

# TLP2301

## 1. Applications

- Industrial Inverters
- Communications Equipment
- Home Electric Appliances

## 2. General

The Toshiba TLP2301 consists of a high-speed detector based on the photo-transistor optically coupled to infrared LED. It is housed in the SO6 package. The TLP2301 has realized the early switching characteristics by several kΩ resistance. The TLP2301 correspond to the transmission rate of 20 kbps, and has become a product which fills between a general-purpose transistor coupler and IC couplers corresponding to 1 Mbps.

## 3. Features

- (1) Collector-emitter voltage: 40 V (min)
- (2) Current transfer ratio: 50% (min) (@ $I_F = 1 \text{ mA}$ ,  $V_{CE} = 5 \text{ V}$ )  
GB Rank: 100% (min) (@ $I_F = 1 \text{ mA}$ ,  $V_{CE} = 5 \text{ V}$ )
- (3) Isolation voltage: 3750 Vrms (min)
- (4) Propagation delay time:  $t_{pHL} = 30 \mu\text{s}$  (max),  $t_{pLH} = 30 \mu\text{s}$  (max) @  $I_F = 1 \text{ mA}$ ,  $R_L = 10 \text{ k}\Omega$ ,  $T_a = 25 \text{ }^\circ\text{C}$
- (5) Operating temperature: -55 to 125 °C
- (6) 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**)

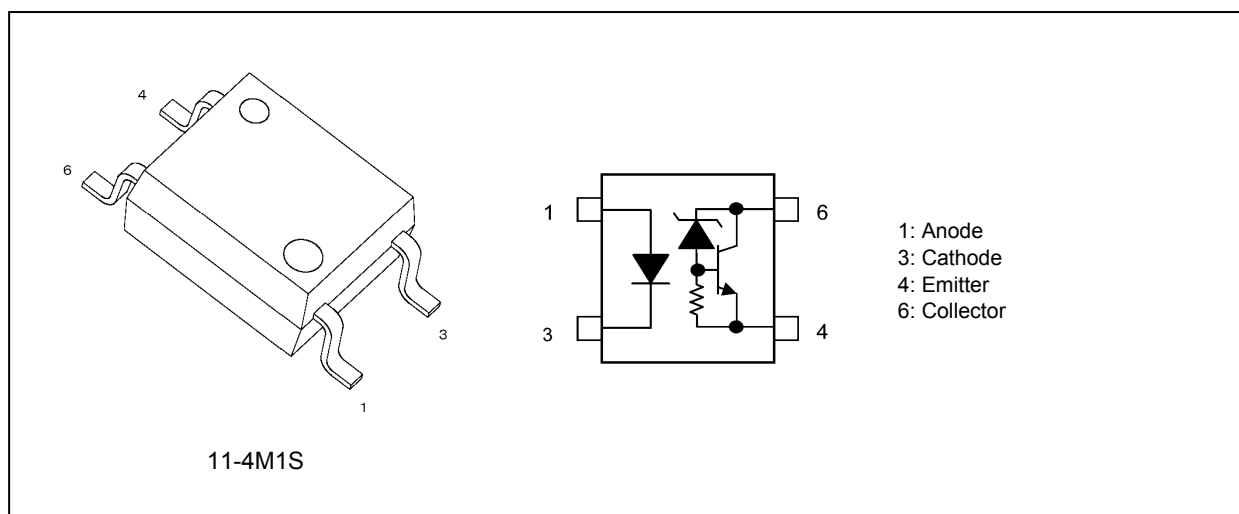
CQC-approved: GB4943.1, GB8898 Japan and Thailand Factory



