Photocouplers GaAℓAs Infrared LED & Photo IC

# TLP2361

## 1. Applications

- Factory Networking
- High-Speed Digital Interfacing for Instrumentation and Control Devices
- I/O Interface Boards

## 2. General

The Toshiba TLP2361 consists of a high-output GaAℓAs light-emitting diode coupled with integrated high gain, high-speed photodetectors. It is housed in the SO6 package.

This photocoupler guarantees operation at up to 125 ℃ and on supplies from 2.7 V to 5.5 V. Since TLP2361 has guaranteed 1 mA low supply current ($I_{CCL}$/$I_{CCH}$), and 1.6 mA ($T_a$ = 125 ℃) low threshold input current($I_{FHL}$), it contributes to energy saving of devices. It can drive directly from a microcomputer for a low input current.

The TLP2361 has an internal Faraday shield that provides a guaranteed common-mode transient immunity of ±20 kV/μs.

## 3. Features

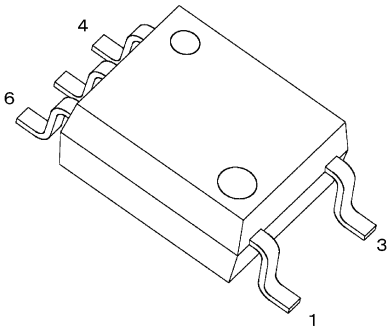
(1) Inverter logic type (Totem pole output)
(2) Package: SO6
(3) Operating temperature: -40 to 125 ℃
(4) Supply voltage: 2.7 to 5.5 V
(5) Data transfer rate: 15 MBd (typ.) (NRZ)
(6) Threshold input current: 1.3 mA (max) (@$T_a$ = 105 ℃)
: 1.6 mA (max) (@$T_a$ = 125 ℃)
(7) Supply current: 1.0 mA (max)
(8) Common-mode transient immunity: ±20 kV/μs (min)
(9) Isolation voltage: 3750 Vrms (min)
(10) Safety standards
UL-approved: UL1577, File No.E67349
cUL-approved: CSA Component Acceptance Service No.5A File No.E67349
VDE-approved: EN60747-5-5 **(Note 1)**
CQC-approved: GB4943.1, GB8898 Thailand Factory

仅适用于海拔 2000m 以下地区安全使用

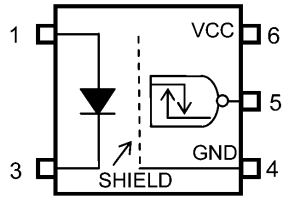
Note 1: When an EN60747-5-5 approved type is needed, please designate the **Option (V4)**.

Start of commercial production
2013-06

## 4. Packaging and Pin Configuration

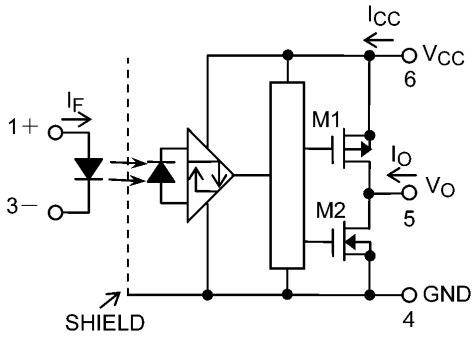



11-4L1S




1: Anode
3: Cathode
4: GND
5: $V_O$ (Output)
6: $V_{CC}$

## 5. Internal Circuit (Note)




Note: A 0.1-μF bypass capacitor must be connected between pin 6 and pin 4.

## 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 °C)

| | Characteristics | | Symbol | Note | Rating | Unit |
|---|---|---|---|---|---|---|
| LED | Input forward current | | $I_F$ | | 10 | mA |
| | Input forward current derating | ($T_a \geq$ 110 °C) | $\Delta I_F/\Delta T_a$ | | -0.13 | mA/°C |
| | Input forward current (pulsed) | | $I_{FP}$ | (Note 1) | 40 | mA |
| | Input forward current derating (pulsed) | ($T_a \geq$ 110 °C) | $\Delta I_{FP}/\Delta T_a$ | | -1.0 | mA/°C |
| | Peak transient input forward current | | $I_{FPT}$ | (Note 2) | 1 | A |
| | Peak transient input forward current derating | ($T_a \geq$ 110 °C) | $\Delta I_{FPT}/\Delta T_a$ | | -25 | mA/°C |
| | Input power dissipation | | $P_D$ | | 20 | mW |
| | Input power dissipation derating | ($T_a \geq$ 110 °C) | $\Delta P_D/\Delta T_a$ | | -0.5 | mW/°C |
| | Input reverse voltage | | $V_R$ | | 5 | V |
| Detector | Output current | | $I_O$ | | 10 | mA |
| | Output voltage | | $V_O$ | | 6 | V |
| | Supply voltage | | $V_{CC}$ | | 6 | |
| | Output power dissipation | | $P_O$ | | 20 | mW |
| | Output power dissipation derating | ($T_a \geq$ 110 °C) | $\Delta P_O/\Delta T_a$ | | -0.5 | mW/°C |
| Common | Operating temperature | | $T_{opr}$ | | -40 to 125 | °C |
| | Storage temperature | | $T_{stg}$ | | -55 to 125 | |
| | Lead soldering temperature | (10 s) | $T_{sol}$ | | 260 | |
| | Isolation voltage | AC, 60 s., R.H. ≤ 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) ≤ 1 ms, duty = 50 %

