

# TLP2309

## 1. Applications

- Transistor Inverters
- Switching Power Supplies
- High-Speed Digital Interfacing

## 2. General

The Toshiba TLP2309 consists of a high-output GaAs light-emitting diode coupled with a high-speed photo-diode-transistor chip. It is housed in the SO6 package.

The TLP2309 guarantees operation at up to 110°C and on supplies both 3.3 V and 5 V. Also, since the TLP2309 guarantees a creepage / clearance distance  $\geq 5$  mm and internal isolation thickness  $\geq 0.4$  mm, this product is in the reinforced insulation class according to international safety standards.

## 3. Features

- (1) Inverter logic type (open collector output)
- (2) Package: SO6
- (3) Operating temperature: -40 to 110 °C
- (4) Supply voltage: 3.3 V / 5 V
- (5) Data transfer rate: 1 Mbit/s (typ.) (NRZ)
- (6) Common-mode transient immunity: 15 kV/ $\mu$ s (min)
- (7) Isolation voltage: 3750 Vrms (min)
- (8) Safety standards

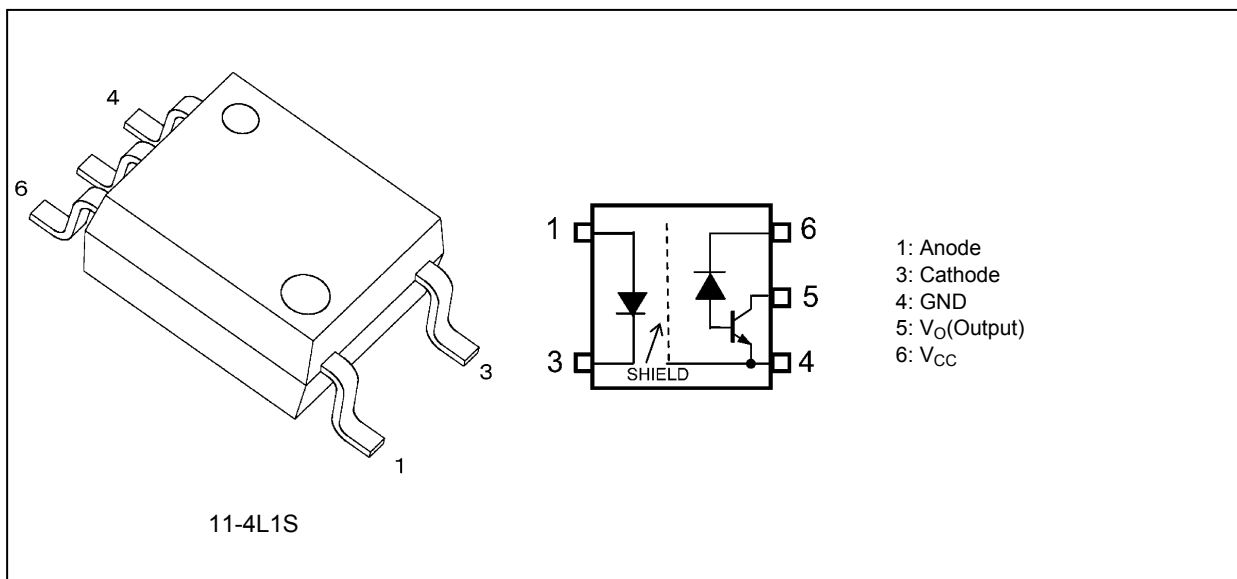
UL-approved: UL1577 File No.E67349

cUL-approved: CSA Component Acceptance Service No.5A, File No.E67349

VDE-approved: Option (V4) EN60747-5-5(Note)

Note: When an EN60747-5-5 approved type is needed, please designate the Option (V4).

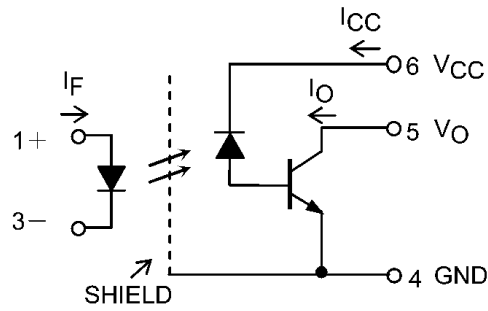
## 4. Packaging and Pin Configuration



Start of commercial production

2011-04

**5. Internal Circuit**



**Fig. 5.1 Internal Circuit**

**6. Principle of Operation**

**6.1. Truth Table**

| Input | LED | Output |
|-------|-----|--------|
| H     | ON  | L      |
| L     | OFF | H      |

**6.2. Mechanical Parameters**

| Characteristics              | Min | Unit |
|------------------------------|-----|------|
| Creepage distances           | 5.0 | mm   |
| Clearance distances          | 5.0 |      |
| Internal isolation thickness | 0.4 |      |

