

# TLP293

## 1. Applications

- Switching Power Supplies
- Programmable Logic Controllers (PLCs)
- I/O Interface Boards

## 2. General

TLP293 is a low input and high isolation type photocoupler that consists of a phototransistor optically coupled to an infrared LED in a SO4 package.

Since TLP293 is guaranteed high isolation voltage (3750 Vrms) and wide operating temperature ( $T_a = -55$  to  $125$  °C), it is suitable for high density surface mounting applications such as programmable controllers.

## 3. Features

- (1) Collector-emitter voltage: 80 V (min)
- (2) Current transfer ratio: 50 % (min) (@ $I_F = 0.5$  mA,  $V_{CE} = 5$  V)  
GB Rank: 100 % (min) (@ $I_F = 0.5$  mA,  $V_{CE} = 5$  V)
- (3) Isolation voltage: 3750 Vrms (min)
- (4) Operating temperature:  $-55$  to  $125$  °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**)

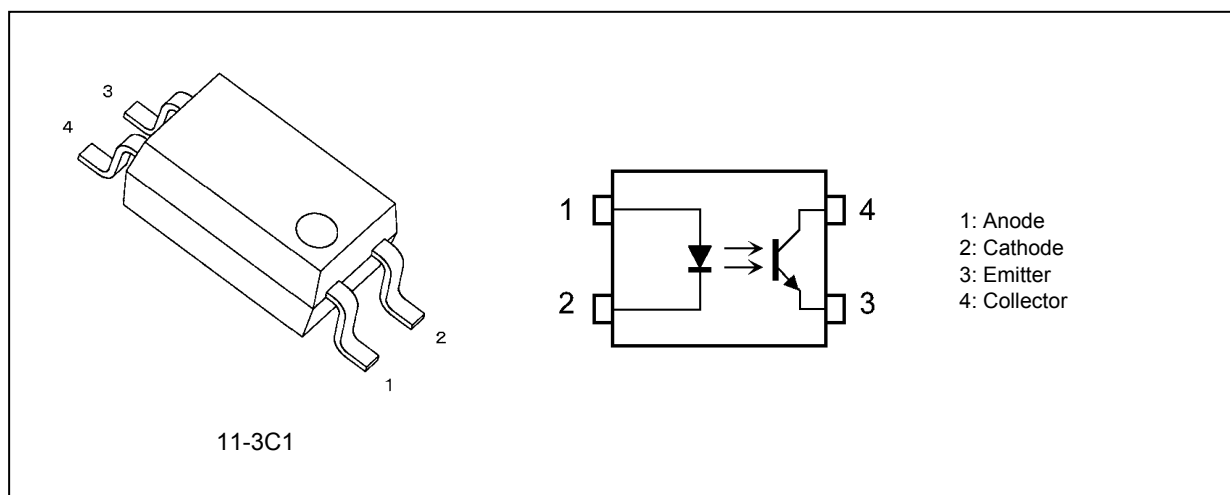
CQC-approved: GB4943.1, GB8898 Thailand Factory



仅适用于海拔 2000m 以下地区安全使用

Note 1: When a VDE approved type is needed, please designate the **Option (V4)**.

## 4. Packaging and Pin Assignment



Start of commercial production

2013-09

## 5. Mechanical Parameters

| Characteristics              | Min | Unit |
|------------------------------|-----|------|
| Creepage distances           | 5.0 | mm   |
| Clearance                    | 5.0 |      |
| 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 reverse voltage  | $V_R$                   |          | 5          | V                    |
|          | 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/ $^\circ\text{C}$ |
|          | Junction temperature   | $T_j$                   |          | 135        | $^\circ\text{C}$     |
| Detector | Collector-emitter voltage  | $V_{CEO}$               |          | 80         | 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  | $P_T$                   |          | 200        | mW                   |
|          | Total power dissipation derating ( $T_a \geq 25\text{ }^\circ\text{C}$ )     | $\Delta P_T/\Delta T_a$ |          | -1.82      | mW/ $^\circ\text{C}$ |
|          | Isolation voltage AC, 60 s, R.H. $\leq 60\%$                                 | $BV_S$                  | (Note 2) | 3750       | 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)  $\leq 0.1\text{ ms}$ ,  $f = 100\text{ Hz}$

