

# TLP2403

## 1. Applications

- High-Speed Digital Interfacing for Instrumentation and Control Devices
- Simplex/Multiplex Data Transmission

## 2. General

The Toshiba TLP2403 consists of a high-output GaAlAs light-emitting diode coupled with a high-speed photo-diode-transistor chip. It is housed in the SO8 package.

The TLP2403 uses a high-speed, high-gain detector element and thus is ideal for applications which require low-input current and high-speed data transmission.

## 3. Features

- (1) Package: SO8
- (2) Operating temperature: -40 to 100°C
- (3) Current transfer ratio: 400% (min) @  $I_F = 0.5 \text{ mA}$
- (4) Maximum output current: 60 mA
- (5) Propagation delay time:  $t_{pHL} = 2 \mu\text{s}$  (typ.),  $t_{pLH} = 4 \mu\text{s}$  (typ.) @  $R_L = 4.7 \text{ k}\Omega$ ,  $I_F = 0.5 \text{ mA}$
- (6) Isolation voltage: 3750 Vrms (min)
- (7) Safety standards

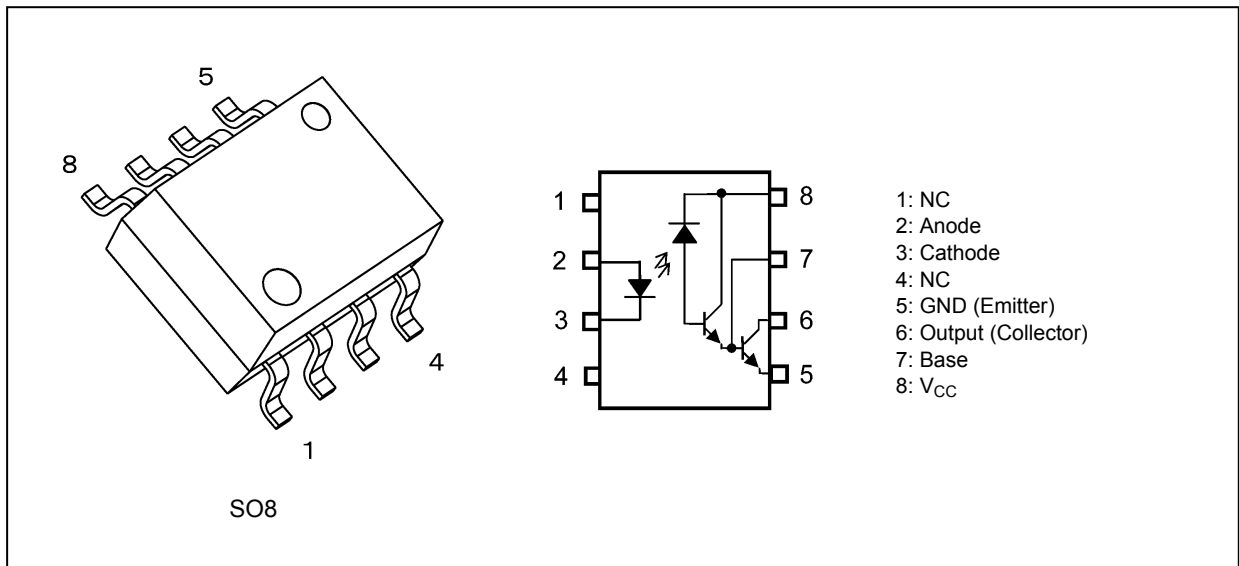
UL-approved: UL1577 File No.E67349

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

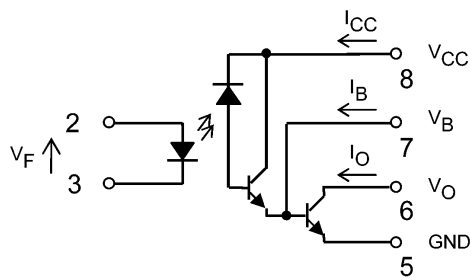
VDE-approved: Option (V4) EN60747-5-2 (**Note**)

Note: When an EN60747-5-2 approved type is needed, please designate the **Option (V4)**.