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

2013-03

## 5. Principle of Operation

### 5.1. 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  | $V_{CEO}$                 |          | 40         | 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 |                      |
|          | Lead soldering temperature (10 s)  | $T_{sol}$                 |          | 260        | $^\circ\text{C}$     |
|          | Total power dissipation  | $P_T$                     |          | 200        | mW                   |
| Common   | 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 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 | $V_{(BR)CEO}$ |      | $I_C = 0.1\text{ mA}$                                  | 40  | —    | —    | V             |
|          | Emitter-collector breakdown voltage | $V_{(BR)ECO}$ |      | $I_E = 0.1\text{ mA}$                                  | 7   | —    | —    | V             |
|          | Dark Current                        | $I_{DARK}$    |      | $V_{CE} = 40\text{ V}$                                 | —   | 0.01 | 0.08 | $\mu\text{A}$ |
|          |                                     |               |      | $V_{CE} = 40\text{ V}, T_a = 85\text{ }^\circ\text{C}$ | —   | 2    | 50   | $\mu\text{A}$ |
|          | 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               |                 | $I_C/I_F$        | (Note1) | $I_F = 1\text{ mA}, V_{CE} = 5\text{ V}$                   | 50  | —    | 600 | %             |
|                                      |                 |                  |         | $I_F = 1\text{ mA}, V_{CE} = 5\text{ V}, \text{GB Rank}$   | 100 | —    | 600 |               |
| Saturated current transfer ratio     |                 | $I_C/I_{F(sat)}$ |         | $I_F = 1\text{ mA}, V_{CE} = 0.3\text{ V}$                 | —   | 100  | —   | %             |
|                                      |                 |                  |         | $I_F = 1\text{ mA}, V_{CE} = 0.3\text{ V}, \text{GB Rank}$ | 50  | —    | —   |               |
| 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          |                 | $I_{C(off)}$     |         | $V_F = 0.7\text{ V}, V_{CE} = 40\text{ V}$                 | —   | 1    | 10  | $\mu\text{A}$ |

Note1: See Table 9.1 for current transfer ratio.

**Table 9.1 Current Transfer Ratio (CTR) Rank (Note) (Unless otherwise specified,  $T_a = 25\text{ }^\circ\text{C}$ )**

| Rank | Test Condition                           | Current transfer ratio<br>$I_C/I_F$<br>Min | Current transfer ratio<br>$I_C/I_F$<br>Max | Marking of<br>classification | Unit |
|------|--|--|--|------------------------------|------|
| None | $I_F = 1\text{ mA}, V_{CE} = 5\text{ V}$ | 50   | 600  | Blank, GB                    | %    |
| GB   |  | 100  | 600  | GB                           |      |

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

Example: TLP2301(GB)

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

Example: TLP2301(GB,E: TLP2301)

## 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                                    | 3750      | —         | —   | Vrms     |

Note 1: This device is considered as a two-terminal device: 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          |
|------------------------------|-----------|------|--|-----|------|-----|---------------|
| Propagation delay time (H/L) | $t_{pHL}$ |      | See figure 10.1<br>$V_{CC} = 5\text{ V}$ , $I_F = 1\text{ mA}$ , $R_L = 10\text{ k}\Omega$ | —   | 8    | 30  | $\mu\text{s}$ |
| Propagation delay time (L/H) | $t_{pLH}$ |      | See figure 10.1<br>$V_{CC} = 5\text{ V}$ , $I_F = 1\text{ mA}$ , $R_L = 10\text{ k}\Omega$ | —   | 15   | 30  | $\mu\text{s}$ |