Note 2: This device is considered as a two-terminal device: Pins 1 and 2 are shorted together, and pins 3 and 4 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               | $I_R$         |                                    | $V_R = 5\text{ V}$                                     | —   | —    | 5    | $\mu\text{A}$ |
|                               | Input capacitance                   | $C_t$         |                                    | $V = 0\text{ V}, f = 1\text{ MHz}$                     | —   | 30   | —    | pF            |
| Detector                      | Collector-emitter breakdown voltage | $V_{(BR)CEO}$ |                                    | $I_C = 0.5\text{ mA}$                                  | 80  | —    | —    | V             |
|                               | Emitter-collector breakdown voltage | $V_{(BR)ECO}$ |                                    | $I_E = 0.1\text{ mA}$                                  | 7   | —    | —    | V             |
|                               | Dark Current                        | $I_{DARK}$    |                                    | $V_{CE} = 48\text{ V}$                                 | —   | 0.01 | 0.08 | $\mu\text{A}$ |
|                               |                                     |               |                                    | $V_{CE} = 48\text{ V}, T_a = 85\text{ }^\circ\text{C}$ | —   | 2    | 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 | %             |
|                                      |                  |          |      | $I_F = 5\text{ mA}, V_{CE} = 5\text{ V}, \text{GB Rank}$   | 100 | —    | 600 |               |
|                                      |                  |          |      | $I_F = 0.5\text{ mA}, V_{CE} = 5\text{ V}$                 | 50  | —    | 600 |               |
|                                      |                  |          |      | $I_F = 0.5\text{ mA}, V_{CE} = 5\text{ V}, \text{GB Rank}$ | 100 | —    | 600 |               |
| Saturated current transfer ratio     | $I_C/I_{F(sat)}$ |          |      | $I_F = 1\text{ mA}, V_{CE} = 0.4\text{ V}$                 | —   | 60   | —   |               |
|                                      |                  |          |      | $I_F = 1\text{ mA}, V_{CE} = 0.4\text{ V}, \text{GB Rank}$ | 30  | —    | —   |               |
| Collector-emitter saturation voltage | $V_{CE(sat)}$    |          |      | $I_C = 2.4\text{ mA}, I_F = 8\text{ mA}$                   | —   | —    | 0.3 | V             |
|                                      |                  |          |      | $I_C = 0.2\text{ mA}, I_F = 1\text{ mA}$                   | —   | 0.2  | —   |               |
|                                      |                  |          |      | $I_C = 0.2\text{ mA}, I_F = 1\text{ mA}, \text{GB Rank}$   | —   | —    | 0.3 |               |
| OFF-state collector current          | $I_{C(off)}$     |          |      | $V_F = 0.7\text{ V}, V_{CE} = 48\text{ V}$                 | —   | —    | 10  | $\mu\text{A}$ |

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  | Rank short code | Note     | 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, YE, GR, GB, BL, Y+, G, G+, B | %    |
|       |                 |          | $I_F = 0.5\text{ mA}, V_{CE} = 5\text{ V}$ |  |  |                                     |      |
| Y     | —               |          | $I_F = 5\text{ mA}, V_{CE} = 5\text{ V}$   | 50                                     | 150                                    | YE                                  |      |
|       |                 |          | $I_F = 0.5\text{ mA}, V_{CE} = 5\text{ V}$ |  |  |                                     |      |
| GR    | —               |          | $I_F = 5\text{ mA}, V_{CE} = 5\text{ V}$   | 100                                    | 300                                    | GR                                  |      |
|       |                 |          | $I_F = 0.5\text{ mA}, V_{CE} = 5\text{ V}$ |  |  |                                     |      |
| GB    | —               |          | $I_F = 5\text{ mA}, V_{CE} = 5\text{ V}$   | 100                                    | 600                                    | GB, GR, BL                          |      |
|       |                 |          | $I_F = 0.5\text{ mA}, V_{CE} = 5\text{ V}$ |  |  |                                     |      |
| BL    | —               |          | $I_F = 5\text{ mA}, V_{CE} = 5\text{ V}$   | 200                                    | 600                                    | BL                                  |      |
|       |                 |          | $I_F = 0.5\text{ mA}, V_{CE} = 5\text{ V}$ |  |  |                                     |      |
| YH    | —               |          | $I_F = 0.5\text{ mA}, V_{CE} = 5\text{ V}$ | 75                                     | 150                                    | Y+                                  |      |
| GRL   | GL              | (Note 1) | $I_F = 0.5\text{ mA}, V_{CE} = 5\text{ V}$ | 100                                    | 200                                    | G                                   |      |
| GRH   | GH              | (Note 1) | $I_F = 0.5\text{ mA}, V_{CE} = 5\text{ V}$ | 150                                    | 300                                    | G+                                  |      |
| BLL   | B               | (Note 1) | $I_F = 0.5\text{ mA}, V_{CE} = 5\text{ V}$ | 200                                    | 400                                    | B                                   |      |

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

Example: TLP293(GB,E)

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

Example: TLP293(GB,E) → TLP293

Note 1: A rank in the order name is sometimes omitted like above "Rank short code".

