

# TLP388

## 1. Applications

- Programmable Logic Controllers (PLCs)
- Air Conditioner Inverters

## 2. General

TLP388 consists of phototransistors optically coupled to infrared LED. The TLP388 is housed in the thin SO6L (4 pin) package and that guarantees high temperature operation ( $T_a = 125\text{ }^\circ\text{C max}$ ).

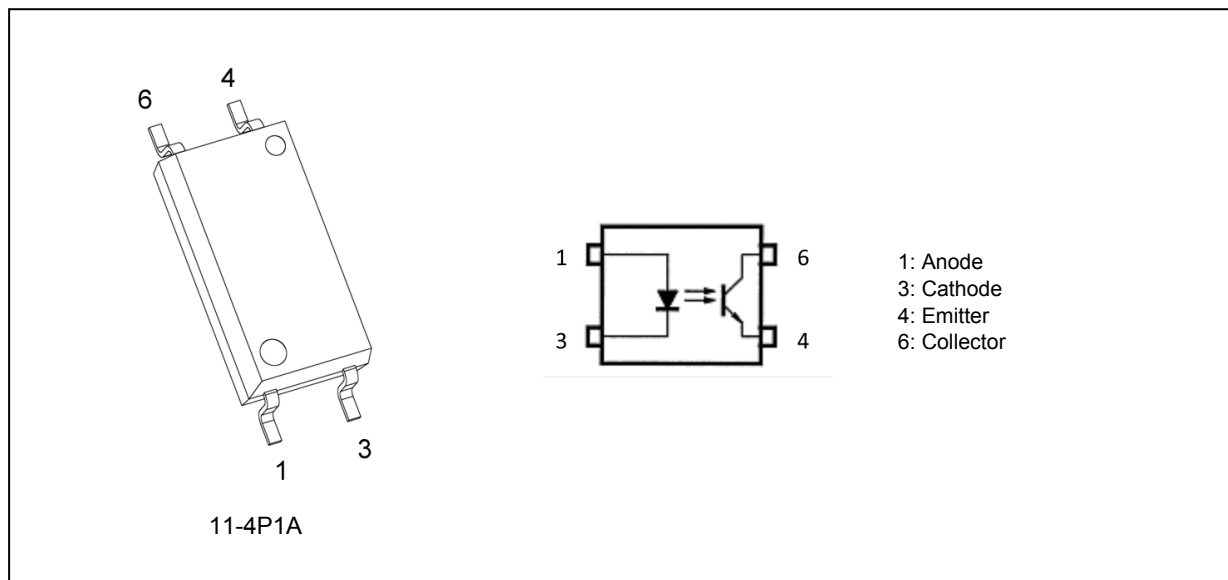
With the high brakedown voltage between the collector and emitter ( $V_{CE0}$ ) 350 V, TLP388 is suitable for use in programmable logic controllers (PLCs), and home appliances, include air conditioners.

## 3. Features

- (1) Collector-emitter voltage: 350 V (min)
- (2) Current transfer ratio: 50 % (min) (@ $I_F = 5\text{ mA}$ ,  $V_{CE} = 5\text{ V}$ )  
Rank GB: 100 % (min) (@ $I_F = 5\text{ mA}$ ,  $V_{CE} = 5\text{ V}$ )
- (3) Isolation voltage: 5000 Vrms (min)
- (4) Operating temperature range: -55 to 125  $^\circ\text{C}$
- (5) Safety standards  
UL-recognized: UL 1577, File No.E67349  
cUL-recognized: CSA Component Acceptance Service No.5A File No.E67349  
VDE-approved: EN 60747-5-5, EN 62368-1 (**Note 1**)  
CQC-approved: GB4943.1, GB8898 Thailand Factory

Note 1: When a VDE approved type is needed, please designate the **Option (D4)**.

## 4. Packaging and Pin Assignment



Start of commercial production  
2016-02

## 5. Mechanical Parameters

Characteristics	Min	Unit
Creepage distances	8.0	mm
Clearance	8.0	
Internal isolation thickness	0.4	

## 6. Absolute Maximum Ratings (Note) (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$ )

	Characteristics	Symbol	Note	Rating	Unit
LED	Input forward current	$I_F$		50	mA
	Input forward current derating ( $T_a \geq 90\text{ }^\circ\text{C}$ )	$\Delta I_F/\Delta T_a$		-1.11	mA/ $^\circ\text{C}$
	Input forward current (pulsed)	$I_{FP}$	(Note 1)	1	A
	Input power dissipation	$P_D$		100	mW
	Input power dissipation derating ( $T_a \geq 90\text{ }^\circ\text{C}$ )	$\Delta P_D/\Delta T_a$		-2.22	mW/ $^\circ\text{C}$
	Input reverse voltage	$V_R$		5	V
	Junction temperature	$T_j$		135	$^\circ\text{C}$
Detector	Collector-emitter voltage	$V_{CEO}$		350	V
	Emitter-collector voltage	$V_{ECO}$		7	V
	Collector current	$I_C$		50	mA
	Collector power dissipation	$P_C$		150	mW
	Collector power dissipation derating ( $T_a \geq 25\text{ }^\circ\text{C}$ )	$\Delta P_C/\Delta T_a$		-1.36	mW/ $^\circ\text{C}$
	Junction temperature	$T_j$		135	$^\circ\text{C}$
Common	Operating temperature	$T_{opr}$		-55 to 125	$^\circ\text{C}$
	Storage temperature	$T_{stg}$		-55 to 125	$^\circ\text{C}$
	Lead soldering temperature (10 s)	$T_{sol}$		260	$^\circ\text{C}$
	Total power dissipation	$P_T$		250	mW
	Total power dissipation derating ( $T_a \geq 25\text{ }^\circ\text{C}$ )	$\Delta P_T/\Delta T_a$		-2.27	mW/ $^\circ\text{C}$
	Isolation voltage (AC, 60 s, R.H. $\leq 60\%$ )	$BV_S$	(Note 2)	5000	Vrms