Note 2: Pulse width (PW) ≤ 1 μs, 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 | $I_{F(ON)}$ | (Note 1) | 2 | — | 6 | mA |
| Input off-state voltage | $V_{F(OFF)}$ | | 0 | — | 0.8 | V |
| Supply voltage | $V_{CC}$ | (Note 2) | 2.7 | 3.3/5.0 | 5.5 | |
| Operating temperature | $T_{opr}$ | (Note 2) | -40 | — | 125 | °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 μF) should be connected between pin 6 and pin 4 to stabilize the operation of a high-gain linear amplifier. Otherwise, this photocoupler may not switch properly. The bypass capacitor should be placed within 1 cm of each pin.

Note 1: The rise and fall times of the input on-current should be less than 0.5 μs.

Note 2: Denotes the operating range, not the recommended operating condition.

## 9. Electrical Characteristics (Note) (Unless otherwise specified, $T_a$ = -40 to 125 °C, $V_{CC}$ = 2.7 to 5.5 V)

| Characteristics | Symbol | Note | Test Circuit | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|---|---|
| Input forward voltage | $V_F$ | | — | $I_F$ = 2 mA, $T_a$ = 25 °C | 1.35 | 1.50 | 1.65 | V |
| Input forward voltage temperature coefficient | $\Delta V_F/\Delta T_a$ | | — | $I_F$ = 2 mA | — | -2.0 | — | mV/°C |
| Input reverse current | $I_R$ | | — | $V_R$ = 5 V, $T_a$ = 25 °C | — | — | 10 | μA |
| Input capacitance | $C_t$ | | — | V = 0 V, f = 1 MHz, $T_a$ = 25 °C | — | 20 | — | pF |
| Low-level output voltage | $V_{OL}$ | | Fig. 12.1.1 | $I_F$ = 2 mA, $I_O$ = 20 μA | — | — | 0.1 | V |
| | | | | $I_F$ = 2 mA, $I_O$ = 3.2 mA | — | 0.12 | 0.4 | |
| High-level output voltage | $V_{OH}$ | | Fig. 12.1.2 | $I_O$ = -20 μA, $V_F$ = 0.8 V, $V_{CC}$ = 3.3 V | 3.2 | 3.29 | — | |
| | | | | $I_O$ = -20 μA, $V_F$ = 0.8 V, $V_{CC}$ = 5 V | 4.9 | 4.99 | — | |
| | | | | $I_O$ = -3.2 mA, $V_F$ = 0.8 V, $V_{CC}$ = 3.3 V | 2.3 | 3.15 | — | |
| | | | | $I_O$ = -3.2 mA, $V_F$ = 0.8 V, $V_{CC}$ = 5 V | 4.0 | 4.87 | — | |
| Low-level supply current | $I_{CCL}$ | | Fig. 12.1.3 | $I_F$ = 2 mA | — | 0.65 | 1.0 | mA |
| High-level supply current | $I_{CCH}$ | | Fig. 12.1.4 | $I_F$ = 0 mA | — | 0.65 | 1.0 | |
| Threshold input current (H/L) | $I_{FHL}$ | | — | $I_O$ = 3.2 mA, $V_O$ < 0.4 V, $T_a$ = -40 to 105 °C | — | 0.5 | 1.3 | |
| | | | | $I_O$ = 3.2 mA, $V_O$ < 0.4 V, $T_a$ = -40 to 125 °C | — | 0.5 | 1.6 | |

Note: All typical values are at $V_{CC}$ = 5 V, $T_a$ = 25 °C, unless otherwise noted.

## 10. Isolation Characteristics (Unless otherwise specified, $T_a$ = 25 °C)

| Characteristics | Symbol | Note | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|---|
| Total capacitance (input to output) | $C_S$ | (Note 1) | $V_S$ = 0 V, f = 1 MHz | — | 0.8 | — | pF |
| Isolation resistance | $R_S$ | (Note 1) | $V_S$ = 500 V, R.H. ≤ 60 % | $1 \times 10^{12}$ | $10^{14}$ | — | Ω |
| Isolation voltage | $BV_S$ | (Note 1) | 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 125 °C, $V_{CC}$ = 2.7 to 5.5 V)