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

|          | Characteristics   | Symbol                      | Note     | Rating     | Unit                 |
|----------|---|-----------------------------|----------|------------|----------------------|
| LED      | Input forward current   | $I_F$                       |          | 25         | mA                   |
|          | Input forward current derating ( $T_a \geq 100\text{ }^\circ\text{C}$ )               | $\Delta I_F/\Delta T_a$     |          | -1.0       | mA/ $^\circ\text{C}$ |
|          | Input forward current (pulsed)  | $I_{FP}$                    | (Note 1) | 50         | mA                   |
|          | Input forward current derating (pulsed) ( $T_a \geq 100\text{ }^\circ\text{C}$ )      | $\Delta I_{FP}/\Delta T_a$  |          | -2.0       | mA/ $^\circ\text{C}$ |
|          | Peak transient input forward current  | $I_{FPT}$                   | (Note 2) | 1          | A                    |
|          | Peak transient input forward current derating ( $T_a \geq 85\text{ }^\circ\text{C}$ ) | $\Delta I_{FPT}/\Delta T_a$ |          | -25        | mA/ $^\circ\text{C}$ |
|          | Input power dissipation   | $P_D$                       |          | 40         | mW                   |
|          | Input power dissipation derating ( $T_a \geq 100\text{ }^\circ\text{C}$ )             | $\Delta P_D/\Delta T_a$     |          | -1.6       | mW/ $^\circ\text{C}$ |
|          | Input reverse voltage   | $V_R$                       |          | 5          | V                    |
| Detector | Output current  | $I_O$                       |          | 8          | mA                   |
|          | Peak output current   | $I_{OP}$                    |          | 16         |                      |
|          | Supply voltage  | $V_{CC}$                    |          | -0.5 to 30 | V                    |
|          | Output voltage  | $V_O$                       |          | -0.5 to 20 |                      |
|          | Output power dissipation  | $P_O$                       |          | 100        | mW                   |
|          | Output power dissipation derating ( $T_a \geq 100\text{ }^\circ\text{C}$ )            | $\Delta P_O/\Delta T_a$     |          | -4.0       | mW/ $^\circ\text{C}$ |
| Common   | Operating temperature   | $T_{opr}$                   |          | -40 to 110 | $^\circ\text{C}$     |
|          | Storage temperature   | $T_{stg}$                   |          | -55 to 125 |                      |
|          | Lead soldering temperature (10 s)   | $T_{sol}$                   |          | 260        |                      |
|          | Isolation voltage AC, 60 s, R.H. $\leq 60\%$  | $BV_S$                      | (Note 3) | 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)  $\leq 1\text{ ms}$ , duty = 50 %

Note 2: Pulse width (PW)  $\leq 1\text{ }\mu\text{s}$ , 300 pps

Note 3: This device is considered as a two-terminal device: Pins 1 and 3 are shorted together, and pins 4, 5 and 6 are shorted together.

## 8. Recommended Operating Conditions (Note)

| Characteristics         | Symbol       | Note     | Min | Typ.    | Max | Unit             |
|-------------------------|--------------|----------|-----|---------|-----|------------------|
| Input on-state current  | $I_{F(ON)}$  |          | 10  | —       | 20  | mA               |
| Input off-state voltage | $V_{F(OFF)}$ |          | 0   | —       | 0.8 | V                |
| Supply voltage          | $V_{CC}$     |          | 2.7 | 3.3 / 5 | 20  |                  |
| Operating temperature   | $T_{opr}$    | (Note 1) | -40 | —       | 110 | $^\circ\text{C}$ |

Note: The recommended operating conditions are given as a design guide necessary to obtain the intended performance of the device. Each parameter is an independent value. When creating a system design using this device, the electrical characteristics specified in this datasheet should also be considered.

Note: A ceramic capacitor (0.1  $\mu\text{F}$ ) should be connected between pin 6 and pin 4 to stabilize the operation. Otherwise, this photocoupler may not switch properly. The bypass capacitor should be placed within 1 cm of each pin.

Note 1: Denotes the operating range, not the recommended operating condition.

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

| Characteristics                               | Symbol                  | Test Condition  | Min  | Typ. | Max | Unit          |
|---|-------------------------|---|------|------|-----|---------------|
| Input forward voltage                         | $V_F$                   | $I_F = 10\text{ mA}$  | 1.45 | 1.55 | 1.7 | V             |
| Input forward voltage temperature coefficient | $\Delta V_F/\Delta T_a$ | $I_F = 10\text{ mA}$ , $T_a = -40\text{ }^\circ\text{C}$ to $110\text{ }^\circ\text{C}$                   | —    | -2.0 | —   | mV/°C         |
| Input reverse current                         | $I_R$                   | $V_R = 5\text{ V}$  | —    | —    | 10  | $\mu\text{A}$ |
| Input capacitance                             | $C_t$                   | $V = 0\text{ V}$ , $f = 1\text{ MHz}$   | —    | 60   | —   | pF            |
| High-level output current                     | $I_{OH}$                | $I_F = 0\text{ mA}$ , $V_O = 5.5\text{ V}$ , $V_{CC} = 5.5\text{ V}$                                      | —    | 3    | 500 | $\mu\text{A}$ |
|   |                         | $I_F = 0\text{ mA}$ , $V_O = 20\text{ V}$ , $V_{CC} = 30\text{ V}$  | —    | —    | 5   |               |
|   |                         | $I_F = 0\text{ mA}$ , $V_O = 20\text{ V}$ , $V_{CC} = 30\text{ V}$ ,<br>$T_a = 110\text{ }^\circ\text{C}$ | —    | —    | 50  |               |
| High-level supply current                     | $I_{CCH}$               | $I_F = 0\text{ mA}$ , $V_{CC} = 30\text{ V}$  | —    | 0.01 | 1   |               |
| Current transfer ratio                        | $I_O/I_F$               | $I_F = 10\text{ mA}$ , $V_O = 0.4\text{ V}$ , $V_{CC} = 3.3\text{ V}$                                     | 15   | —    | —   | %             |
|   |                         | $I_F = 16\text{ mA}$ , $V_O = 0.4\text{ V}$ , $V_{CC} = 4.5\text{ V}$                                     | 15   | —    | —   |               |
| Low-level output voltage                      | $V_{OL}$                | $I_F = 16\text{ mA}$ , $V_{CC} = 4.5\text{ V}$ , $I_O = 2.4\text{ mA}$                                    | —    | —    | 0.4 | V             |

Note: All typical values are at  $T_a = 25\text{ }^\circ\text{C}$ .