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 1: Pulse width (PW)  $\leq 0.1$  ms,  $f = 100$  Hz

Note 2: This device is considered as a two-terminal device: Pins 1 and 3 are shorted together, and pins 4 and 6 are shorted together.

### 7. Electrical Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$ )

	Characteristics	Symbol	Note	Test Condition	Min	Typ.	Max	Unit
LED	Input forward voltage	$V_F$		$I_F = 10\text{ mA}$	1.1	1.25	1.4	V
	Input reverse current	$I_R$		$V_R = 5\text{ V}$	—	—	10	$\mu\text{A}$
	Input capacitance	$C_t$		$V = 0\text{ V}, f = 1\text{ MHz}$	—	30	—	pF
Detector	Collector-emitter breakdown voltage	$V_{(BR)CEO}$		$I_C = 0.1\text{ mA}$	350	—	—	V
	Emitter-collector breakdown voltage	$V_{(BR)ECO}$		$I_E = 0.1\text{ mA}$	7	—	—	V
	Dark Current	$I_{DARK}$		$V_{CE} = 300\text{ V}$	—	0.01	0.2	$\mu\text{A}$
				$V_{CE} = 300\text{ V}, T_a = 85\text{ }^\circ\text{C}$	—	—	50	
Collector-emitter capacitance	$C_{CE}$		$V = 0\text{ V}, f = 1\text{ MHz}$	—	10	—	pF	

### 8. Coupled Electrical Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$ )

	Characteristics	Symbol	Note	Test Condition	Min	Typ.	Max	Unit
Current transfer ratio	$I_C/I_F$	(Note 1)		$I_F = 5\text{ mA}, V_{CE} = 5\text{ V}$	50	—	600	%
				$I_F = 5\text{ mA}, V_{CE} = 5\text{ V}, \text{Rank GB}$	100	—	600	
Saturated current transfer ratio	$I_C/I_{F(sat)}$			$I_F = 10\text{ mA}, V_{CE} = 0.4\text{ V}$	—	60	—	
				$I_F = 10\text{ mA}, V_{CE} = 0.4\text{ V}, \text{Rank GB}$	30	—	—	
Collector-emitter saturation voltage	$V_{CE(sat)}$			$I_C = 2.4\text{ mA}, I_F = 8\text{ mA}$	—	—	0.4	V
				$I_C = 0.2\text{ mA}, I_F = 1\text{ mA}$	—	0.2	—	
				$I_C = 0.2\text{ mA}, I_F = 1\text{ mA}, \text{Rank GB}$	—	—	0.4	
OFF-state collector current	$I_{C(off)}$			$V_F = 0.7\text{ V}, V_{CE} = 350\text{ V}$	—	—	200	$\mu\text{A}$

Note 1: See Table 8.1 for current transfer ratio.

**Table 8.1 Current Transfer Ratio (CTR) Rank (Note) (Unless otherwise specified,  $T_a = 25\text{ }^\circ\text{C}$ )**

Rank	Test Condition	Current transfer ratio $I_C/I_F$ Min	Current transfer ratio $I_C/I_F$ Max	Marking of classification	Unit
Blank	$I_F = 5\text{ mA}, V_{CE} = 5\text{ V}$	50	600	Blank, GB	%
GB		100	600	GB	

Note: Specify both the part number and a rank in this format when ordering.

Example: TLP388(GB,E)

For safety standard certification, however, specify the part number alone.

Example: TLP388(GB,E → TLP388)

### 9. Isolation Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$ )

	Characteristics	Symbol	Note	Test Condition	Min	Typ.	Max	Unit
Total capacitance (input to output)	$C_S$	(Note 1)		$V_S = 0\text{ V}, f = 1\text{ MHz}$	—	0.8	—	pF
Isolation resistance	$R_S$	(Note 1)		$V_S = 500\text{ V}, \text{R.H.} \leq 60\%$	$10^{12}$	$10^{14}$	—	$\Omega$
Isolation voltage	$BV_S$	(Note 1)		AC, 60 s	5000	—	—	Vrms

Note 1: This device is considered as a two-terminal device: Pins 1 and 3 are shorted together, and pins 4 and 6 are shorted together.