| Characteristics | Symbol | Note | Test Circuit | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|---|---|
| Propagation delay time (H/L) | $t_{pHL}$ | (Note 1), (Note 3) | Fig. 12.1.5 | $I_F$ = 0 → 2 mA, $R_T$ = 1.68 kΩ, $C_L$ = 15 pF | — | 49 | 80 | ns |
| Propagation delay time (L/H) | $t_{pLH}$ | (Note 1), (Note 3) | | $I_F$ = 2 → 0 mA, $R_T$ = 1.68 kΩ, $C_L$ = 15 pF | — | 39 | 80 | |
| Pulse width distortion | $\lvert t_{pHL}-t_{pLH}\rvert$ | (Note 1), (Note 3) | | $I_F$ = 2 mA, $R_T$ = 1.68 kΩ, $C_L$ = 15 pF | — | 10 | 25 | |
| Propagation delay skew (device to device) | $t_{psk}$ | (Note 1), (Note 2), (Note 3) | | $I_F$ = 2 mA, $R_T$ = 1.68 kΩ, $C_L$ = 15 pF | -30 | — | 30 | |
| Fall time | $t_f$ | (Note 1), (Note 3) | | $I_F$ = 0 → 2 mA, $R_T$ = 1.68 kΩ, $C_L$ = 15 pF | — | 3 | — | |
| Rise time | $t_r$ | (Note 1), (Note 3) | | $I_F$ = 2 → 0 mA, $R_T$ = 1.68 kΩ, $C_L$ = 15 pF | — | 3 | — | |
| Common-mode transient immunity at output high | $CM_H$ | (Note 3) | Fig. 12.1.6 | $V_{CM}$ = 1000 $V_{p-p}$, $I_F$ = 0 mA, $V_{CC}$ = 3.3 V / 5 V, $T_a$ = 25 °C, $R_T$ = 1.68 kΩ | ±20 | ±25 | — | kV/μs |
| Common-mode transient immunity at output low | $CM_L$ | (Note 3) | | $V_{CM}$ = 1000 $V_{p-p}$, $I_F$ = 2 mA, $V_{CC}$ = 3.3 V / 5 V, $T_a$ = 25 °C, $R_T$ = 1.68 kΩ | ±20 | ±25 | — | |

Note: All typical values are at $T_a$ = 25 °C.

Note 1: f = 5 MHz, duty = 50 %, input current $t_r$ = $t_f$ = 5 ns, $C_L$ is approximately 15 pF which includes probe and stray wiring capacitance.

Note 2: The propagation delay skew, $t_{psk}$, is equal to the magnitude of the worst-case difference in $t_{pHL}$ and/or $t_{pLH}$ that will be seen between units at the same given conditions (supply voltage, input current, temperature, etc).

Note 3: $R_T = R_1 + R_2$ = 1.68 kΩ
Recommendation input resistance conditions : $R_1 = R_2$ = 840 Ω

## 12. Test Circuits and Characteristics Curves

### 12.1. Test Circuits

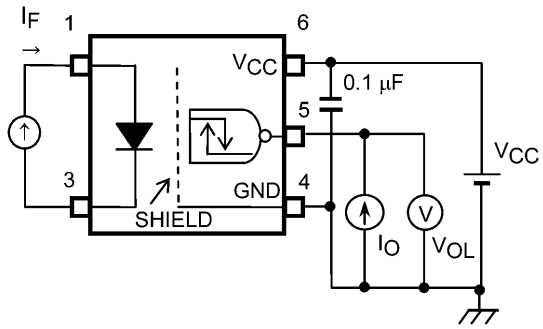



Fig. 12.1.1 $V_{OL}$ Test Circuit

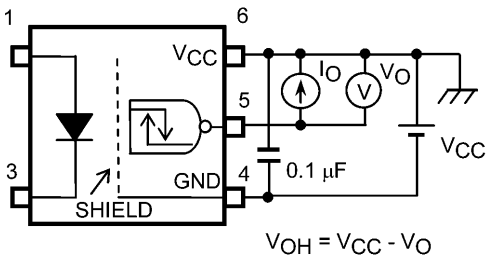



Fig. 12.1.2 $V_{OH}$ Test Circuit

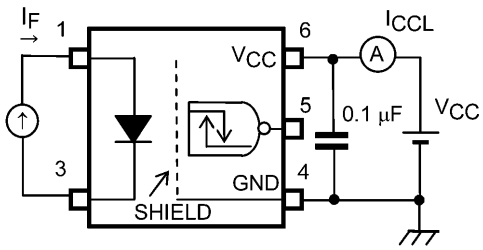



Fig. 12.1.3 $I_{CCL}$ Test Circuit

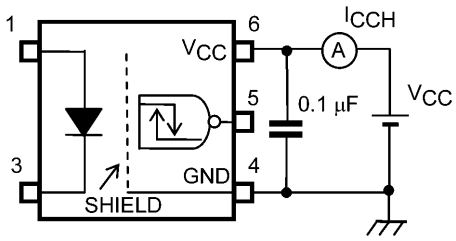
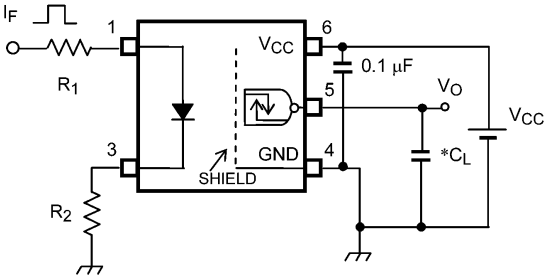
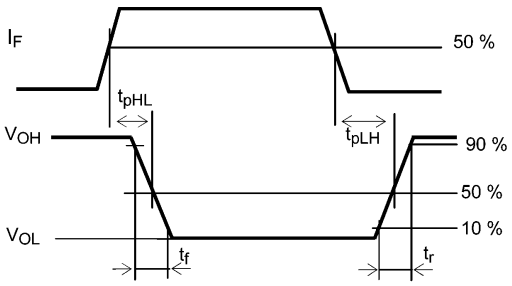