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

| Characteristics                     | Symbol | Note     | Test Conditions                         | 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. $\leq 60\%$ | $1 \times 10^{12}$ | $10^{14}$ | —   | $\Omega$ |
| Isolation voltage                   | $BV_S$ |          | AC, 60 s                                | 3750               | —         | —   | Vrms     |
|                                     |        |          | AC, 1 s in oil                          | —                  | 10000     | —   |          |
|                                     |        |          | DC, 60 s in oil                         | —                  | 10000     | —   | Vdc      |

Note 1: This device is considered as a two-terminal device: Pins 1 and 3 are shorted together, and pins 4, 5 and 6 are shorted together.

**11. Switching Characteristics (Note)**  
(Unless otherwise specified,  $T_a = -40$  to  $110\text{ }^\circ\text{C}$ )

| Characteristics                               | Symbol    | Note     | Test Circuit | Test Condition  | Min | Typ. | Max | Unit              |
|---|-----------|----------|--------------|---|-----|------|-----|-------------------|
| Propagation delay time (H/L)                  | $t_{pHL}$ |          | Fig. 12.1.1  | $I_F = 0 \rightarrow 10\text{ mA}$ , $R_L = 1.9\text{ k}\Omega$ ,<br>$V_{CC} = 3.3\text{ V}$ , $C_L = 15\text{ pF}$   | —   | —    | 1   | $\mu\text{s}$     |
| Propagation delay time (L/H)                  | $t_{pLH}$ |          |              | $I_F = 10 \rightarrow 0\text{ mA}$ , $R_L = 1.9\text{ k}\Omega$ ,<br>$V_{CC} = 3.3\text{ V}$ , $C_L = 15\text{ pF}$   | —   | —    | 1   |                   |
| Propagation delay time (H/L)                  | $t_{pHL}$ |          | Fig. 12.1.1  | $I_F = 0 \rightarrow 16\text{ mA}$ , $R_L = 1.9\text{ k}\Omega$ ,<br>$V_{CC} = 5\text{ V}$ , $C_L = 15\text{ pF}$   | —   | —    | 0.8 |                   |
| Propagation delay time (L/H)                  | $t_{pLH}$ |          |              | $I_F = 16 \rightarrow 0\text{ mA}$ , $R_L = 1.9\text{ k}\Omega$ ,<br>$V_{CC} = 5\text{ V}$ , $C_L = 15\text{ pF}$   | —   | —    | 0.8 |                   |
| Common-mode transient immunity at output high | $CM_H$    | (Note 1) | Fig. 12.1.2  | $I_F = 0\text{ mA}$ , $V_{CC} = 3.3\text{ V} / 5\text{ V}$ ,<br>$V_{CM} = 400\text{ V}_{p-p}$ , $R_L = 4.1\text{ k}\Omega$ ,<br>$T_a = 25\text{ }^\circ\text{C}$  | 15  | 20   | —   | kV/ $\mu\text{s}$ |
| Common-mode transient immunity at output low  | $CM_L$    | (Note 1) |              | $I_F = 10\text{ mA}$ , $V_{CC} = 3.3\text{ V} / 5\text{ V}$ ,<br>$V_{CM} = 400\text{ V}_{p-p}$ , $R_L = 4.1\text{ k}\Omega$ ,<br>$T_a = 25\text{ }^\circ\text{C}$ | -15 | -20  | —   |                   |

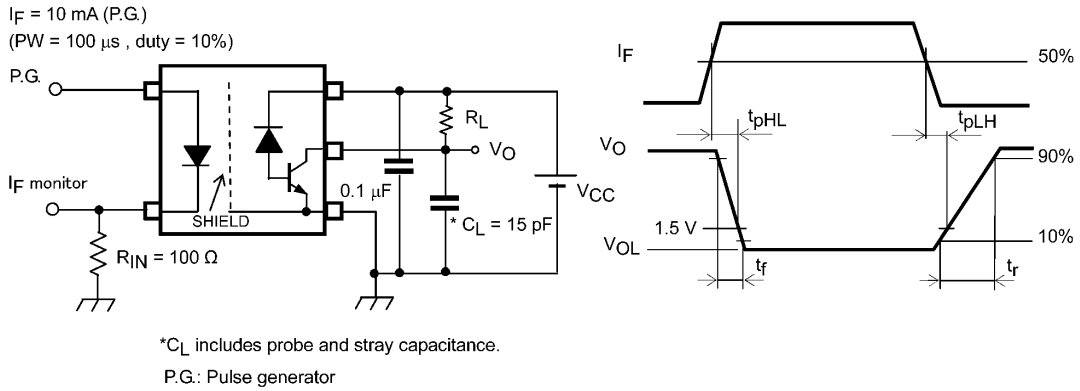
Note: All typical values are at  $T_a = 25\text{ }^\circ\text{C}$ .