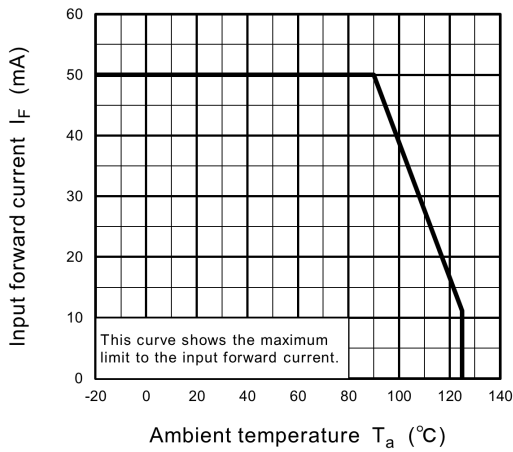
## 10. Switching Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$ )

Characteristics	Symbol	Note	Test Condition	Min	Typ.	Max	Unit
Rise time	$t_r$		$V_{CC} = 10\text{ V}$ , $I_C = 2\text{ mA}$ , $R_L = 100\ \Omega$	—	2	—	$\mu\text{s}$
Fall time	$t_f$			—	3	—	
Turn-on time	$t_{on}$			—	3	—	
Turn-off time	$t_{off}$			—	3	—	
Turn-on time	$t_{on}$		See Fig. 10.1.	—	3	—	
Storage time	$t_s$		$R_L = 1.9\text{ k}\Omega$ , $V_{CC} = 5\text{ V}$ , $I_F = 16\text{ mA}$	—	60	—	
Turn-off time	$t_{off}$			—	80	—	

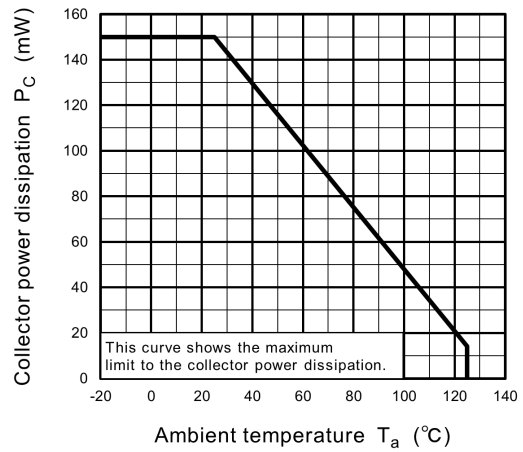


Fig. 10.1 Switching Time Test Circuit and Waveform

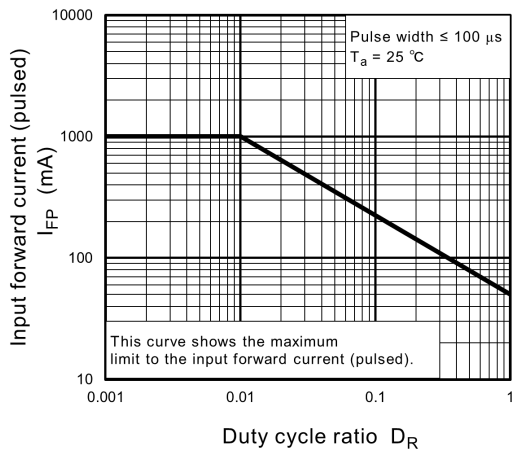
## 11. Characteristics Curves (Note)