Fig. 12.1.4 $I_{CCH}$ Test Circuit

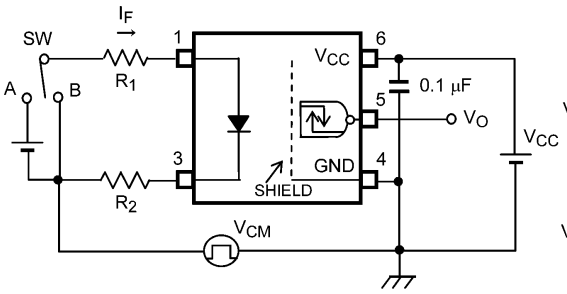
$I_F$ = 2 mA (P.G.)
(f = 5 MHz, duty = 50 %, less than $t_r = t_f$ = 5 ns)

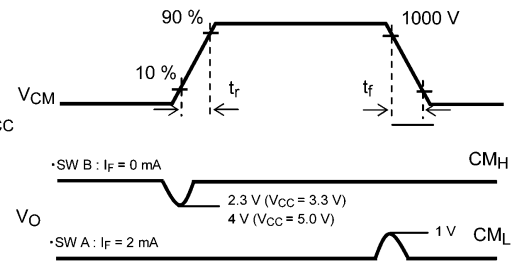



P.G.: Pulse generator
*$C_L$ is approximately 15 pF which includes probe and stray wiring capacitance.
$R_T = R_1 + R_2$