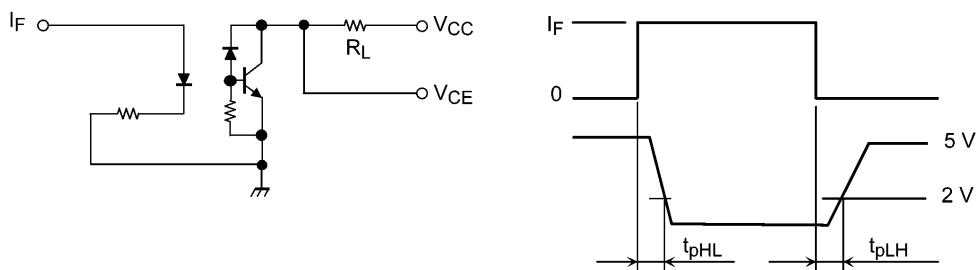
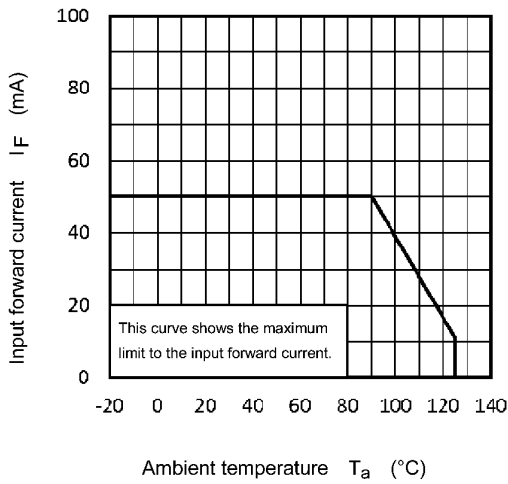
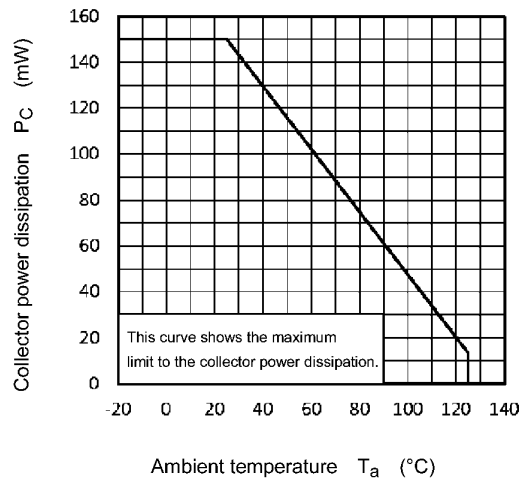


Fig. 10.1 Propagation delay Time Test Circuit and Waveform

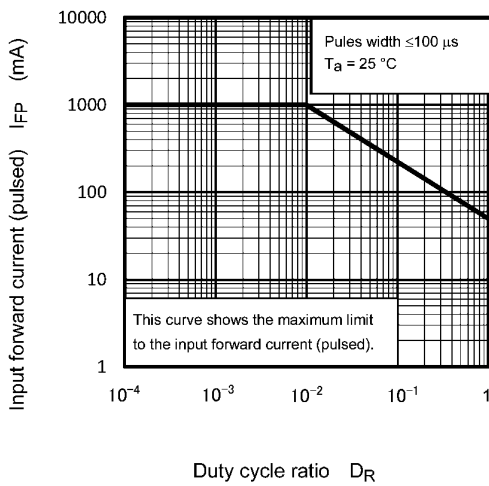
## 11. Characteristics Curves (Note)