## 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) | $V_S = 500\text{ V}$ , R.H. $\leq 60\%$ | $10^{12}$ | $10^{14}$ | —   | $\Omega$ |
| Isolation voltage                   | $BV_S$ | (Note 1) | AC, 60 s                                | 3750      | —         | —   | Vrms     |

Note 1: This device is considered as a two-terminal device: Pins 1 and 2 are shorted together, and pins 3 and 4 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       | $t_r$     |      | $V_{CC} = 10\text{ V}$ , $I_C = 2\text{ mA}$ ,<br>$R_L = 100\ \Omega$         | —   | 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   | —   | 1.3  | —   |               |
| Storage time    | $t_s$     |      | $R_L = 1.9\text{ k}\Omega$ , $V_{CC} = 5\text{ V}$ ,<br>$I_F = 16\text{ mA}$  | —   | 20   | —   |               |
| Turn-off time   | $t_{off}$ |      |   | —   | 35   | —   |               |
| Turn-on time    | $t_{on}$  |      | See Fig. 10.1   | —   | 10   | —   |               |
| Storage time    | $t_s$     |      | $R_L = 4.7\text{ k}\Omega$ , $V_{CC} = 5\text{ V}$ ,<br>$I_F = 1.6\text{ mA}$ | —   | 9    | —   |               |
| Turn-off time   | $t_{off}$ |      |   | —   | 47   | —   |               |

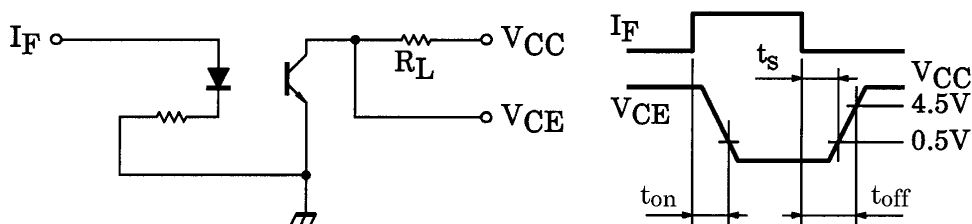
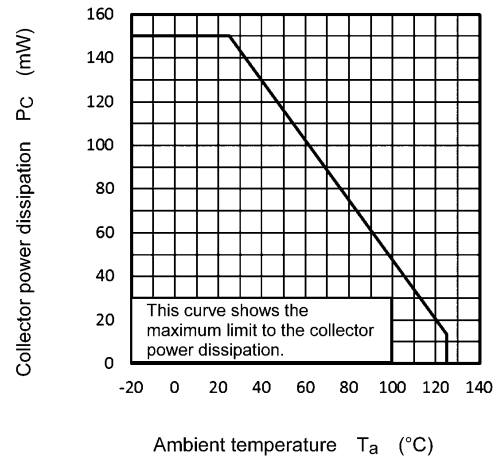


Fig. 10.1 Switching Time Test Circuit and Waveform

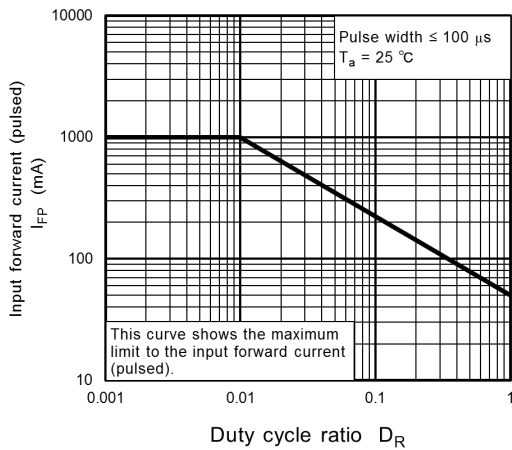
## 11. Characteristics Curves (Note)