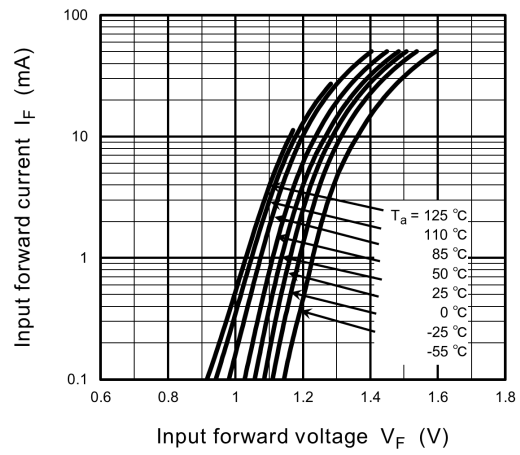
**Fig. 11.1  $I_F - T_a$**



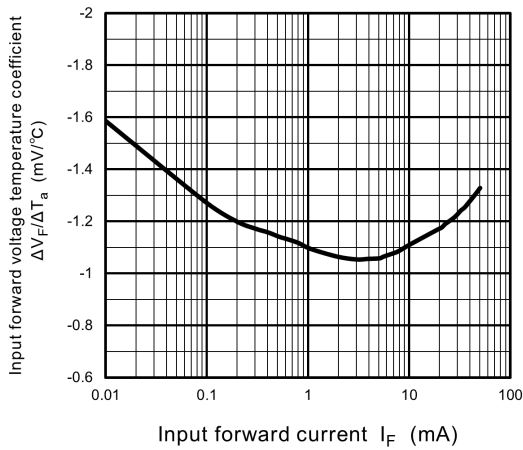
**Fig. 11.2  $P_C - T_a$**



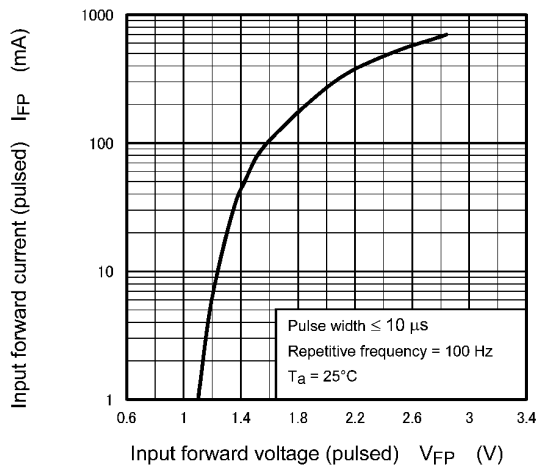
**Fig. 11.3  $I_{FP} - D_R$**



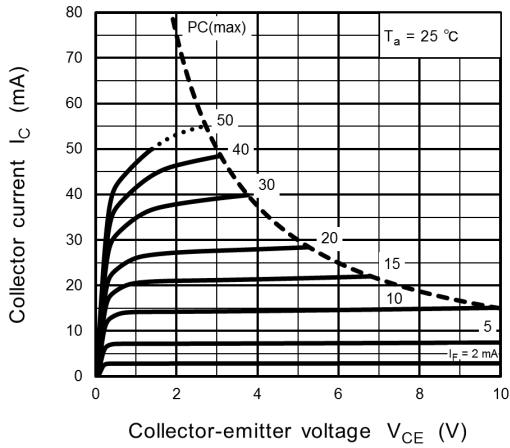
**Fig. 11.4  $I_F - V_F$**



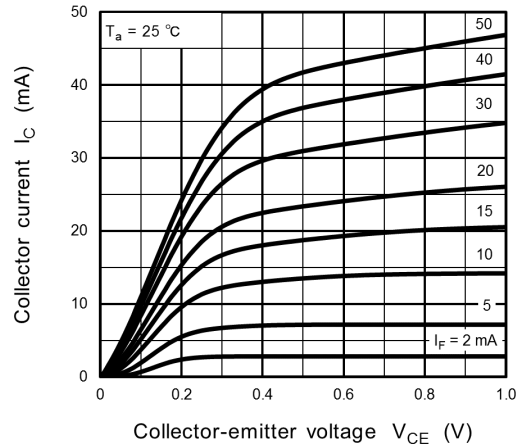
**Fig. 11.5  $\Delta V_F / \Delta T_a - I_F$**