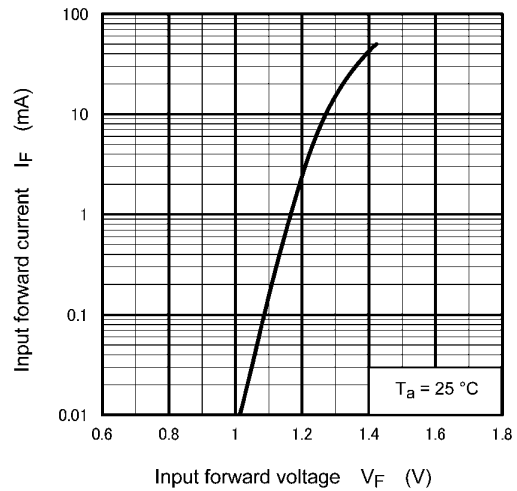
**Fig. 11.1**  $I_F - T_a$



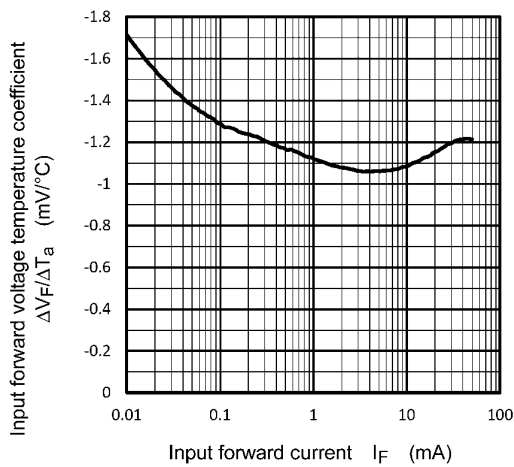
**Fig. 11.2**  $P_C - T_a$



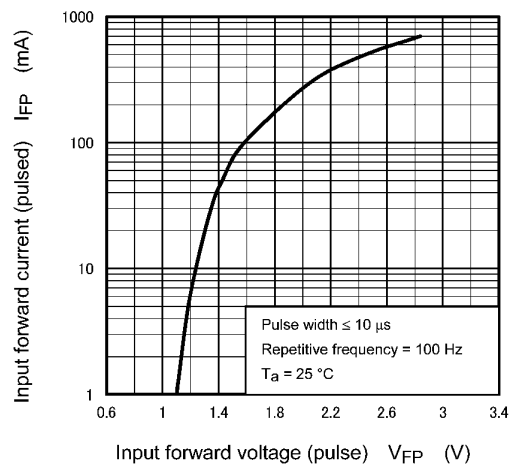
**Fig. 11.3**  $I_{FP} - D_R$



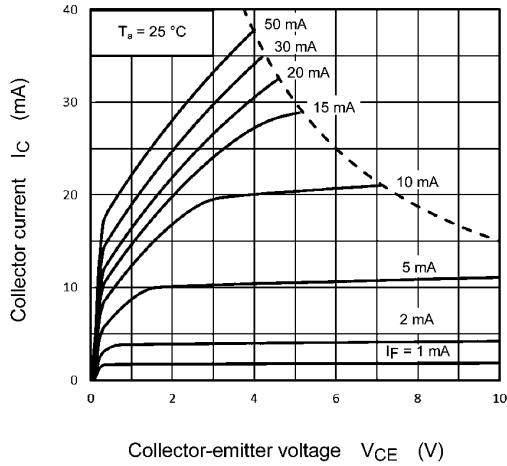
**Fig. 11.4**  $I_F - V_F$



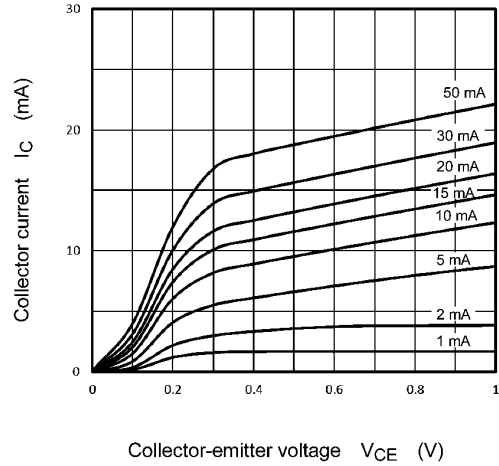
**Fig. 11.5**  $\Delta V_F / \Delta T_a - I_F$