## 4. Packaging and Pin Configuration



**5. Internal Circuit**



**Fig. 5.1 Internal Circuit**

**6. Principle of Operation**

**6.1. Mechanical Parameters**

| Characteristics              | Min | Unit |
|------------------------------|-----|------|
| Creepage distances           | 4.0 | mm   |
| Clearance                    | 4.0 |      |
| Internal isolation thickness | —   |      |

**7. Absolute Maximum Ratings (Note)**

Unless otherwise specified,  $T_a = 25^\circ\text{C}$

|          | Characteristics  | Symbol                          | Note     | Rating     | Unit                 |
|----------|--|---------------------------------|----------|------------|----------------------|
| LED      | Forward current  | $I_F$                           |          | 20         | mA                   |
|          | Forward current derating ( $T_a \geq 85^\circ\text{C}$ )                 | $\Delta I_F/^\circ\text{C}$     |          | -0.67      | mA/ $^\circ\text{C}$ |
|          | Pulse forward current  | $I_{FP}$                        | (Note 1) | 40         | mA                   |
|          | Pulse forward current derating ( $T_a \geq 85^\circ\text{C}$ )           | $\Delta I_{FP}/^\circ\text{C}$  |          | -1.0       | mA/ $^\circ\text{C}$ |
|          | Transient pulse forward current  | $I_{FPT}$                       | (Note 2) | 1          | A                    |
|          | Transient pulse forward current derating ( $T_a \geq 85^\circ\text{C}$ ) | $\Delta I_{FPT}/^\circ\text{C}$ |          | -25        | mA/ $^\circ\text{C}$ |
|          | Reverse voltage  | $V_R$                           |          | 5          | V                    |
|          | Power dissipation  | $P_D$                           |          | 40         | mW                   |
|          | Power dissipation derating ( $T_a \geq 85^\circ\text{C}$ )               | $\Delta P_D/^\circ\text{C}$     |          | -1.0       | mW/ $^\circ\text{C}$ |
| Detector | Output current   | $I_O$                           |          | 60         | mA                   |
|          | Output current derating ( $T_a \geq 25^\circ\text{C}$ )                  | $\Delta I_O/^\circ\text{C}$     |          | -0.6       | mA/ $^\circ\text{C}$ |
|          | Output voltage   | $V_O$                           |          | -0.5 to 18 | V                    |
|          | Supply voltage   | $V_{CC}$                        |          | -0.5 to 18 |                      |
|          | Emitter-base reverse voltage   | $V_{EB}$                        |          | 0.5        |                      |
|          | Output power dissipation   | $P_O$                           |          | 100        | mW                   |
|          | Output power dissipation derating ( $T_a \geq 25^\circ\text{C}$ )        | $\Delta P_O/^\circ\text{C}$     |          | -1.0       | mW/ $^\circ\text{C}$ |
| Common   | Operating temperature  | $T_{opr}$                       |          | -40 to 100 | $^\circ\text{C}$     |
|          | Storage temperature  | $T_{stg}$                       |          | -55 to 125 |                      |
|          | Lead soldering temperature (10 s)  | $T_{sol}$                       |          | 260        |                      |
|          | Isolation voltage AC, 1 min, 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 ms, duty = 50%

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

Note 3: This device is considered as a two-terminal device: Pins 1, 2, 3 and 4 are shorted together, and pins 5, 6, 7 and 8 are shorted together.

**8. Recommended Operating Conditions (Note)**

| Characteristics       | Symbol    | Note     | Min | Typ. | Max | Unit             |
|-----------------------|-----------|----------|-----|------|-----|------------------|
| Forward current       | $I_F$     |          | 0.5 | —    | 15  | mA               |
| Output current        | $I_O$     |          | —   | —    | 30  |                  |
| Supply voltage        | $V_{CC}$  |          | —   | —    | 16  | V                |
| Operating temperature | $T_{opr}$ | (Note 1) | -40 | —    | 100 | $^\circ\text{C}$ |