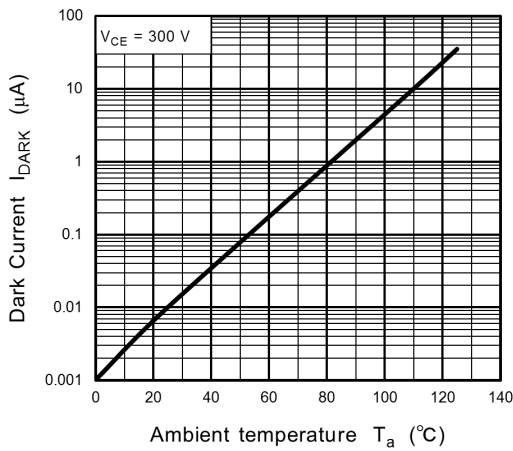
**Fig. 11.6  $I_{FP} - V_{FP}$**



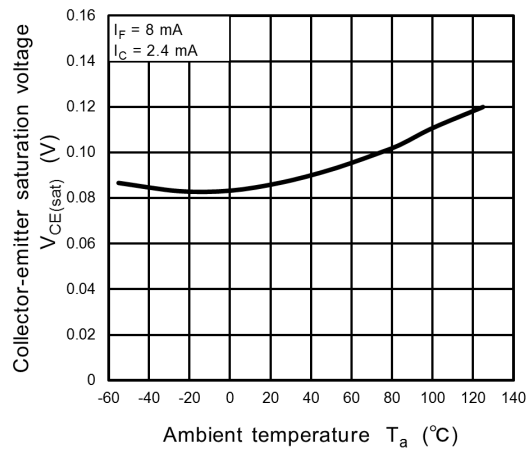
**Fig. 11.7**  $I_C - V_{CE}$



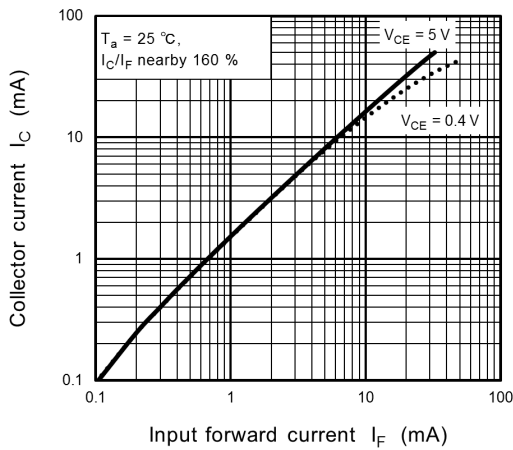
**Fig. 11.8**  $I_C - V_{CE}$



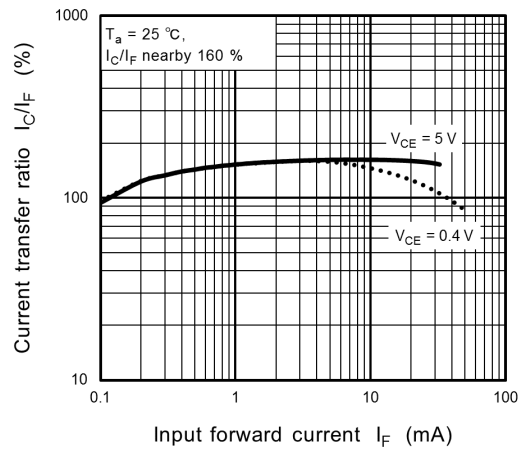
**Fig. 11.9**  $I_{DARK} - T_a$



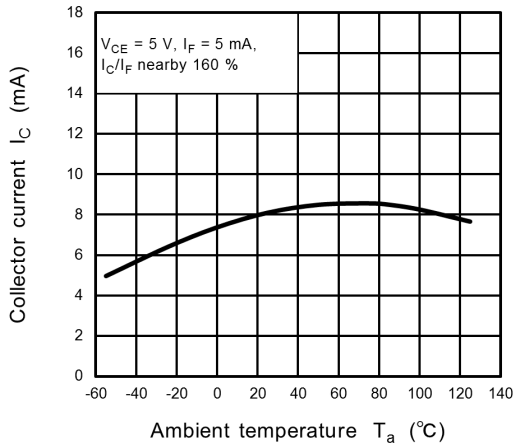
**Fig. 11.10**  $V_{CE(sat)} - T_a$



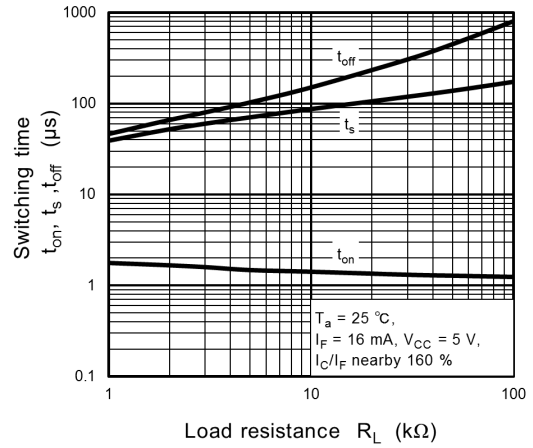
**Fig. 11.11**  $I_C - I_F$



**Fig. 11.12**  $I_C/I_F - I_F$



**Fig. 11.13  $I_C - T_a$**



**Fig. 11.14 Switching Time -  $R_L$**

Note: The above characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.

## 12. Soldering and Storage

### 12.1. 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.

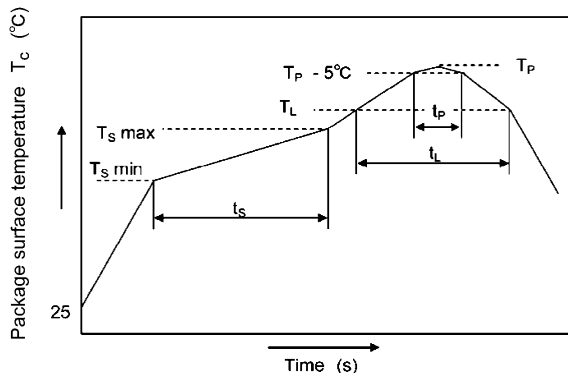
- When using soldering reflow.

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

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

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.



	Symbol	Min	Max	Unit
Preheat temperature	$T_S$	150	200	°C
Preheat time	$t_s$	60	120	s
Ramp-up rate ( $T_L$ to $T_P$ )			3	°C/s
Liquidus temperature	$T_L$	217		°C
Time above $T_L$	$t_L$	60	150	s
Peak temperature	$T_P$		260	°C
Time during which $T_c$ is between ( $T_P - 5$ ) and $T_P$	$t_p$		30	s
Ramp-down rate ( $T_P$ to $T_L$ )			6	°C/s

**An Example of a Temperature Profile When Lead(Pb)-Free Solder Is Used**

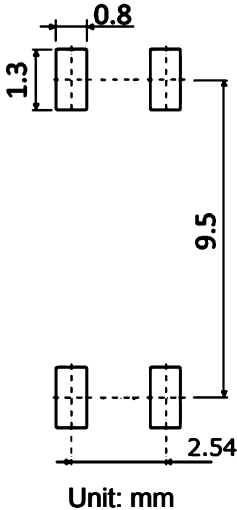
- When using soldering flow  
Preheat the device at a temperature of 150 °C (package surface temperature) for 60 to 120 seconds.  
Mounting condition of 260 °C within 10 seconds is recommended.  
Flow soldering must be performed once.
- When using soldering Iron  
Complete soldering within 10 seconds for lead temperature not exceeding 260 °C or within 3 seconds not exceeding 350 °C  
Heating by soldering iron must be done only once per lead.