Note 1:  $CM_H$  is the maximum rate of rise of the common mode voltage that can be sustained with the output voltage in the logic high state ( $V_O > 2.0\text{ V}$ ).

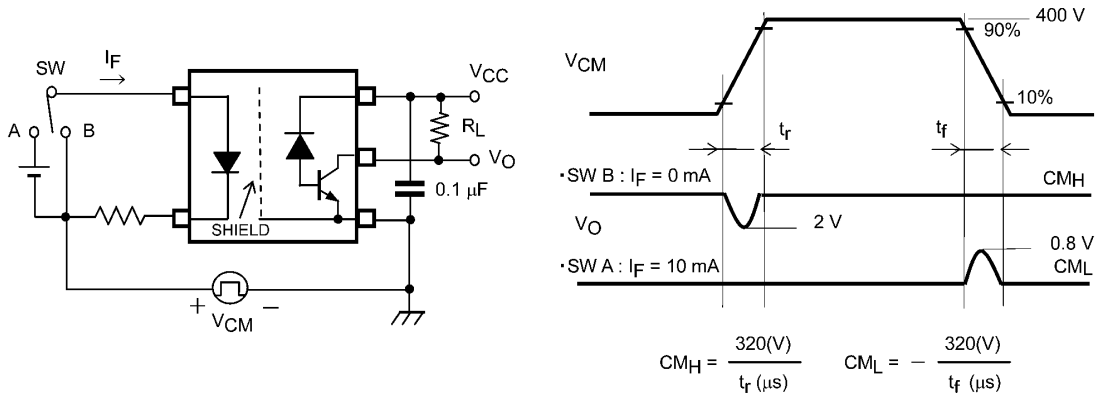
$CM_L$  is the maximum rate of fall of the common mode voltage that can be sustained with the output voltage in the logic low state ( $V_O < 0.8\text{ V}$ ).