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

**9. Electrical Characteristics (Note)**

Unless otherwise specified,  $T_a = 0$  to  $100^\circ\text{C}$

| Characteristics                                  | Symbol                    | Note | Test Circuit | Test Condition   | Min  | Typ. | Max  | Unit                 |
|--|---------------------------|------|--------------|--|------|------|------|----------------------|
| Input forward voltage                            | $V_F$                     |      |              | $I_F = 1.6 \text{ mA}$ , $T_a = 25^\circ\text{C}$                                | 1.30 | 1.45 | 1.70 | V                    |
| Input temperature coefficient of forward voltage | $\Delta V_F / \Delta T_a$ |      |              | $I_F = 1.6 \text{ mA}$   | —    | -1.8 | —    | mV/ $^\circ\text{C}$ |
| Input reverse current                            | $I_R$                     |      |              | $V_R = 5 \text{ V}$ , $T_a = 25^\circ\text{C}$                                   | —    | —    | 10   | $\mu\text{A}$        |
| Input capacitance                                | $C_t$                     |      |              | $V = 0 \text{ V}$ , $f = 1 \text{ MHz}$ , $T_a = 25^\circ\text{C}$               | —    | 60   | —    | pF                   |
| High-level output current                        | $I_{OH}$                  |      |              | $V_F = 0.8 \text{ V}$ , $V_{CC} = V_O = 18 \text{ V}$                            | —    | 0.1  | 100  | $\mu\text{A}$        |
| High-level supply current                        | $I_{CCH}$                 |      |              | $I_F = 0 \text{ mA}$ , $V_{CC} = 5 \text{ V}$ ,<br>$V_O = \text{Open}$           | —    | 0.01 | 10   | $\mu\text{A}$        |
| Low-level supply current                         | $I_{CCL}$                 |      |              | $I_F = 1.6 \text{ mA}$ , $V_{CC} = 5 \text{ V}$ ,<br>$V_O = \text{Open}$         | 0.1  | 1    | 1.5  | mA                   |
| Current transfer ratio                           | $I_O / I_F$               |      |              | $I_F = 0.5 \text{ mA}$ , $V_{CC} = 4.5 \text{ V}$ ,<br>$V_O = 0.4 \text{ V}$     | 400  | 1000 | —    | %                    |
|  |                           |      |              | $I_F = 1.6 \text{ mA}$ , $V_{CC} = 4.5 \text{ V}$ ,<br>$V_O = 0.4 \text{ V}$     | 500  | 900  | —    |                      |
| Low-level output voltage                         | $V_{OL}$                  |      |              | $I_F = 1.6 \text{ mA}$ , $V_{CC} = 4.5 \text{ V}$ ,<br>$I_{OL} = 6.4 \text{ mA}$ | —    | 0.1  | 0.4  | V                    |
|  |                           |      |              | $I_F = 5 \text{ mA}$ , $V_{CC} = 4.5 \text{ V}$ ,<br>$I_{OL} = 15 \text{ mA}$    | —    | 0.1  | 0.4  |                      |
|  |                           |      |              | $I_F = 12 \text{ mA}$ , $V_{CC} = 4.5 \text{ V}$ ,<br>$V_O = 24 \text{ mA}$      | —    | 0.15 | 0.4  |                      |

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

**10. Isolation Characteristics**

Unless otherwise specified,  $T_a = 25^\circ\text{C}$

| Characteristics               | Symbol | Note     | Test Conditions                           | Min                | Typ.      | Max | Unit     |
|-------------------------------|--------|----------|---|--------------------|-----------|-----|----------|
| 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, 1 min                                 | 3750               | —         | —   | Vrms     |
|                               |        |          | AC, 1 s in oil                            | —                  | 10000     | —   |          |
|                               |        |          | DC, 1 min in oil                          | —                  | 10000     | —   | Vdc      |

Note 1: This device is considered as a two-terminal device: Pins 1, 2, 3 and 4 are shorted together, and pins 5, 6, 7 and 8 are shorted together.

**11. Switching Characteristics**

Unless otherwise specified,  $T_a = 0$  to  $100^\circ\text{C}$ ,  $V_{CC} = 5\text{ V}$