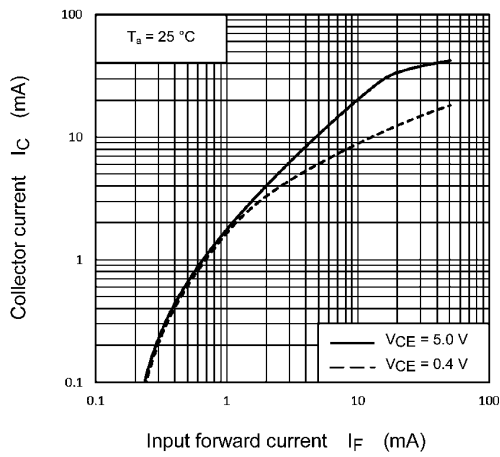
**Fig. 11.6**  $I_{FP} - V_{FP}$



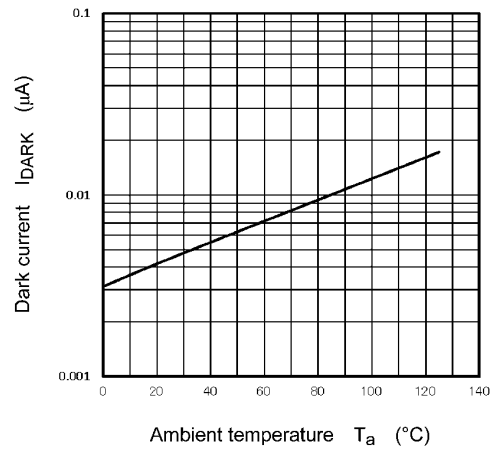
**Fig. 11.7**  $I_C - V_{CE}$



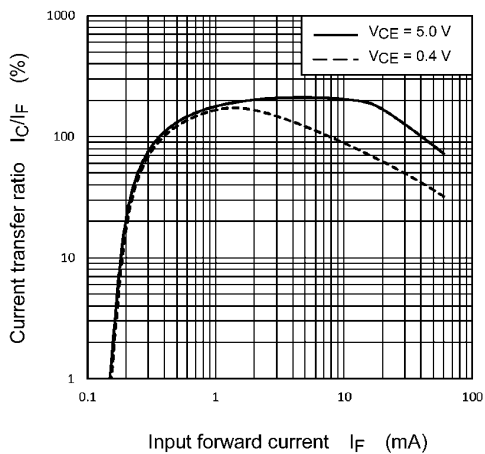
**Fig. 11.8**  $I_C - V_{CE}$



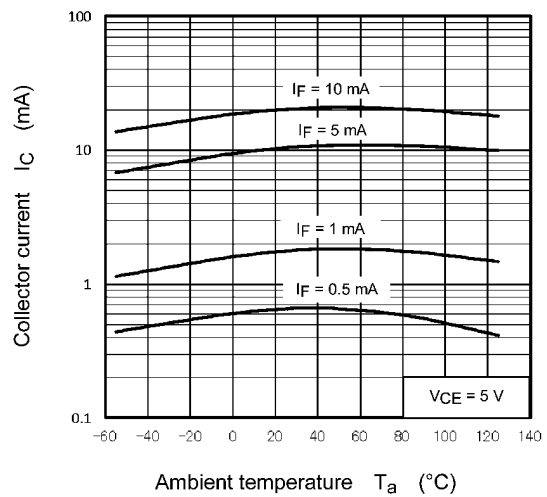
**Fig. 11.9**  $I_C - I_F$



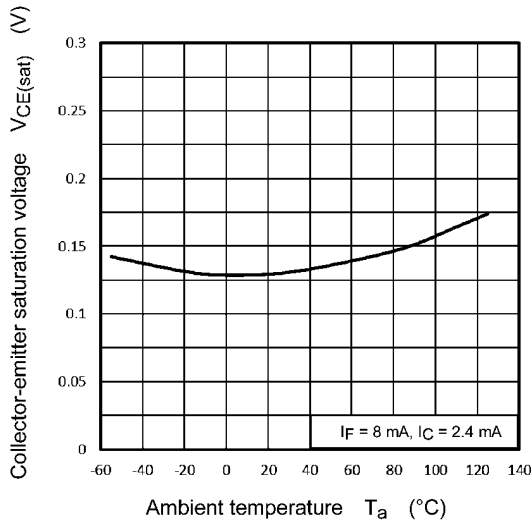
**Fig. 11.10**  $I_{DARK} - T_a$



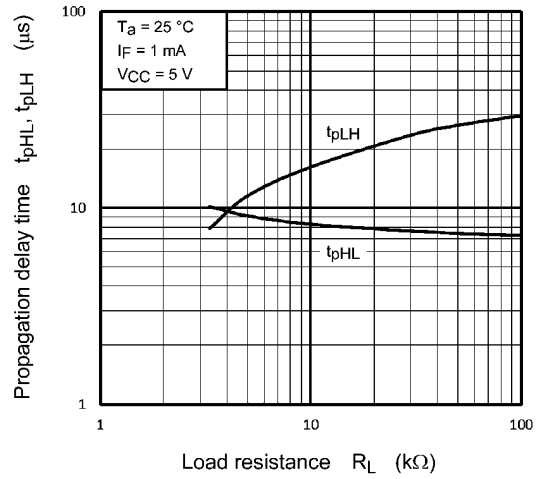
**Fig. 11.11**  $I_C/I_F - I_F$



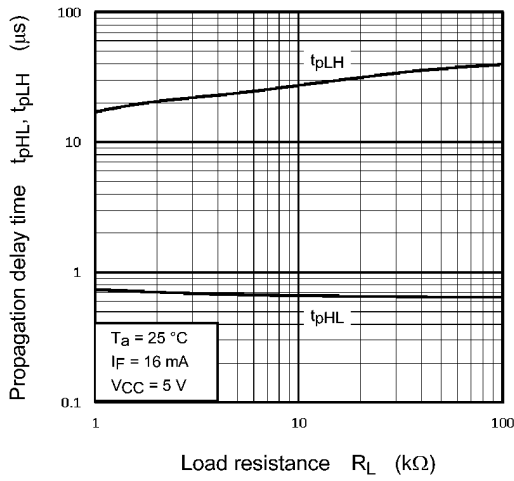