**12. Test Circuits and Characteristics Curves**

**12.1. Test Circuits**

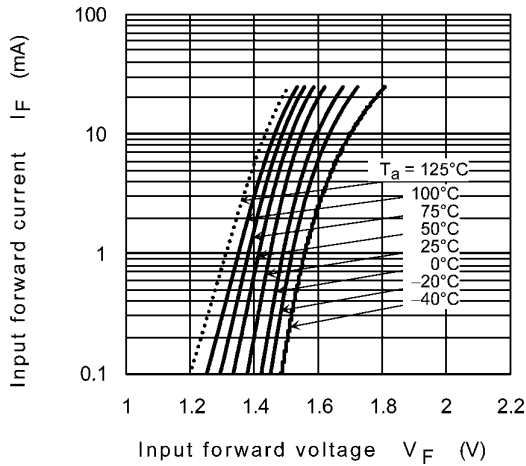


**Fig. 12.1.1 Switching Time Test Circuit**

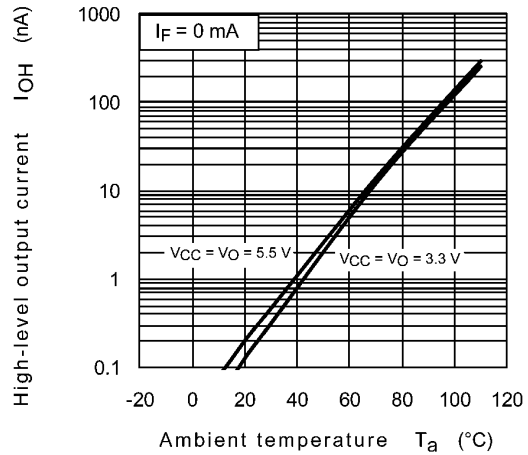


**Fig. 12.1.2 Common-Mode Transient Immunity**

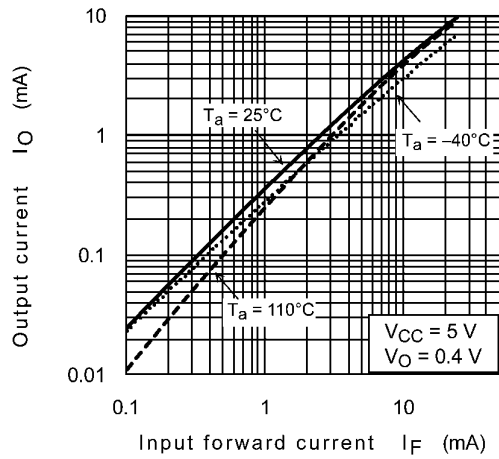
**12.2. Characteristics Curves (Note)**



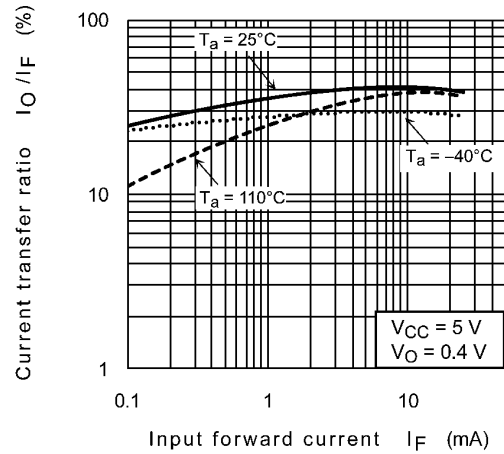
**Fig. 12.2.1  $I_F - V_F$**



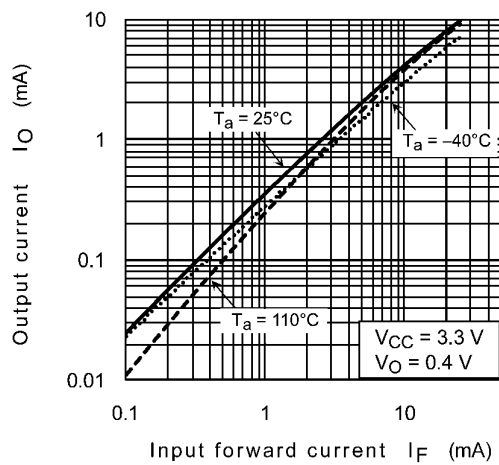
**Fig. 12.2.2  $I_{OH} - T_a$**



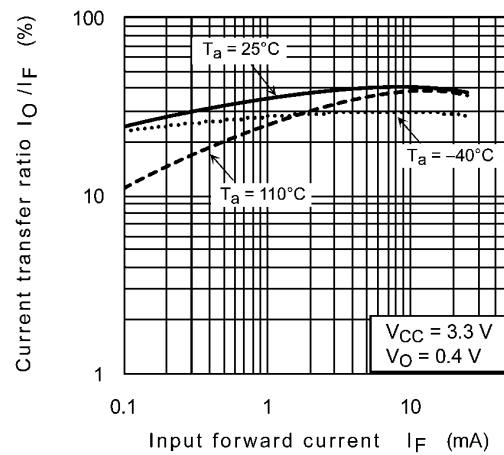
**Fig. 12.2.3  $I_O - I_F$**



**Fig. 12.2.4  $I_O / I_F - I_F$**



**Fig. 12.2.5  $I_O - I_F$**



**Fig. 12.2.6  $I_O / I_F - I_F$**

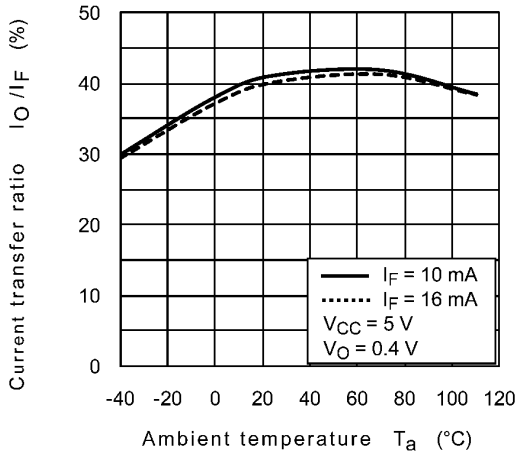