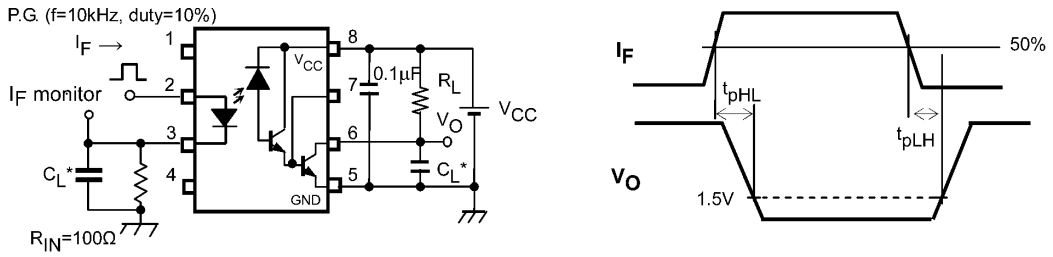
| Characteristics                               | Symbol    | Note     | Test Circuit | Test Condition  | Min | Typ. | Max | Unit                   |
|---|-----------|----------|--------------|---|-----|------|-----|------------------------|
| Propagation delay time (H/L)                  | $t_{pHL}$ |          | Fig. 12.1.1  | $I_F = 0.5\text{ mA}$ , $R_L = 4.7\text{ k}\Omega$ ,<br>$T_a = 25^\circ\text{C}$                              | —   | 2    | 25  | $\mu\text{s}$          |
|   |           |          |              | $I_F = 0.5\text{ mA}$ , $R_L = 4.7\text{ k}\Omega$  | —   | 2    | 30  |                        |
|   |           |          |              | $I_F = 12\text{ mA}$ , $R_L = 270\ \Omega$ ,<br>$T_a = 25^\circ\text{C}$                                      | —   | 0.3  | 1   |                        |
|   |           |          |              | $I_F = 12\text{ mA}$ , $R_L = 270\ \Omega$  | —   | 0.3  | 2   |                        |
|   |           |          |              | $I_F = 1.6\text{ mA}$ , $R_L = 2.2\text{ k}\Omega$ ,<br>$T_a = 25^\circ\text{C}$                              | —   | 0.5  | 10  |                        |
|   |           |          |              | $I_F = 1.6\text{ mA}$ , $R_L = 2.2\text{ k}\Omega$  | —   | 0.5  | 15  |                        |
| Propagation delay time (L/H)                  | $t_{pLH}$ |          | Fig. 12.1.1  | $I_F = 0.5\text{ mA}$ , $R_L = 4.7\text{ k}\Omega$ ,<br>$T_a = 25^\circ\text{C}$                              | —   | 4    | 60  | $\mu\text{s}$          |
|   |           |          |              | $I_F = 0.5\text{ mA}$ , $R_L = 4.7\text{ k}\Omega$  | —   | 4    | 90  |                        |
|   |           |          |              | $I_F = 12\text{ mA}$ , $R_L = 270\ \Omega$ ,<br>$T_a = 25^\circ\text{C}$                                      | —   | 1    | 7   |                        |
|   |           |          |              | $I_F = 12\text{ mA}$ , $R_L = 270\ \Omega$  | —   | 1    | 10  |                        |
|   |           |          |              | $I_F = 1.6\text{ mA}$ , $R_L = 2.2\text{ k}\Omega$ ,<br>$T_a = 25^\circ\text{C}$                              | —   | 4.5  | 35  |                        |
|   |           |          |              | $I_F = 1.6\text{ mA}$ , $R_L = 2.2\text{ k}\Omega$  | —   | 4.5  | 50  |                        |
| Common-mode transient immunity at output high | $CM_H$    | (Note 1) | Fig. 12.1.2  | $I_F = 0\text{ mA}$ , $R_L = 2.2\text{ k}\Omega$ ,<br>$V_{CM} = 10\text{ V}$ , $V_{O(\min)} = 2\text{ V}$     | —   | 500  | —   | $\text{V}/\mu\text{s}$ |
| Common-mode transient immunity at output low  | $CM_L$    | (Note 2) |              | $I_F = 1.6\text{ mA}$ , $R_L = 2.2\text{ k}\Omega$ ,<br>$V_{CM} = 10\text{ V}$ , $V_{O(\max)} = 0.8\text{ V}$ | —   | -500 | —   |                        |

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 ( $V_O > 2.0\text{ V}$ ).