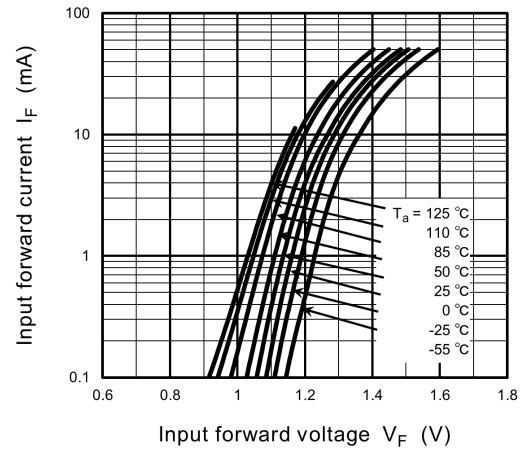
**Fig. 11.1**  $I_F - T_a$



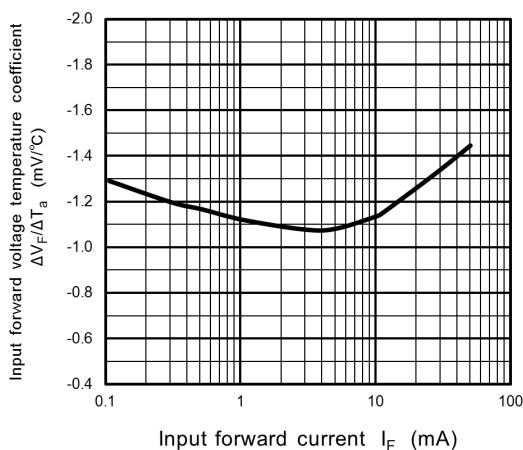
**Fig. 11.2**  $P_C - T_a$



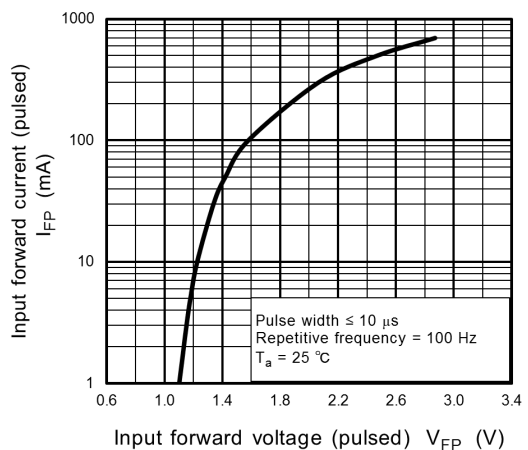
**Fig. 11.3**  $I_{FP} - D_R$



**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  $I_C - T_a$

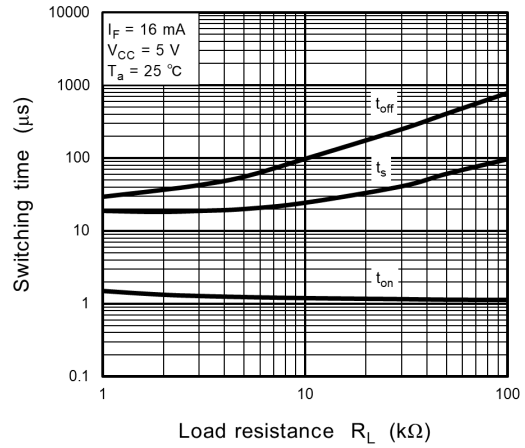


Fig. 11.14 Switching Time -  $R_L$

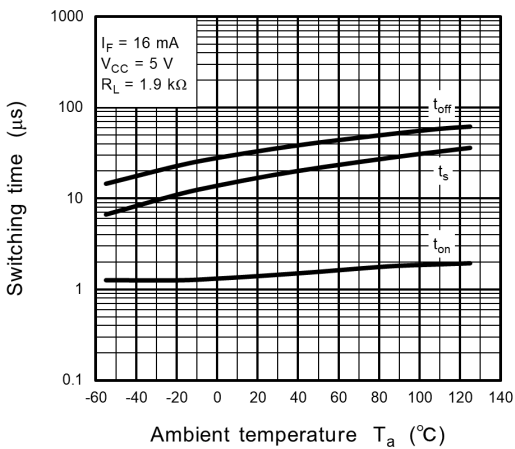


Fig. 11.15 Switching Time -  $T_a$

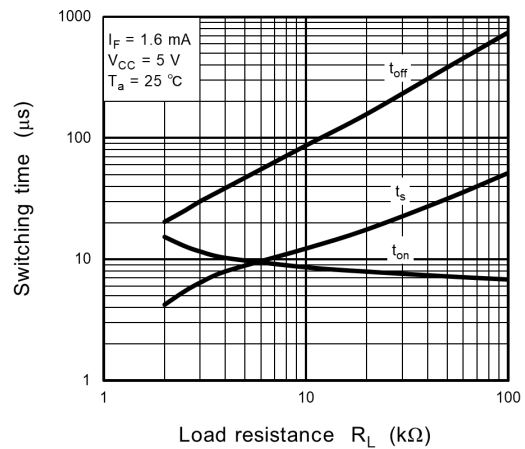


Fig. 11.16 Switching Time -  $R_L$

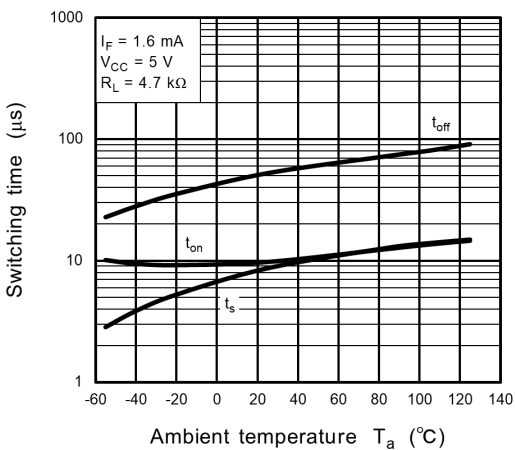


Fig. 11.17 Switching Time -  $T_a$

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.

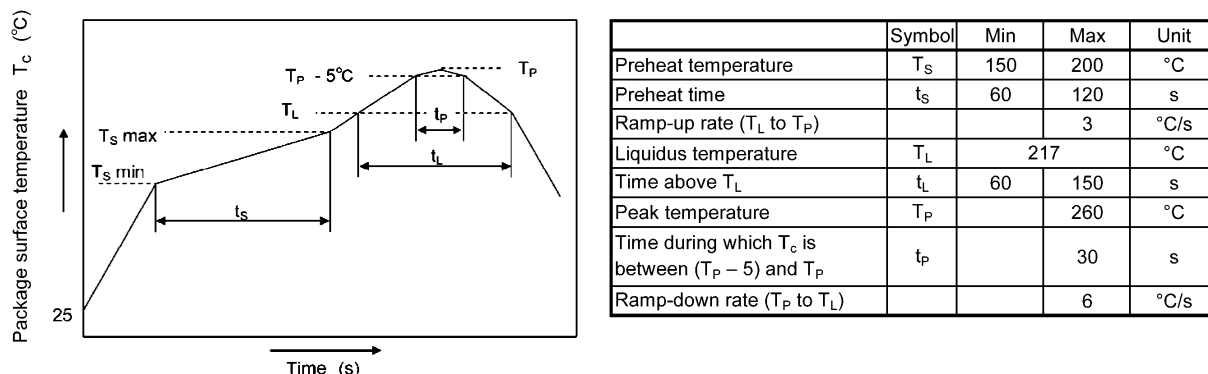
- When using soldering reflow.

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.



**Fig. 12.1.1 An Example of a Temperature Profile When Lead(Pb)-Free Solder Is Used**

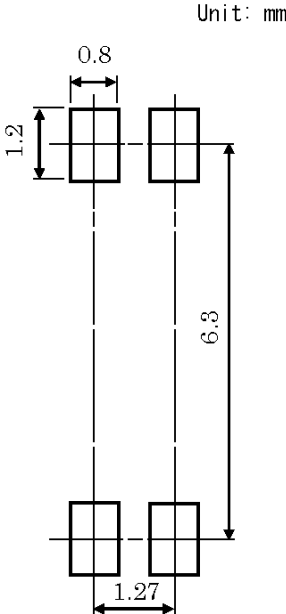
- When using soldering flow  
Preheat the device at a temperature of 150 °C (package surface temperature) for 60 to 120 seconds.  
Mounting condition of 260 °C within 10 seconds is recommended.  
Flow soldering must be performed once.
- When using soldering Iron  
Complete soldering within 10 seconds 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

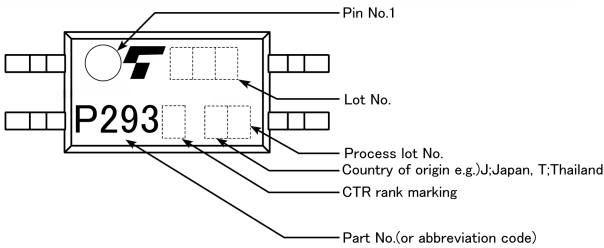
- Avoid storage locations where devices may be exposed to moisture or direct sunlight.
- Follow the precautions printed on the packing label of the device for transportation and storage.
- Keep the storage location temperature and humidity within a range of 5 °C to 35 °C and 45 % to 75 %, respectively.
- 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 (V4) Specification

- Part number: TLP293 (**Note 1**)
- The following part naming conventions are used for the devices that have been qualified according to option (V4) of EN 60747.