Fig. 12.2.7  $I_O/I_F - T_a$

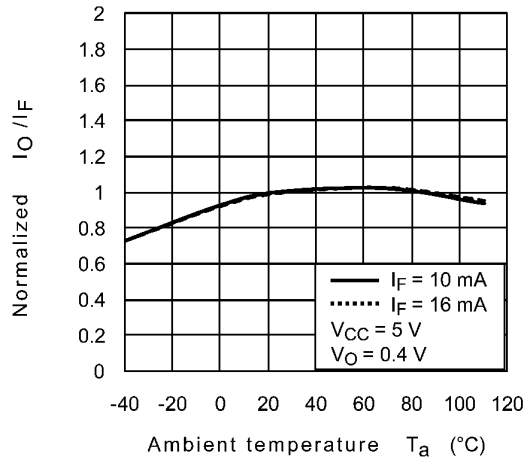


Fig. 12.2.8  $I_O/I_F - T_a$

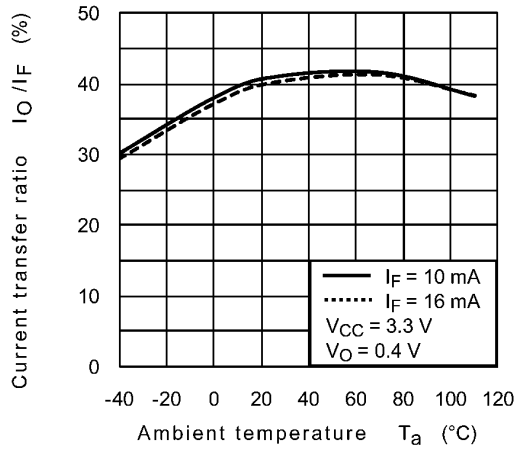


Fig. 12.2.9  $I_O/I_F - T_a$

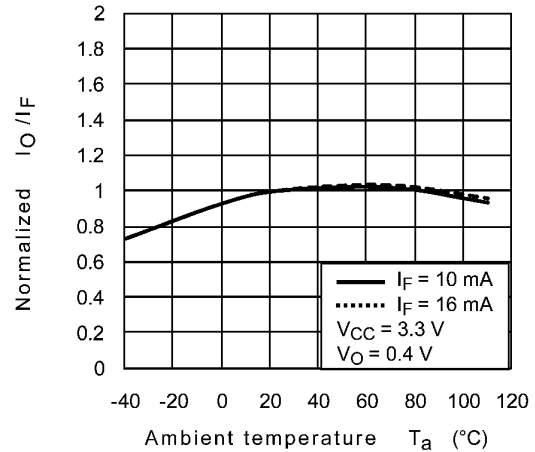


Fig. 12.2.10  $I_O/I_F - T_a$

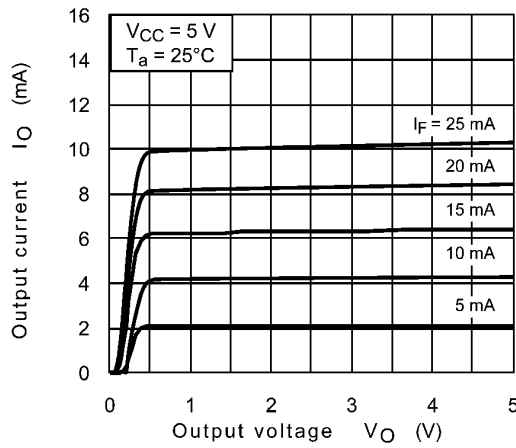


Fig. 12.2.11  $I_O - V_O$

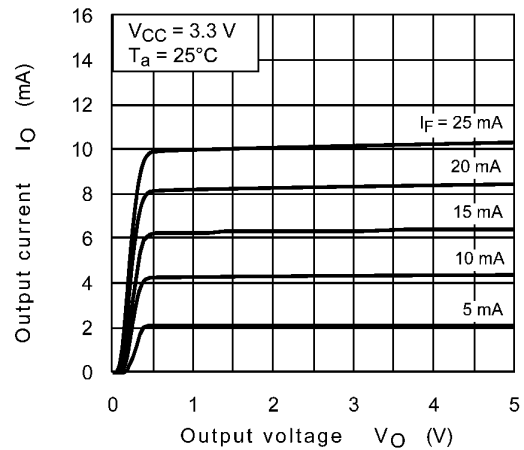


Fig. 12.2.12  $I_O - V_O$

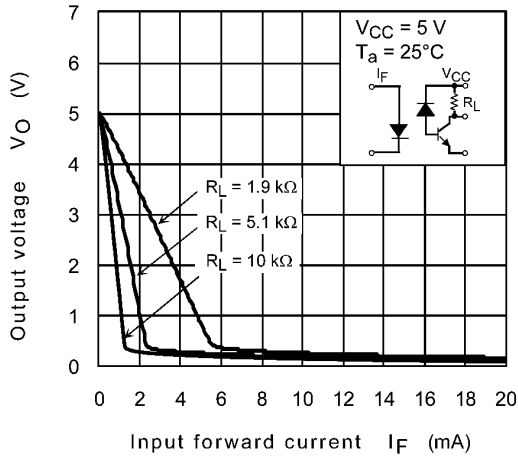


Fig. 12.2.13  $V_O - I_F$

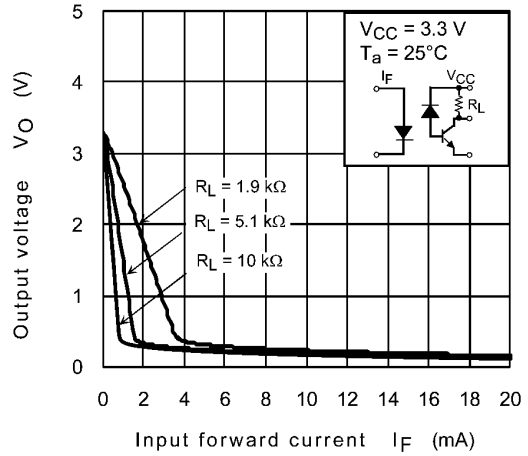


Fig. 12.2.14  $V_O - I_F$

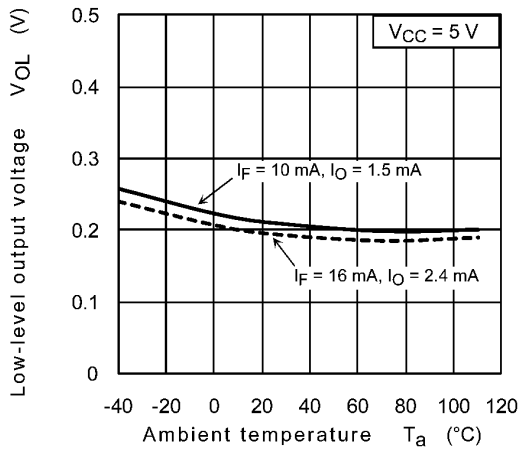


Fig. 12.2.15  $V_{OL} - T_a$

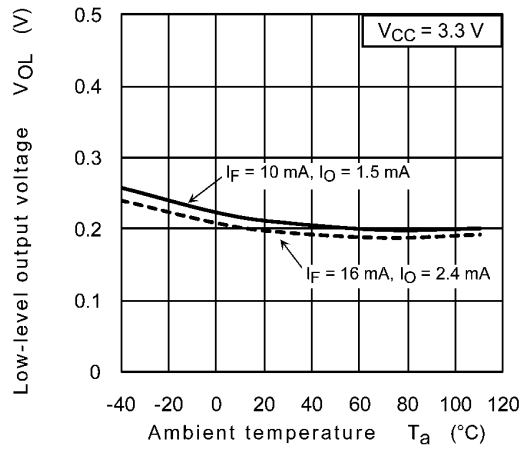