Note 2:  $CM_L$  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**

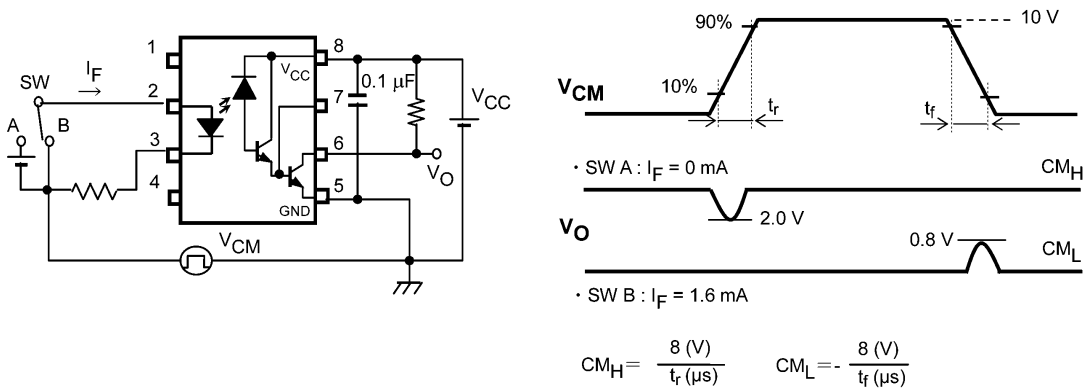
**12.1. Test Circuits**



\*CL is approximately 15 pF which includes probe and stray wiring capacitance.

P.G.: Pulse Generator

**Fig. 12.1.1 Switching Time Test Circuit**



$$CM_H = \frac{8(V)}{t_r(\mu s)} \quad CM_L = -\frac{8(V)}{t_f(\mu s)}$$

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

**13. Soldering and Storage**

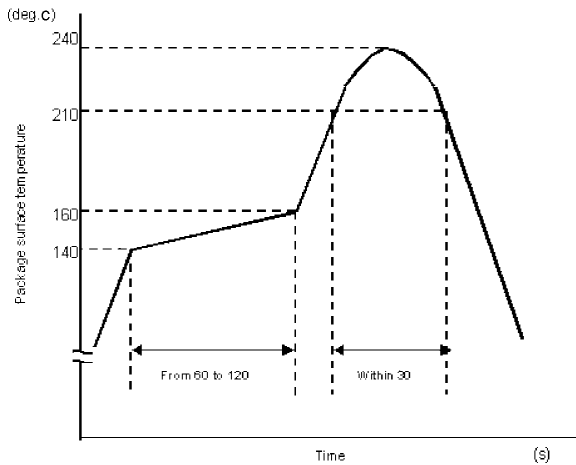
**13.1. Precautions for Soldering**

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.

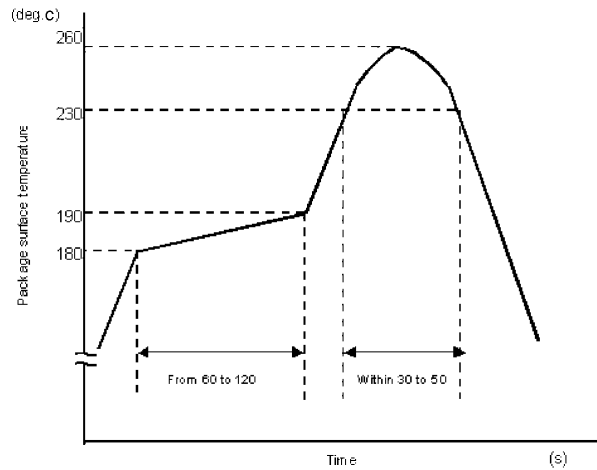
- When using soldering reflow (See Fig. 13.1.1 and 13.1.2)

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 Sn-Pb eutectic solder is used**



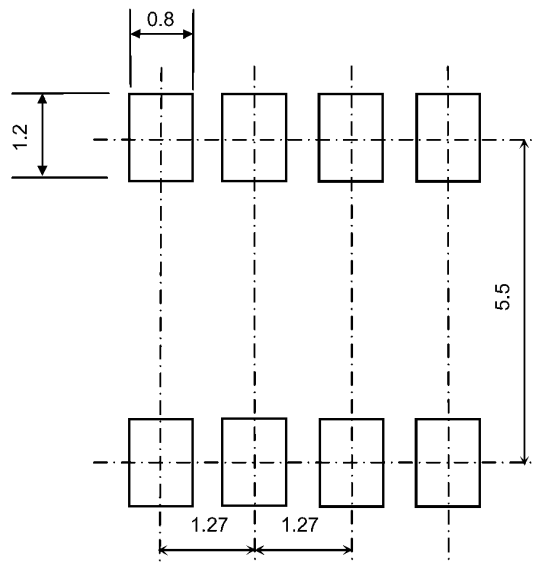
**Fig. 13.1.2 An example of a temperature profile when lead(Pb)-free solder is used**

- When using soldering flow (Applicable to both eutectic solder and Lead(Pb)-Free solder)  
Apply preheating of 150°C 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 (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 done only once per lead.