### 12.2. Precautions for General Storage

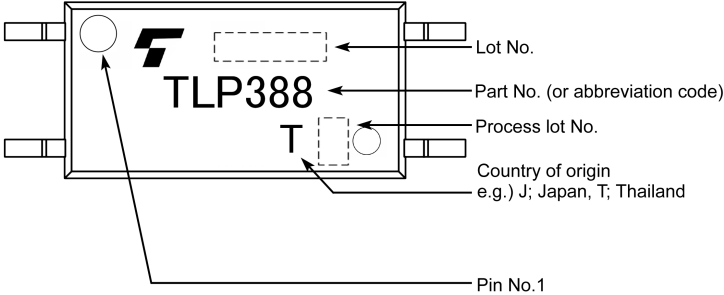
- Avoid storage locations where devices may be exposed to moisture or direct sunlight.
- Follow the precautions printed on the packing label of the device for transportation and storage.
- Keep the storage location temperature and humidity within a range of 5 °C to 35 °C and 45 % to 75 %, respectively.
- Do not store the products in locations with poisonous gases (especially corrosive gases) or in dusty conditions.
- Store the products in locations with minimal temperature fluctuations. Rapid temperature changes during storage can cause condensation, resulting in lead oxidation or corrosion, which will deteriorate the solderability of the leads.
- When restoring devices after removal from their packing, use anti-static containers.
- Do not allow loads to be applied directly to devices while they are in storage.
- If devices have been stored for more than two years under normal storage conditions, it is recommended that you check the leads for ease of soldering prior to use.



13. Land Pattern Dimensions (for reference only)



14. Marking



## 15. EN 60747-5-5 Option (D4) Specification

- Part number: TLP388 (Note 1)
- The following part naming conventions are used for the devices that have been qualified according to option (D4) of EN 60747.

Example: TLP388(D4GB-TL,E)

D4: EN 60747 option

GR: CTR rank

TL: Tape type (TPL)

E: [[G]]/RoHS COMPATIBLE (Note 2)

Note 1: Use TOSHIBA standard type number for safety standard application.

e.g., TLP388(D4GB-TL,E → TLP388

Note 2: Please contact your Toshiba sales representative for details on environmental information such as the product's RoHS compatibility.

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.

Description	Symbol	Rating	Unit
Application classification for rated mains voltage ≤ 150 Vrms for rated mains voltage ≤ 300 Vrms		I-IV I-III	—
Climatic classification		55 / 125 / 21	—
Pollution degree		2	—
Maximum operating insulation voltage	V <sub>IORM</sub>	1230	V <sub>peak</sub>
Input to output test voltage, Method A V <sub>pr</sub> = 1.6 × V <sub>IORM</sub> , type and sample test t <sub>p</sub> = 10 s, partial discharge < 5 pC	V <sub>pr</sub>	1970	V <sub>peak</sub>
Input to output test voltage, Method B V <sub>pr</sub> = 1.875 × V <sub>IORM</sub> , 100 % production test t <sub>p</sub> = 1 s, partial discharge < 5 pC	V <sub>pr</sub>	2310	V <sub>peak</sub>
Highest permissible overvoltage (transient overvoltage, t <sub>pr</sub> = 60 s)	V <sub>TR</sub>	8000	V <sub>peak</sub>
Safety limiting values (max. permissible ratings in case of fault, also refer to thermal derating curve) current (input current I <sub>F</sub> , P <sub>so</sub> = 0) power (output or total power dissipation) temperature	I <sub>si</sub> P <sub>so</sub> T <sub>s</sub>	250 400 150	mA mW °C
Insulation resistance V <sub>IO</sub> = 500 V, T <sub>a</sub> = 25 °C V <sub>IO</sub> = 500 V, T <sub>a</sub> = 100 °C V <sub>IO</sub> = 500 V, T <sub>a</sub> = T <sub>s</sub>	R <sub>si</sub>	≥ 10 <sup>12</sup> ≥ 10 <sup>11</sup> ≥ 10 <sup>9</sup>	Ω

Fig. 15.1 EN 60747 Insulation Characteristics

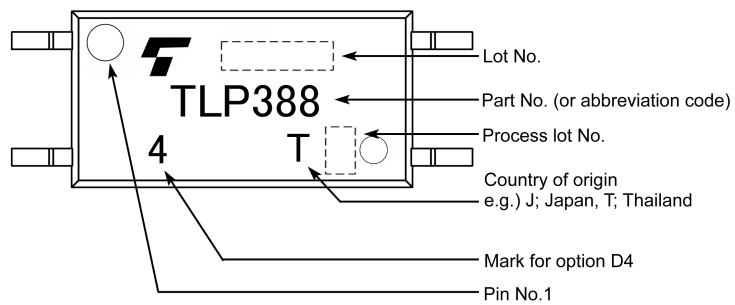
**Table 15.1 Insulation Related Specifications (Note)**

Isolation related specification	Symbol	TLP388
Minimum creepage distance	Cr	8.0 mm
Minimum clearance	Cl	8.0 mm
Minimum insulation thickness	ti	0.4 mm
Comparative tracking index	CTI	175

Note: 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.



**Fig. 15.2 Marking on Packing**



**Fig. 15.3 Marking Example (Note)**

Note: The above marking is applied to the photocouplers that have been qualified according to option (D4) of EN 60747.