Example: TLP293(V4GR-TL,E

V4: EN 60747 option

GR: CTR rank

TL: Tape type (L direction: TPL)

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

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

e.g., TLP293(V4GR-TL,E → TLP293

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<br>for rated mains voltage $\leq 150$ Vrms<br>for rated mains voltage $\leq 300$ Vrms   |                               | I-IV<br>I-III                                   | —              |
| Climatic classification  |                               | 55 / 125 / 21                                   | —              |
| Pollution degree   |                               | 2   | —              |
| Maximum operating insulation voltage   | VIORM                         | 707   | Vpeak          |
| Input to output test voltage, Method A<br>$V_{pr} = 1.6 \times VIORM$ , type and sample test<br>$t_p = 10$ s, partial discharge $< 5$ pC   | $V_{pr}$                      | 1131  | Vpeak          |
| Input to output test voltage, Method B<br>$V_{pr} = 1.875 \times VIORM$ , 100 % production test<br>$t_p = 1$ s, partial discharge $< 5$ pC   | $V_{pr}$                      | 1330  | Vpeak          |
| Highest permissible overvoltage<br>(transient overvoltage, $t_{pr} = 60$ s)  | VTR                           | 6000  | Vpeak          |
| Safety limiting values (max. permissible ratings in case of fault,<br>also refer to thermal derating curve)<br>current (input current $I_F$ , $P_{SO} = 0$ )<br>power (output or total power dissipation)<br>temperature | $I_{si}$<br>$P_{SO}$<br>$T_s$ | 250<br>400<br>150                               | mA<br>mW<br>°C |
| Insulation resistance<br>$V_{IO} = 500$ V, $T_a = 25$ °C<br>$V_{IO} = 500$ V, $T_a = 100$ °C<br>$V_{IO} = 500$ V, $T_a = T_s$  | $R_{si}$                      | $\geq 10^{12}$<br>$\geq 10^{11}$<br>$\geq 10^9$ | $\Omega$       |

Fig. 15.1 EN 60747 Insulation Characteristics

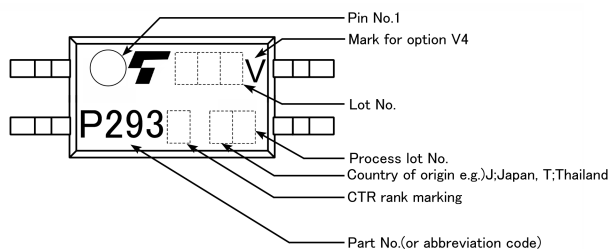
**Table 15.1 Insulation Related Specifications (Note)**

| Insulation Related Parameters | Symbol | TLP293 |
|-------------------------------|--------|--------|
| Minimum creepage distance     | Cr     | 5.0 mm |
| Minimum clearance             | Cl     | 5.0 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 for EN 60747**



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

Note: The above marking is applied to the photocouplers that have been qualified according to option (V4) of EN 60747.