Fig. 12.1.5 Switching Time Test Circuit and Waveform




$R_T = R_1 + R_2$

$$CM_H = \frac{800(V)}{t_f(\mu s)} \qquad CM_L = \frac{800(V)}{t_r(\mu s)}$$

Fig. 12.1.6 Common-Mode Transient Immunity and Waveform

## 12.2. Characteristics Curves (Note)

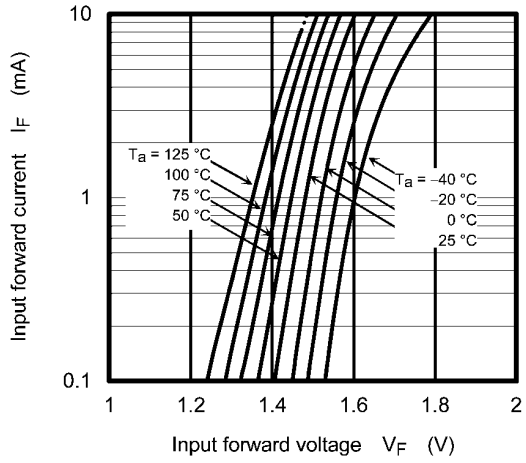



Fig. 12.2.1 $I_F$ - $V_F$

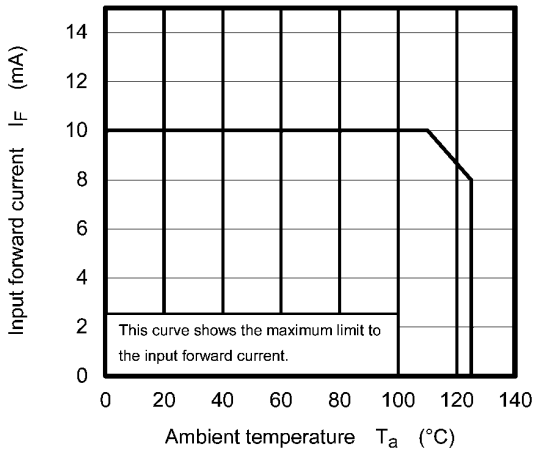



Fig. 12.2.2 $I_F$ - $T_a$

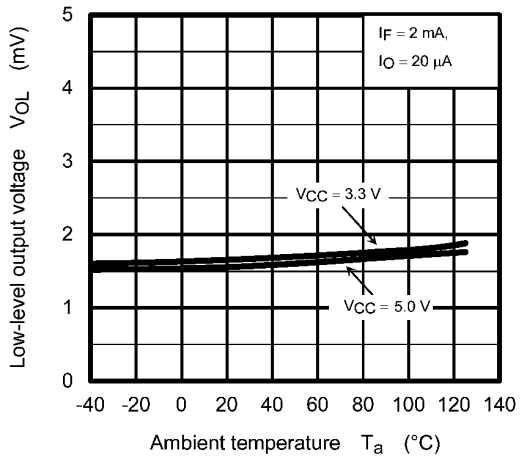



Fig. 12.2.3 $V_{OL}$ - $T_a$

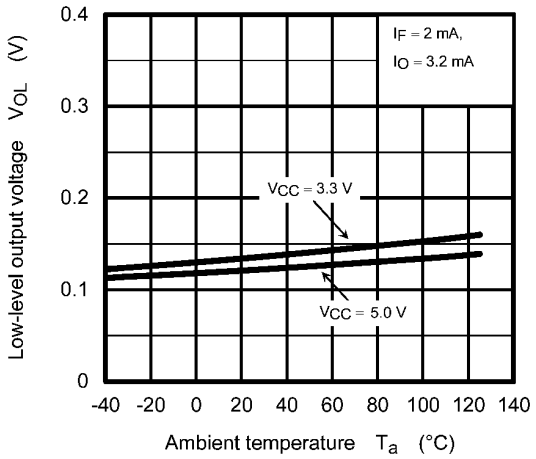



Fig. 12.2.4 $V_{OL}$ - $T_a$

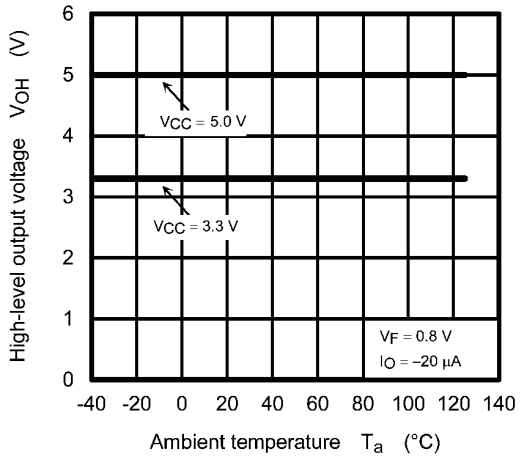



Fig. 12.2.5 $V_{OH}$ - $T_a$

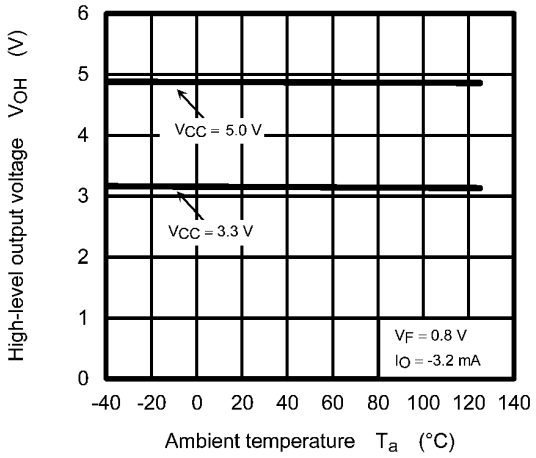



Fig. 12.2.6 $V_{OH}$ - $T_a$

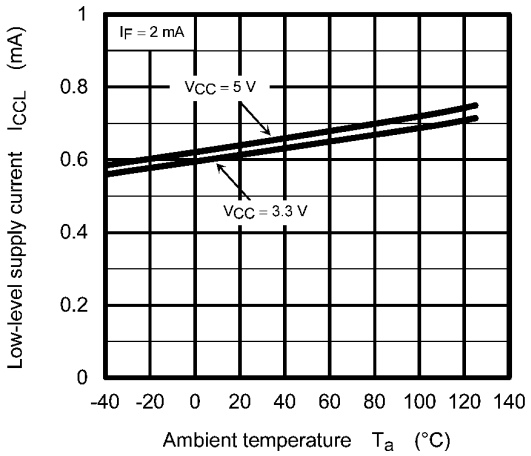