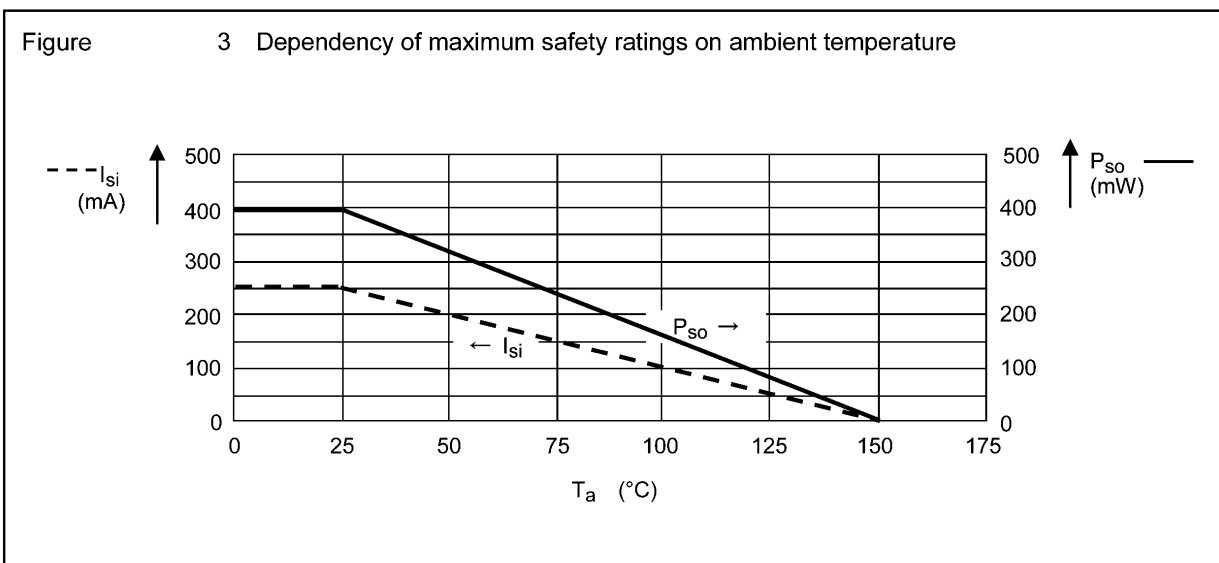
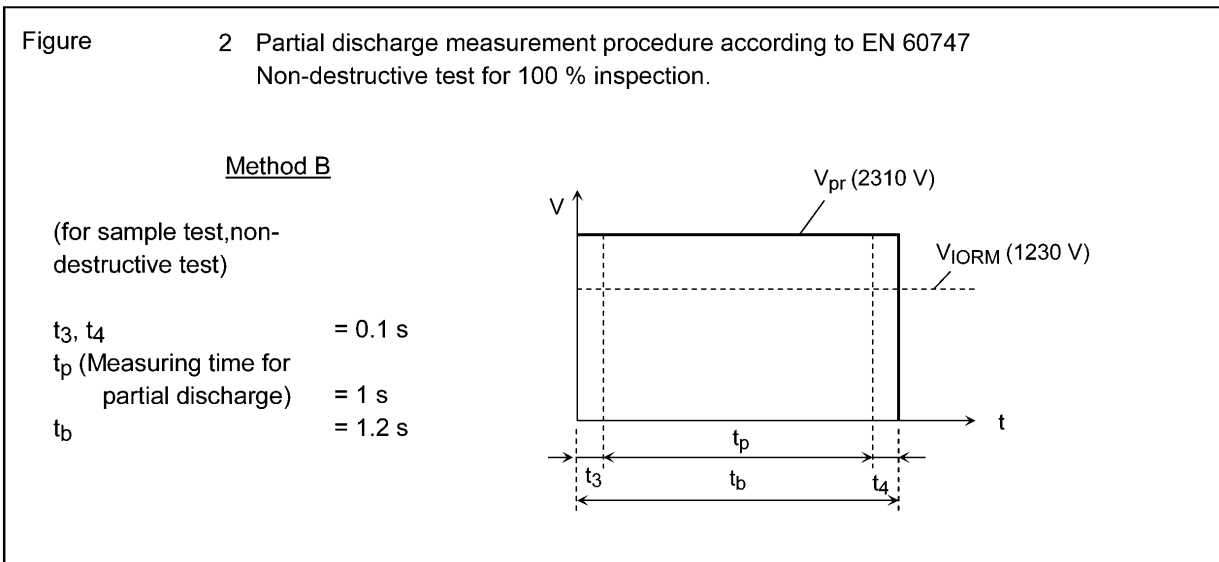
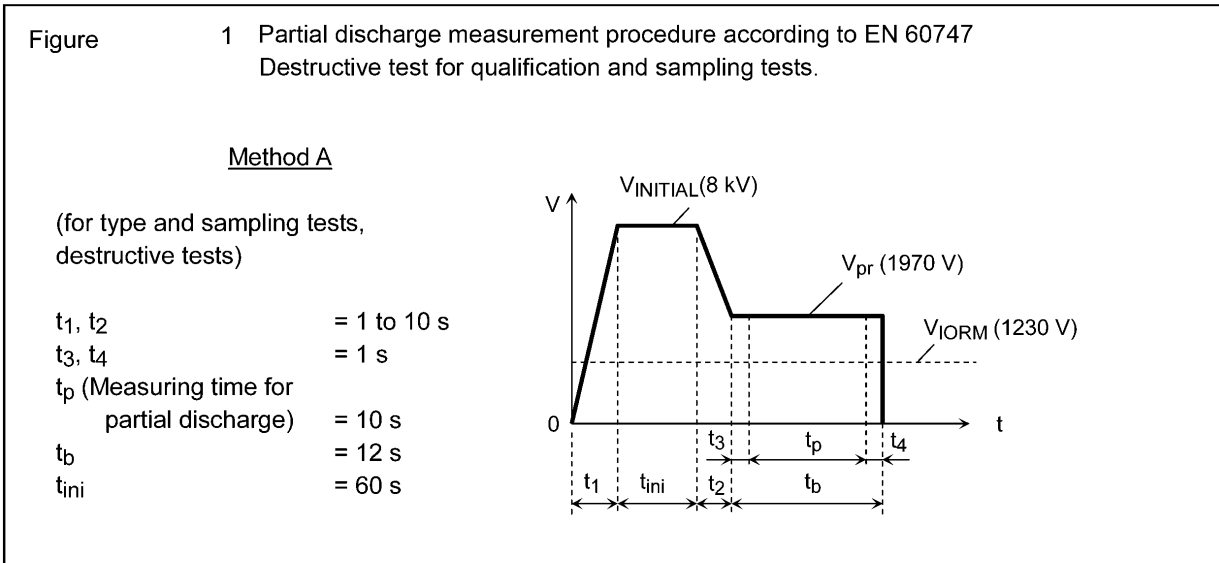