**13.2. Precautions for General Storage**

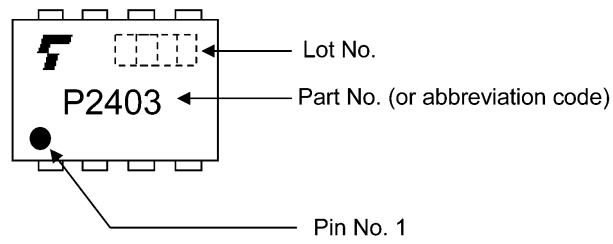
- Avoid storage locations where devices may be exposed to moisture or direct sunlight.
- Follow the precautions printed on the packing label of the device for transportation and storage.
- Keep the storage location temperature and humidity within a range of 5°C to 35°C and 45% to 75%, respectively.
-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



**Fig. 14.1 Land Pattern Dimensions for Reference Only (unit: mm)**

**15. Marking**



**Fig. 15.1 Marking**



**16. EN60747-5-2 Option (V4) Specification**

- Part number: TLP2403 (**Note**)
- The following part naming conventions are used for the devices that have been qualified according to option (V4) of EN60747.

Example: TLP2403(V4-TP, F)

V4: EN60747 option specification

TP: Standard taping name

Note: Use TOSHIBA standard type number for safety standard application.  
e.g., TLP2403(V4-TP, F) → TLP2403

| Description  | Symbol                        | Rating            | Unit           |
|--|-------------------------------|-------------------|----------------|
| Application classification<br><br>for rated mains voltage $\leq 150V_{rms}$<br>for rated mains voltage $\leq 300V_{rms}$   |                               | I-IV<br>I-III     | —              |
| Climatic classification  |                               | 40/ 100 / 21      | —              |
| Pollution degree   |                               | 2                 | —              |
| Maximum operating insulation voltage   | $V_{IORM}$                    | 565               | Vpk            |
| Input to output test voltage, method A<br>$V_{pr}=1.5 \times V_{IORM}$ , type and sample test<br>$t_p=10s$ , partial discharge $<5pC$  | $V_{pr}$                      | 850               | Vpk            |
| Input to output test voltage, method B<br>$V_{pr}=1.875 \times V_{IORM}$ , 100% production test<br>$t_p=1s$ , partial discharge $<5pC$   | $V_{pr}$                      | 1060              | Vpk            |
| Highest permissible overvoltage<br>(transient overvoltage, $t_{pr} = 60s$ )  | $V_{TR}$                      | 6000              | Vpk            |
| Safety limiting values (max. permissible ratings in case of<br>fault, also refer to thermal derating curve)<br><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><br>$V_{IO} = 500V$ , $T_a=T_s$  | $R_{si}$                      | $\geq 10^9$       | $\Omega$       |

**Fig. 16.1 EN60747 Insulation Characteristics**


|                              |     |       |
|------------------------------|-----|-------|
| Minimum creepage distance    | Cr  | 4.0mm |
| Minimum clearance            | Cl  | 4.0mm |
| Minimum insulation thickness | ti  | -     |
| Comperative tracking index   | CTI | 175   |