**Fig. 11.12**  $I_C - T_a$



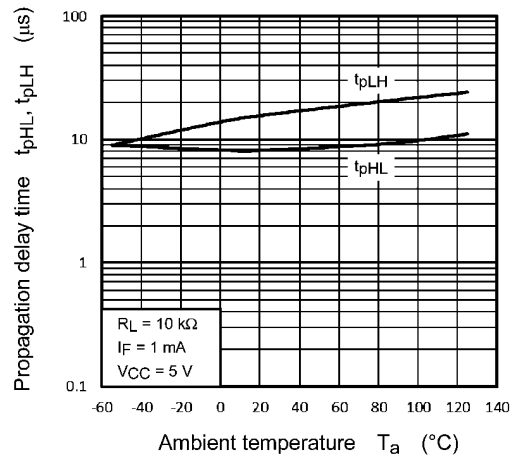
**Fig. 11.13**  $V_{CE(sat)} - T_a$



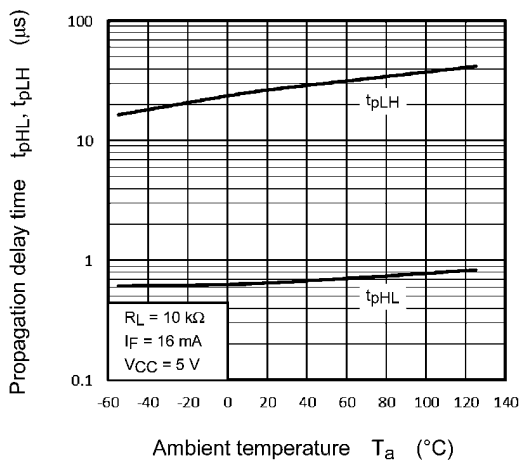
**Fig. 11.14**  $t_{pHL}, t_{pLH} - R_L$



**Fig. 11.15**  $t_{pHL}, t_{pLH} - R_L$



**Fig. 11.16**  $t_{pHL}, t_{pLH} - T_a$



**Fig. 11.17**  $t_{pHL}, t_{pLH} - T_a$

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.

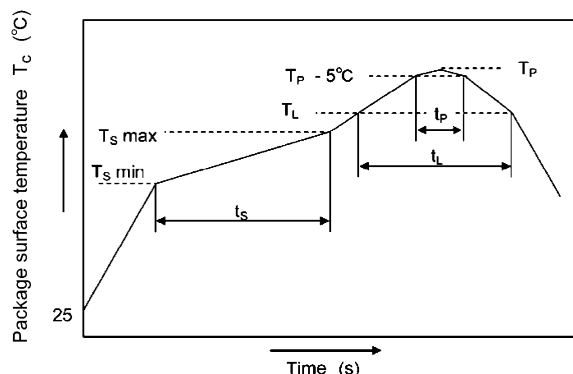
- When using soldering reflow.