Fig. 15.4 Measurement Procedure

## 16. Ordering Information

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

Example) TLP388(GB-TPL,E 3000 pcs

Part number: TLP388

CTR rank: GB

Tape type: TPL (L direction)

[[G]]/RoHS COMPATIBLE: E (**Note 1**)

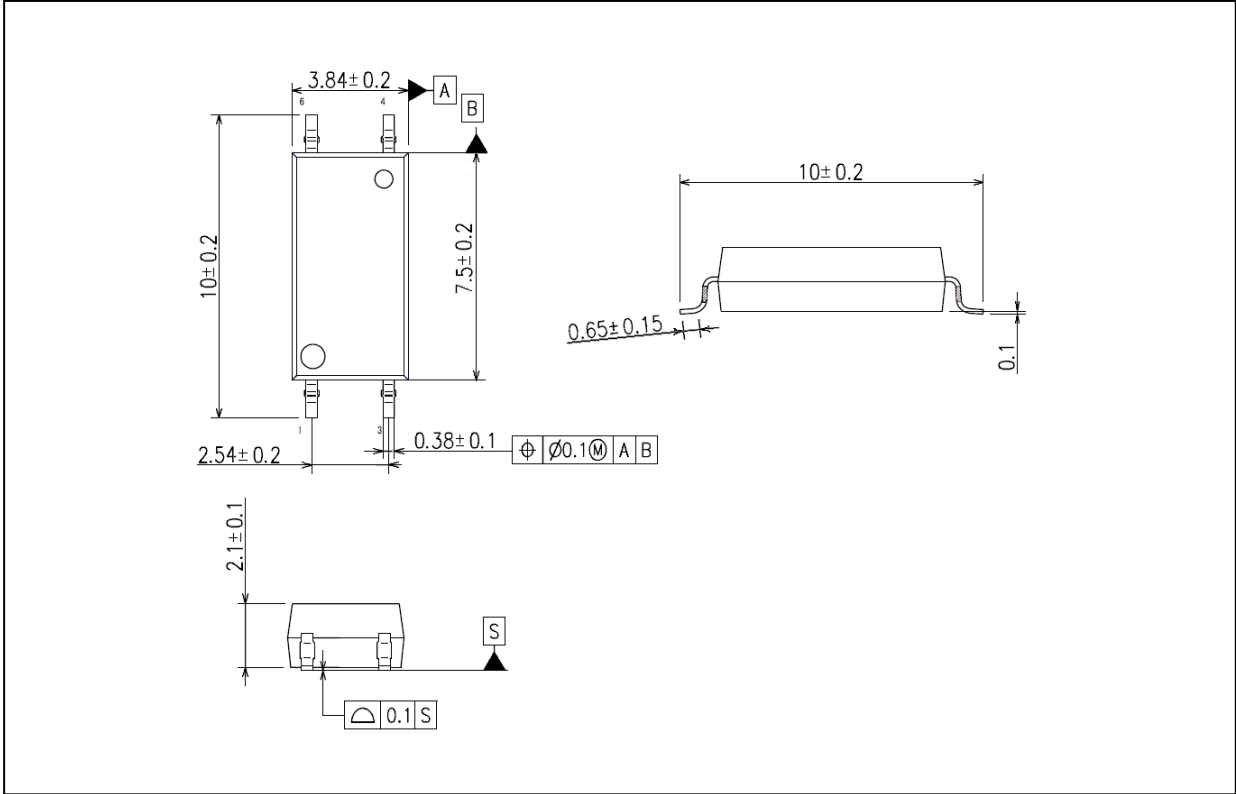
Quantity (must be a multiple of 3000): 3000 pcs

Note 1: Please contact your Toshiba sales representative for details on environmental information such as the product's RoHS compatibility.

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.

Package Dimensions

Unit: mm



Weight: 0.128 g (typ.)

Package Name(s)
TOSHIBA: 11-4P1A

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