**Fig. 16.2 Insulation Related Specifications (Note)**

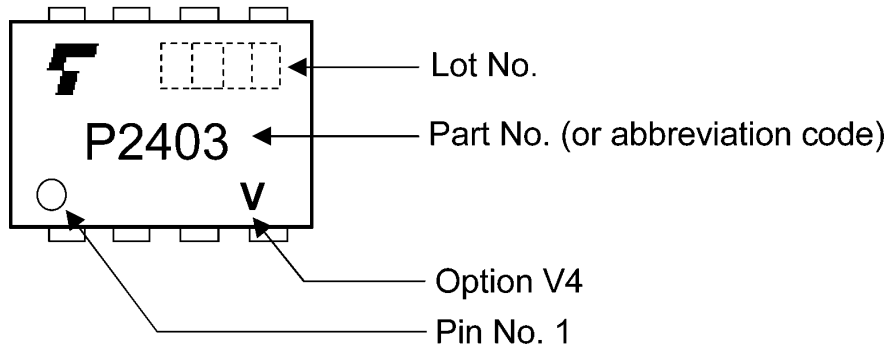
Note: If a printed circuit is incorporated, the creepage distance and clearance may be reduced below this value. (e. g., at a standard distance between soldering eye centers of 3.5 mm). If this is not permissible, the user shall take suitable measures.

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.

Marking on product for EN60747 : V

Marking on packing for EN60747 : 

Marking Example : TLP2403

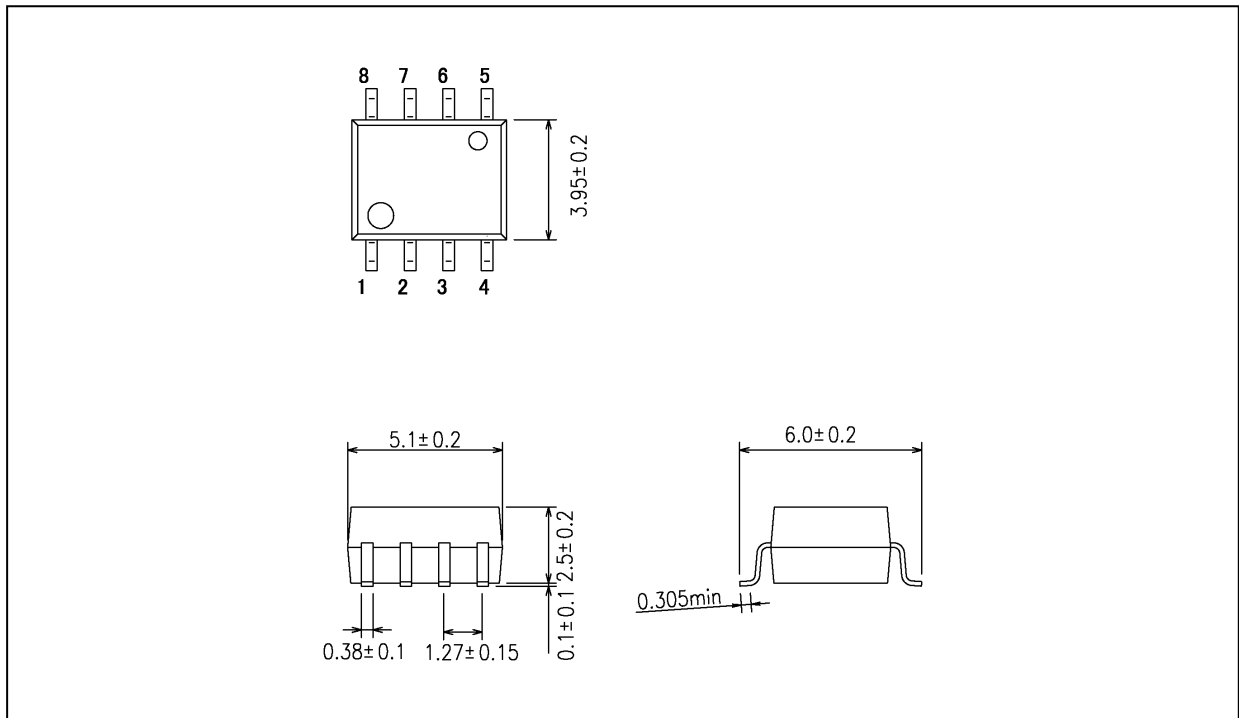


**Fig. 16.3 Marking Example (Note)**

Note: The above marking is applied to the photocouplers that have been qualified according to option (V4) of EN60747.

**Package Dimensions**

Unit: mm



Weight: 0.11 g (typ.)

| Package Name(s)  |
|------------------|
| TOSHIBA: 11-5K1S |
| Nickname: SO8    |

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