Fig. 12.2.16  $V_{OL} - T_a$

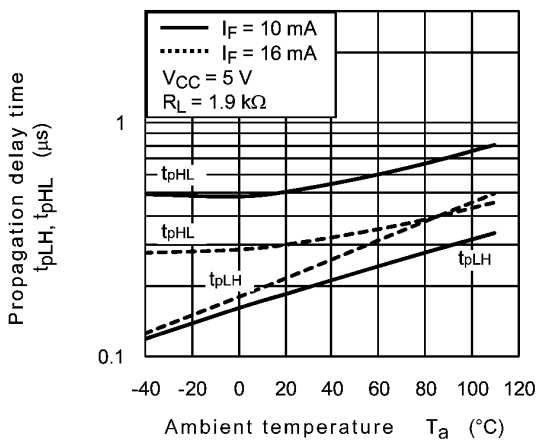


Fig. 12.2.17  $t_{pLH}, t_{pHL} - T_a$

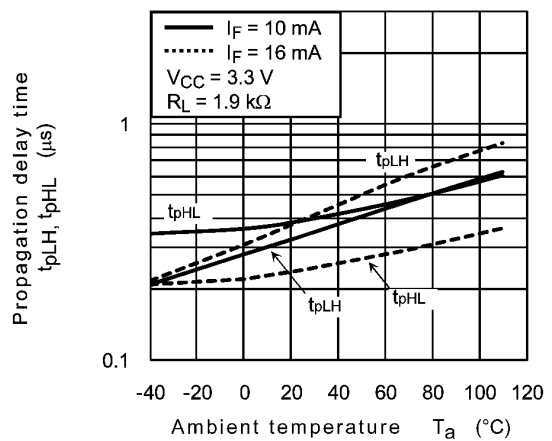
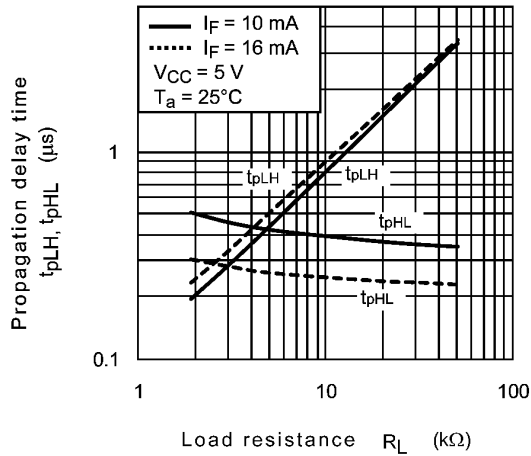
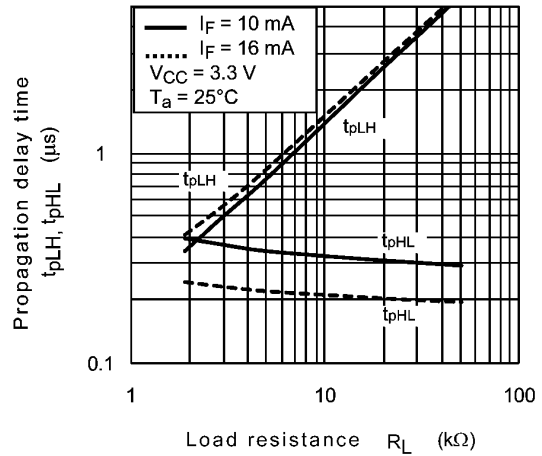


Fig. 12.2.18  $t_{pLH}, t_{pHL} - T_a$





**Fig. 12.2.19**  $t_{pLH}, t_{pHL} - R_L$



**Fig. 12.2.20**  $t_{pLH}, t_{pHL} - R_L$

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

**13. Soldering and Storage**

**13.1. 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.

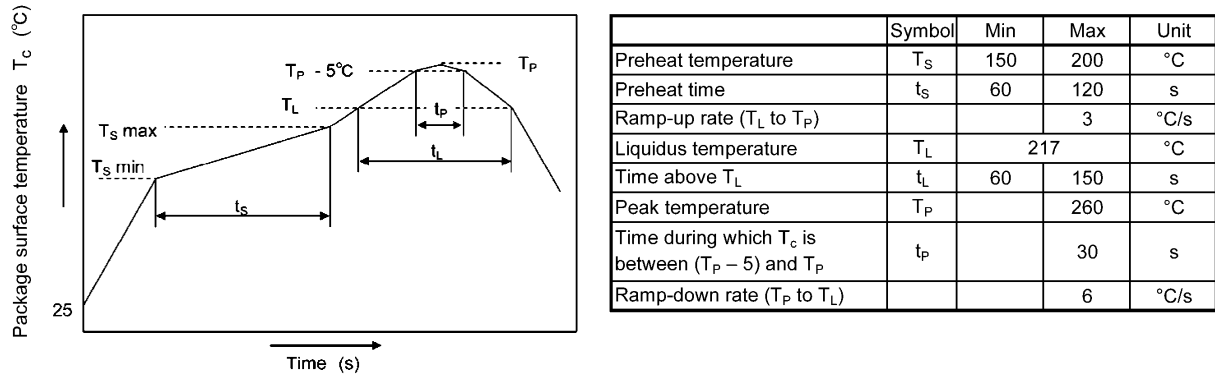
- When using soldering reflow.

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.