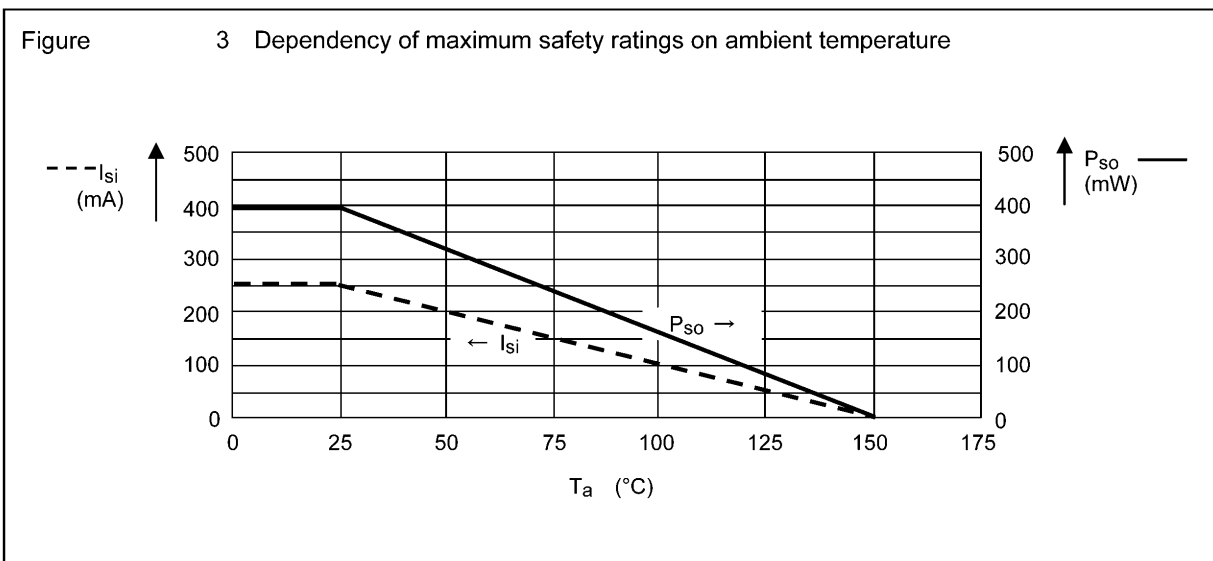
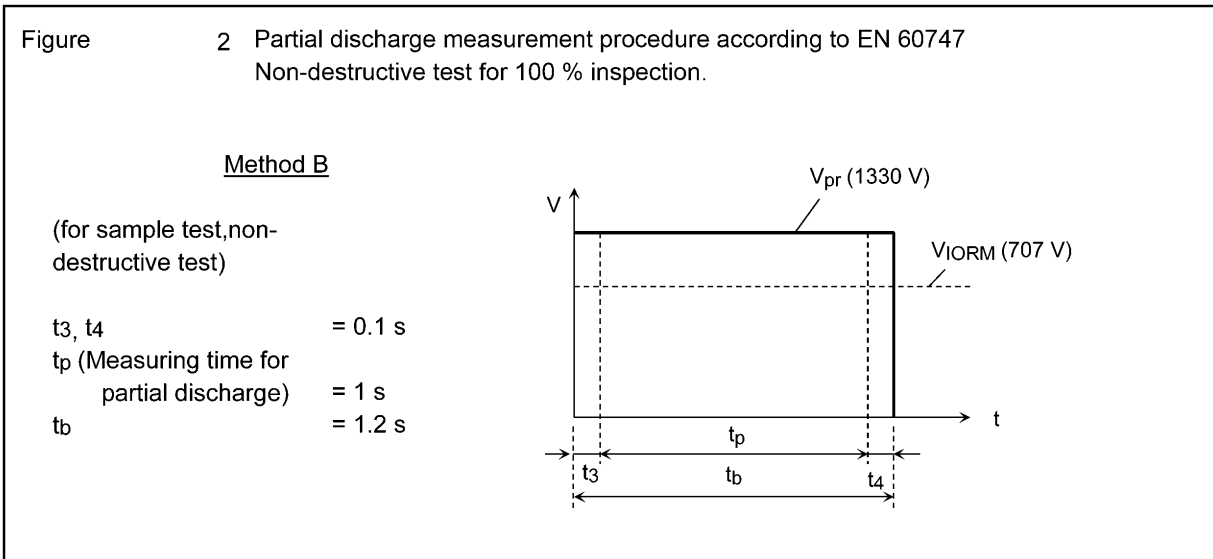
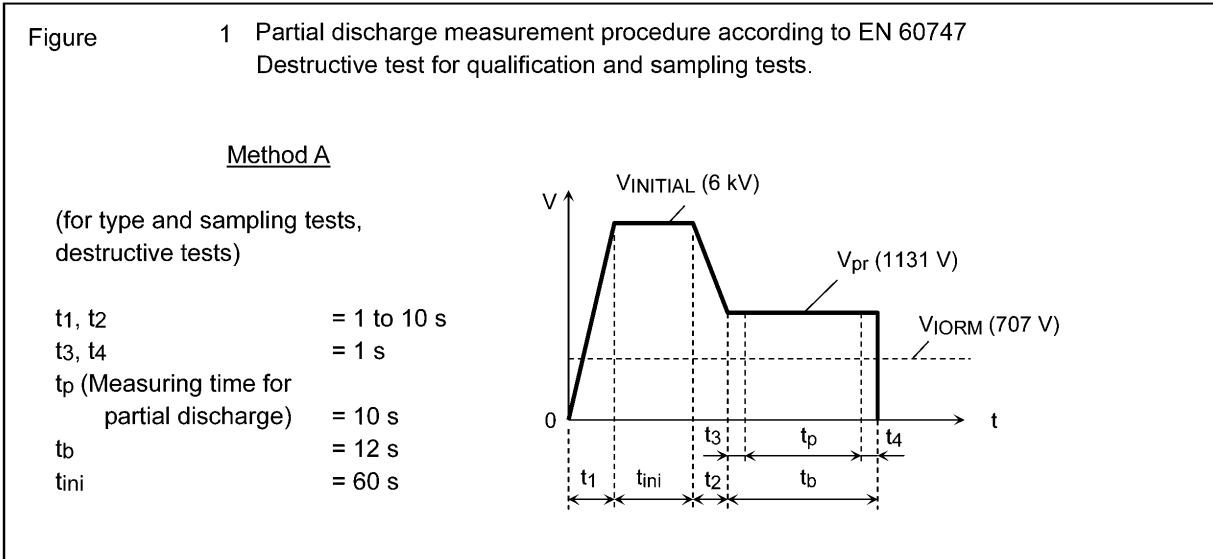