Fig. 12.2.7 $I_{CCL}$ - $T_a$

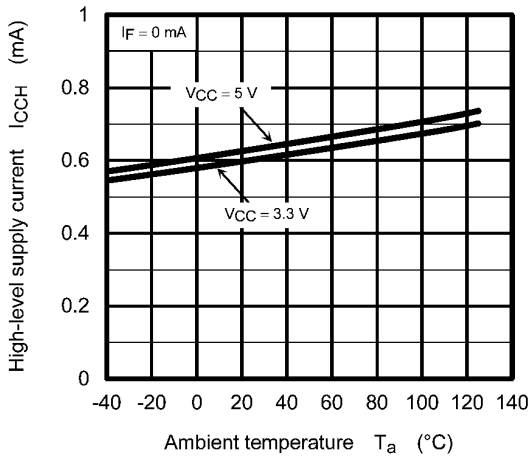



Fig. 12.2.8 $I_{CCH}$ - $T_a$

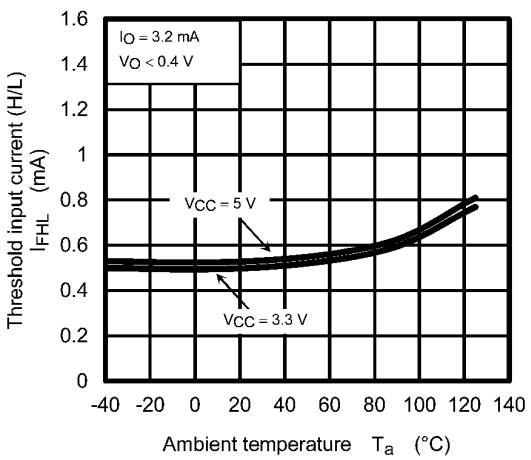



Fig. 12.2.9 $I_{FHL}$ - $T_a$

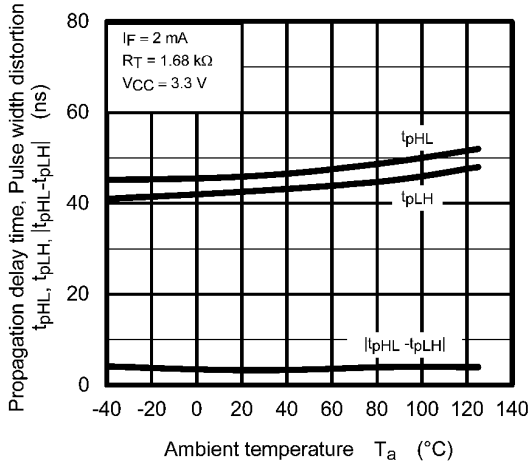



Fig. 12.2.10 $t_{pHL}$, $t_{pLH}$, $|t_{pHL}-t_{pLH}|$ - $T_a$

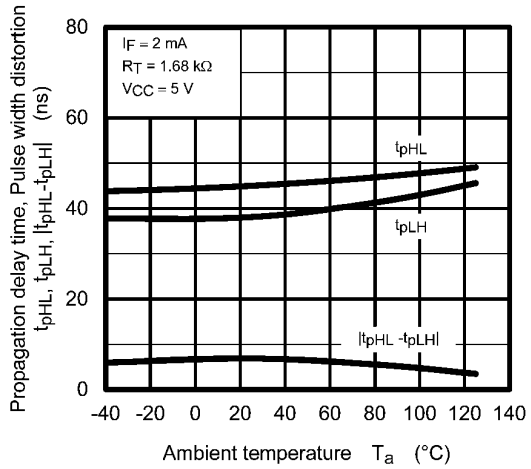



Fig. 12.2.11 $t_{pHL}$, $t_{pLH}$, $|t_{pHL}-t_{pLH}|$ - $T_a$

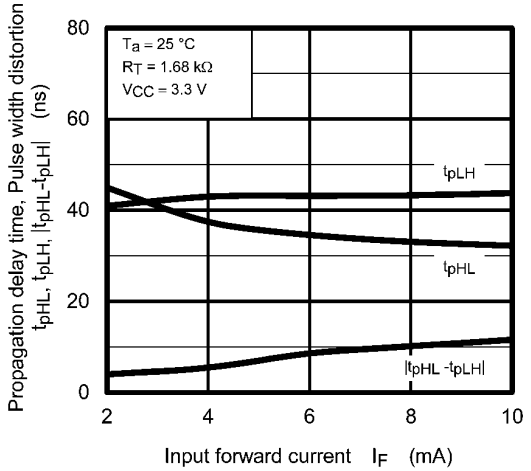



Fig. 12.2.12 $t_{pHL}$, $t_{pLH}$, $|t_{pHL}-t_{pLH}|$ - $I_F$

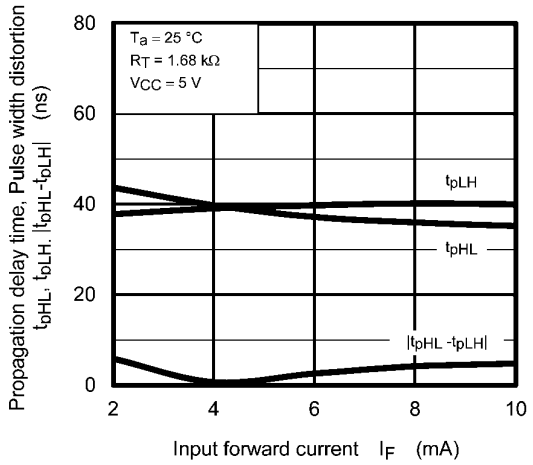



**Fig. 12.2.13 $t_{pHL}$, $t_{pLH}$, $|t_{pHL}-t_{pLH}|$ - $I_F$**

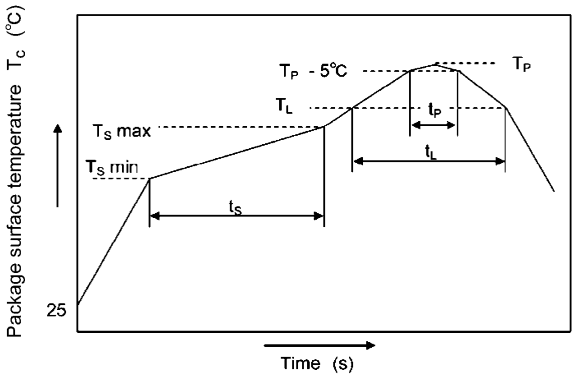
Note: The above characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.