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.



|  | 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**

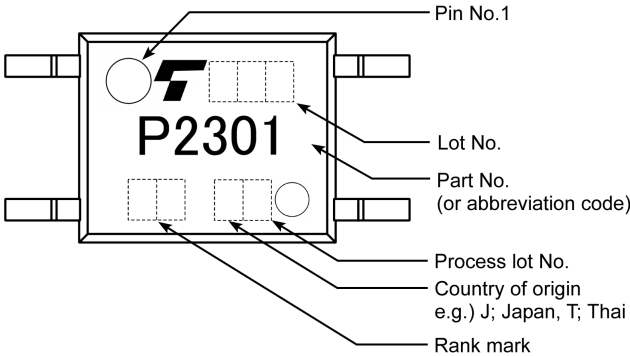
- When using soldering flow  
Preheat the device at a temperature of 150 °C (package surface temperature) for 60 to 120 seconds.  
Mounting condition of 260 °C within 10 seconds is recommended.  
Flow soldering must be performed once.
- When using soldering Iron  
Complete soldering within 10 seconds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

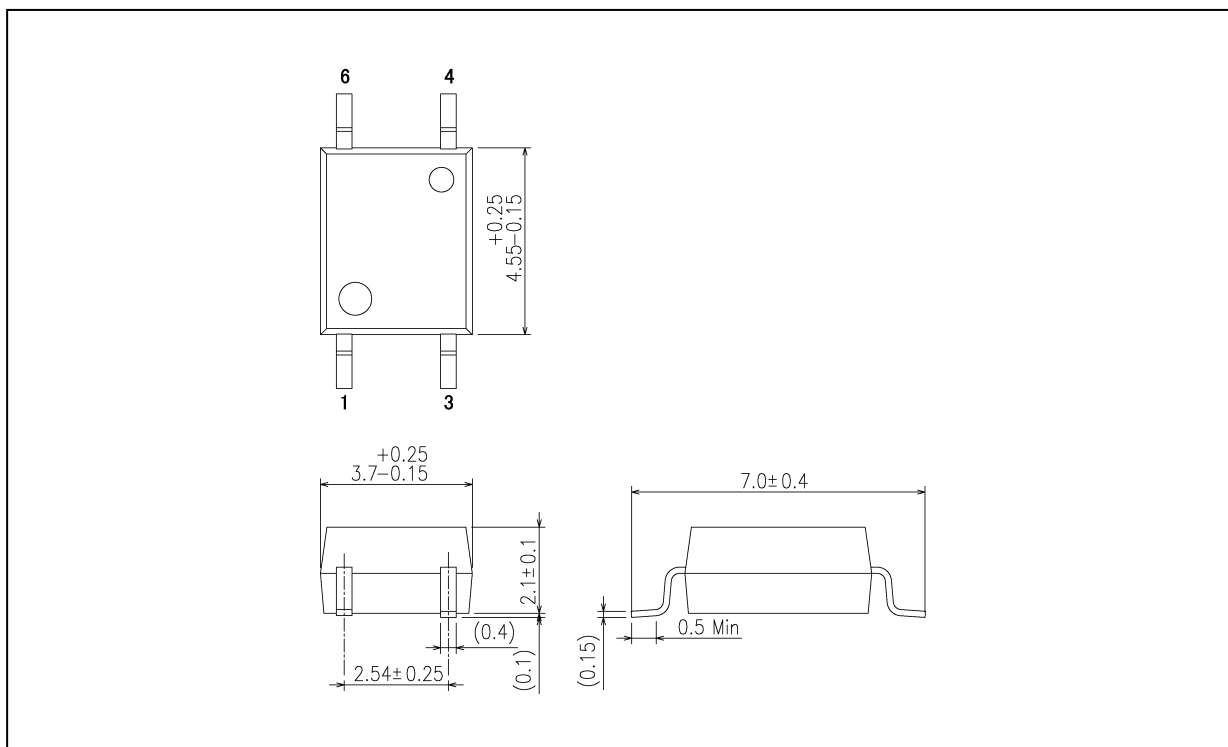


**13. Marking**



## Package Dimensions

Unit: mm



Weight: 0.08 g (typ.)

| Package Name(s)  |
|------------------|
| TOSHIBA: 11-4M1S |

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