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