# 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.




| | 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 |

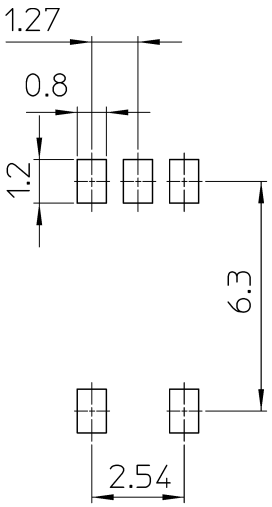
**Fig. 13.1.1 An example of a temperature profile when lead(Pb)-free solder is used**

- 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

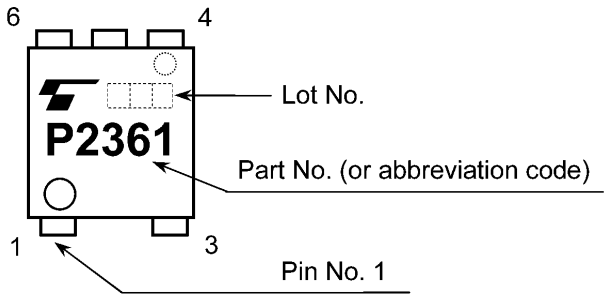
- Avoid storage locations where devices may be exposed to moisture or direct sunlight.
- Follow the precautions printed on the packing label of the device for transportation and storage.
- Keep the storage location temperature and humidity within a range of 5 °C to 35 °C and 45 % to 75 %, respectively.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




**Unit: mm**

## 15. Marking



## 16. EN60747-5-5 Option (V4) Specification

- Part number: TLP2361 **(Note 1)**
- The following part naming conventions are used for the devices that have been qualified according to option (V4) of EN60747.
  Example: TLP2361(V4-TPL,E(O
  V4: EN60747 option
  TPL: Tape type
  E: [[G]]/RoHS COMPATIBLE **(Note 2)**

Note 1: Use TOSHIBA standard type number for safety standard application.
e.g., TLP2361(V4-TPL,E(O → TLP2361

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 electronics equipment.

| Description | Symbol | Rating | Unit |
|---|---|---|---|
| Application classification<br><br>for rated mains voltage ≤150 Vrms<br>for rated mains voltage ≤300 Vrms | | <br><br>I-IV<br>I-III | — |
| Climatic classification | | 40 / 125 / 21 | — |
| Pollution degree | | 2 | — |
| Maximum operating insulation voltage | $V_{IORM}$ | 707 | Vpeak |
| Input to output test voltage, Method A<br>$V_{pr}$ = 1.6 × $V_{IORM}$, 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 × $V_{IORM}$, 100 % production test<br>$t_p$ = 1 s, partial discharge < 5 pC | $V_{pr}$ | 1325 | Vpeak |
| Highest permissible overvoltage<br>(transient overvoltage, $t_{pr}$ = 60 s) | $V_{TR}$ | 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 | <br><br>$I_{si}$<br>$P_{so}$<br>$T_s$ | <br><br>250<br>400<br>150 | <br><br>mA<br>mW<br>°C |
| Insulation resistance $V_{IO}$ = 500 V, $T_a$ = 25 °C<br>$V_{IO}$ = 500 V, $T_a$ = 100 °C<br>$V_{IO}$ = 500 V, $T_a$ = $T_s$ | $R_{si}$ | ≥ $10^{12}$<br>≥ $10^{11}$<br>≥ $10^{9}$ | Ω |

**Fig. 16.1 EN60747 Isolation Characteristics**

| | | |
|---|---|---|
| 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 |

**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.

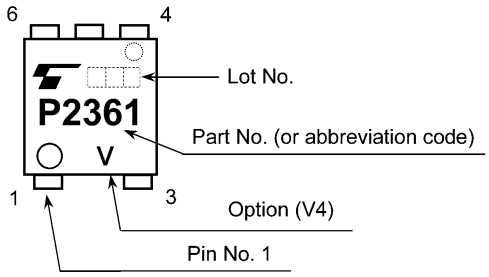



**Fig. 16.3 Marking Example (Note)**

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

Figure 1 Partial discharge measurement procedure according to EN60747
Destructive test for qualification and sampling tests.

Method A

(for type and sampling tests, destructive tests)

| | |
|---|---|
| $t_1$, $t_2$ | = 1 to 10 s |
| $t_3$, $t_4$ | = 1 s |
| $t_p$ (Measuring time for partial discharge) | = 10 s |
| $t_b$ | = 12 s |
| $t_{ini}$ | = 60 s |

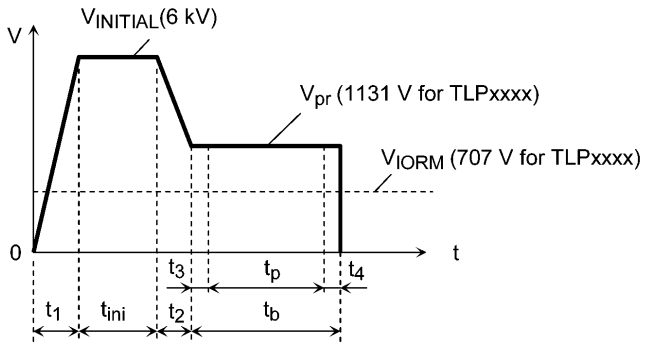



Figure 2 Partial discharge measurement procedure according to EN60747
Non-destructive test for100 % inspection.