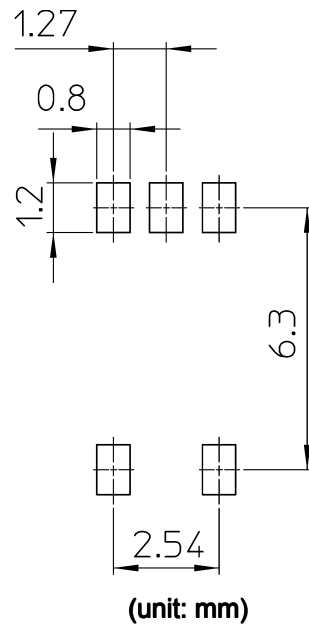
**Fig. 13.1.1 An example of a temperature profile when lead(Pb)-free solder is used**

- 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.

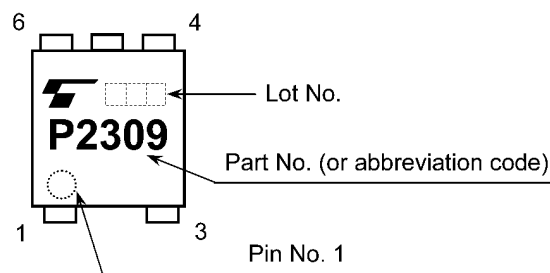
**13.2. Precautions for General Storage**

- 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.

**14. Land Pattern Dimensions for Reference Only**

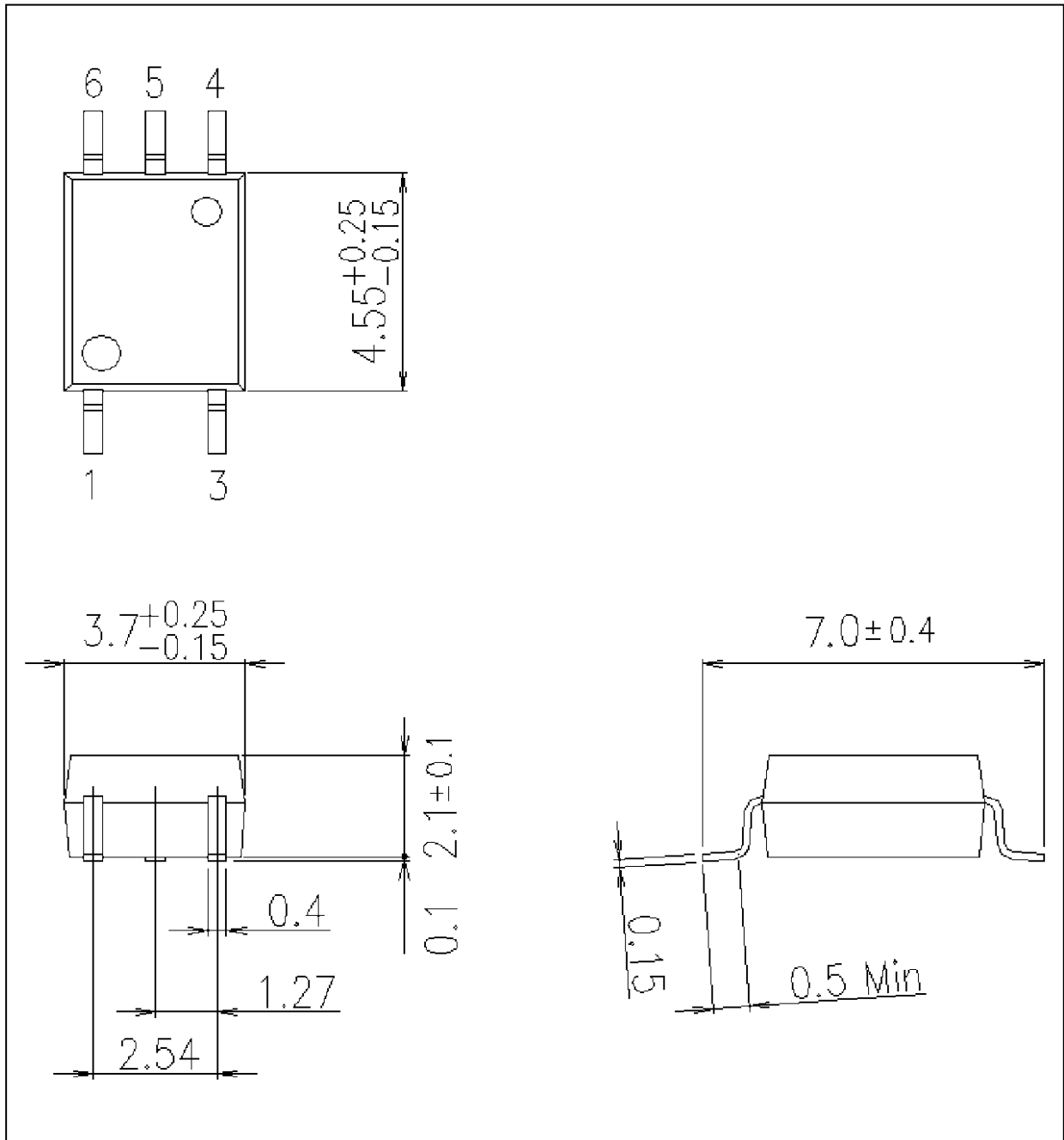


**15. Marking**



**Package Dimensions**

Unit: mm



Weight: 0.08 g (typ.)

| Package Name(s)  |
|------------------|
| TOSHIBA: 11-4L1S |

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