Fig. 15.4 Measurement Procedure

## 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) TLP293(GR-TPL,E 5000 pcs

Part number: TLP293

CTR rank: GR

Tape type: TPL (L direction)

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

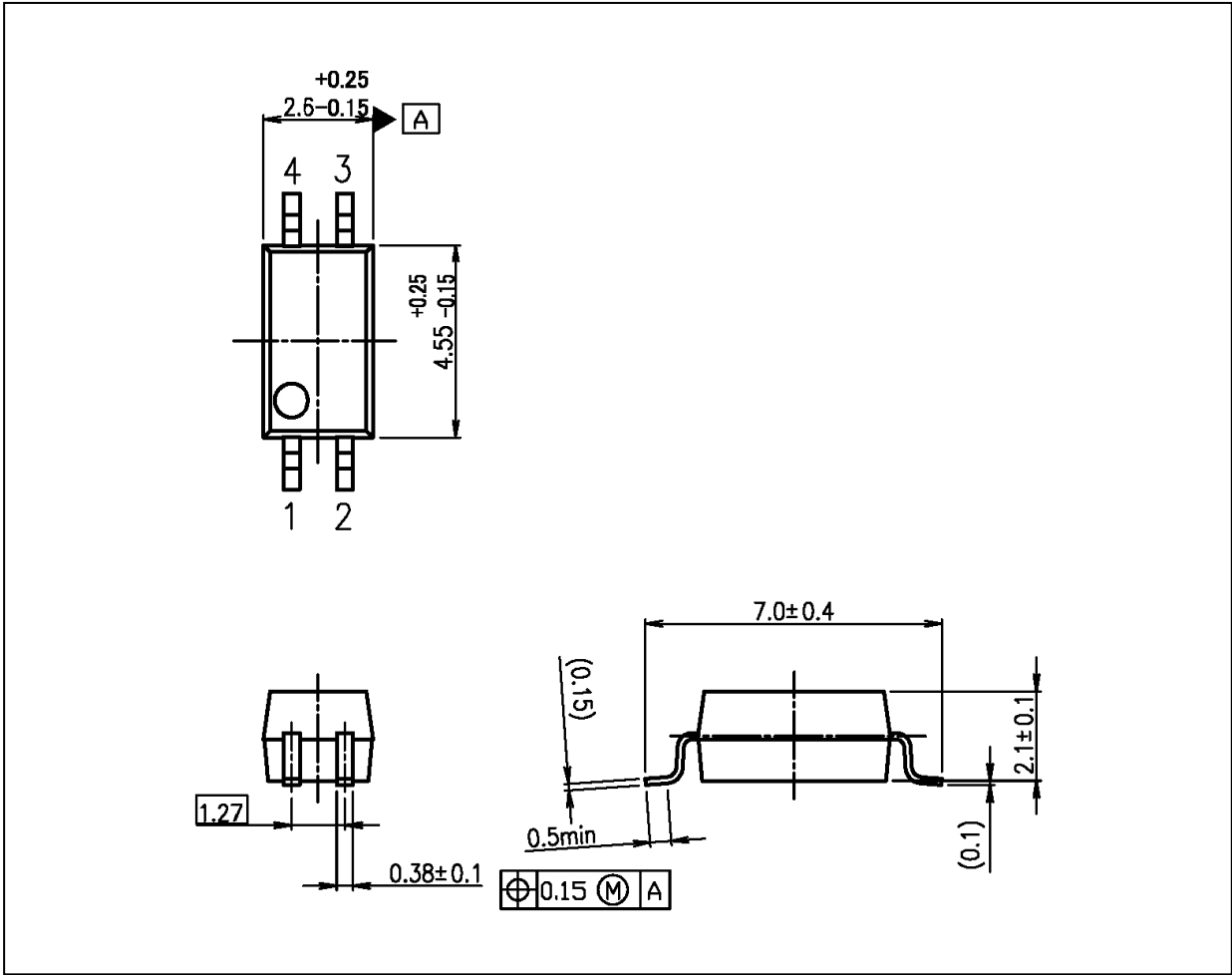
Quantity (must be a multiple of 2500): 5000 pcs

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: 0.05 g (typ.)

| Package Name(s) |
|-----------------|
| TOSHIBA: 11-3C1 |

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