Method B

(for sample test, non-destructive test)

| | |
|---|---|
| $t_3$, $t_4$ | = 0.1 s |
| $t_p$ (Measuring time for partial discharge) | = 1 s |
| $t_b$ | = 1.2 s |

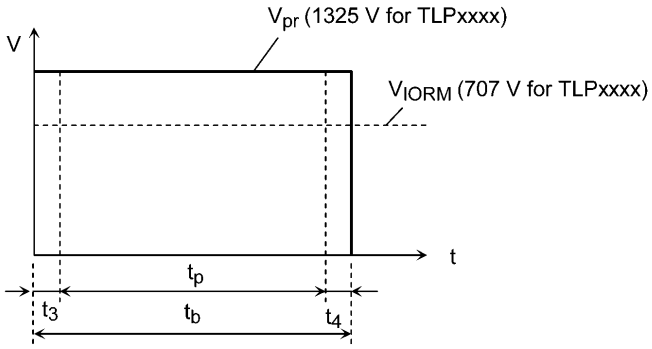



Figure 3 Dependency of maximum safety ratings on ambient temperature

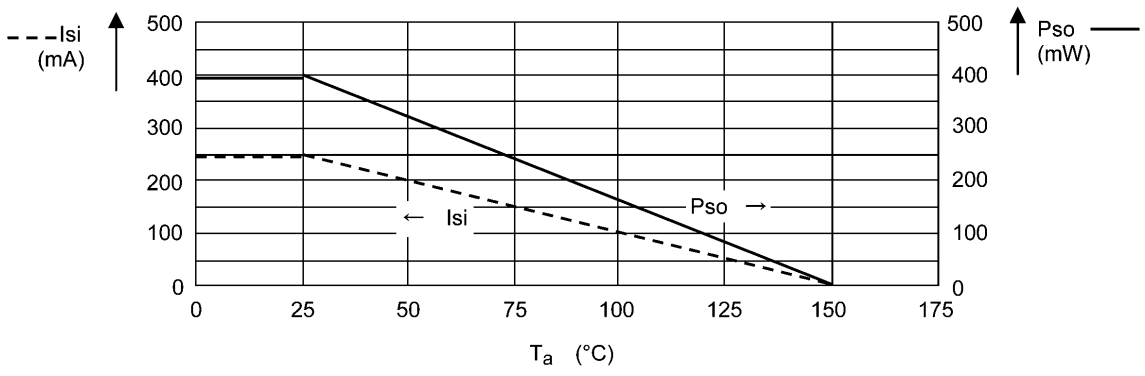
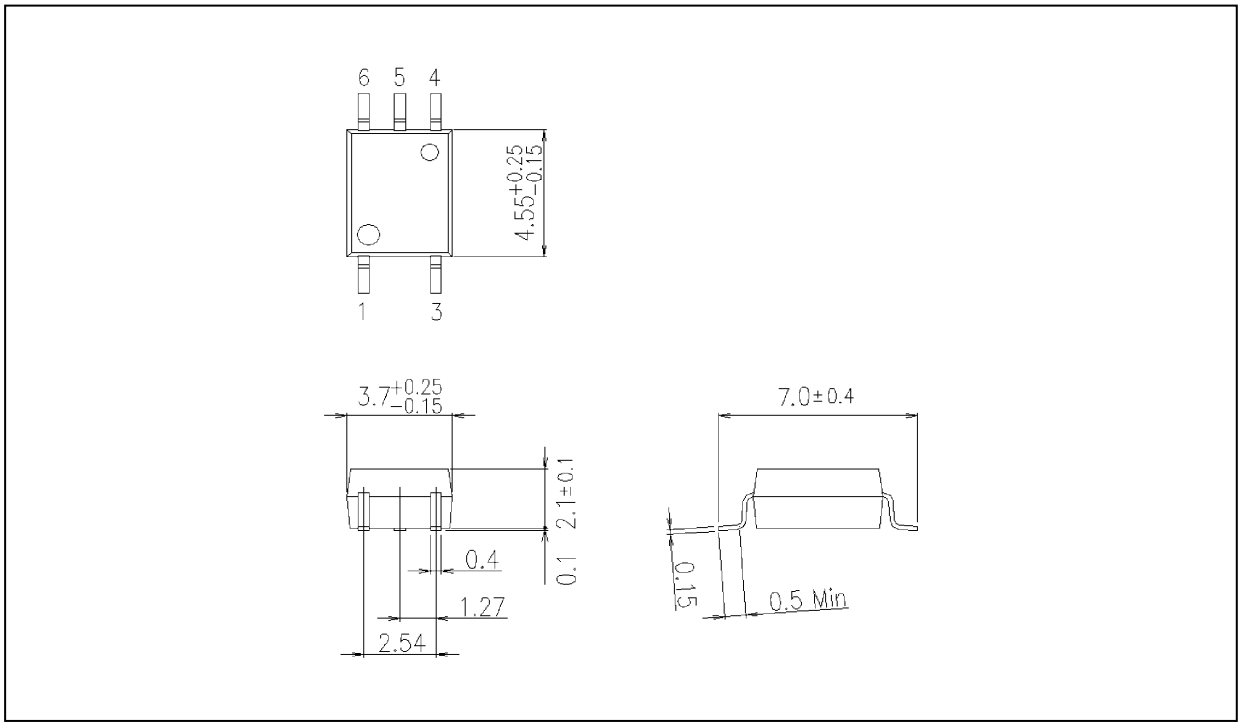



**Fig. 16.4 Measurement Procedure**

## Package Dimensions

Unit: mm




Weight: 0.08 g (typ.)

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

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