

# TLP2161

## 1. Applications

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

## 2. General

The Toshiba TLP2161 consists of a high-output GaAs light-emitting diode coupled with a high-speed photo-diode-transistor chip. It is housed in the SO8 package. It has two circuits built into a single SO8 package, which can reduce the mounting area.

This photocoupler guarantees operation at up to 125 °C and on supplies from 2.7 V to 5.5 V. Since TLP2161 has guaranteed 2 mA low supply current ( $I_{CC1}/I_{CC2}$ ), and 1.6 mA ( $T_a = 125\text{ °C}$ ) 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 TLP2161 has an internal Faraday shield that provides a guaranteed common-mode transient immunity of  $\pm 20\text{ kV}/\mu\text{s}$ .

## 3. Features

- (1) Inverter logic type (Totem pole output)
- (2) Package: SO8
- (3) Operating temperature: -40 to 125 °C
- (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) ( $T_a = 105\text{ °C}$ )  
: 1.6 mA (max) ( $T_a = 125\text{ °C}$ )
- (7) Supply current: 2 mA (max)
- (8) Common-mode transient immunity:  $\pm 20\text{ kV}/\mu\text{s}$  (min)
- (9) Isolation voltage: 2500 Vrms (min)
- (10) Safety standards

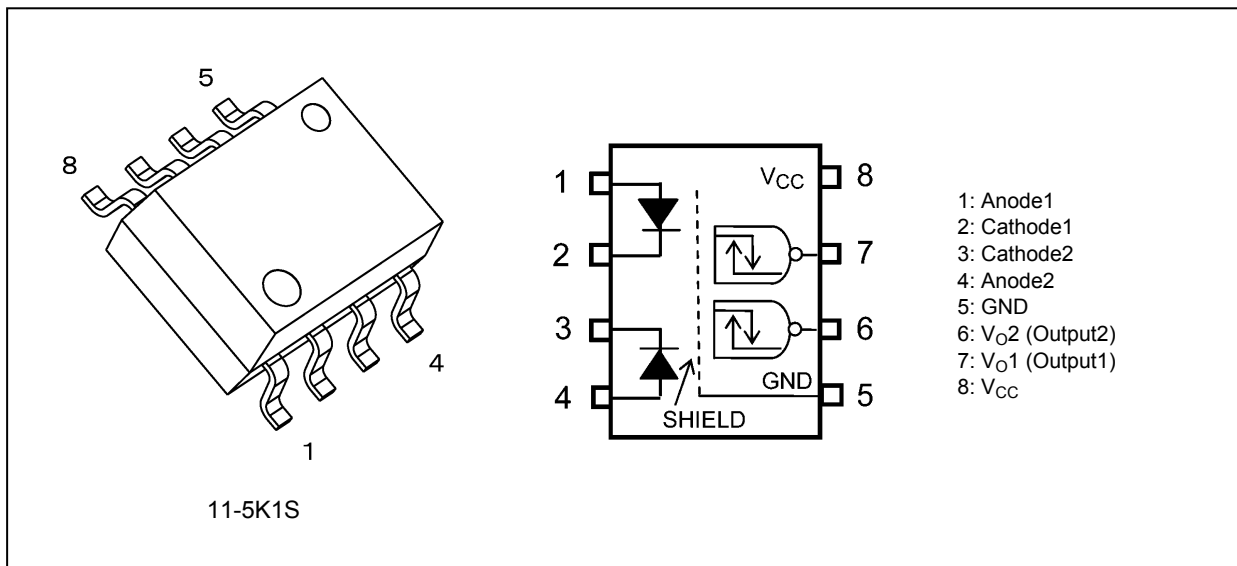
UL-under application: UL1577 File No.E67349

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

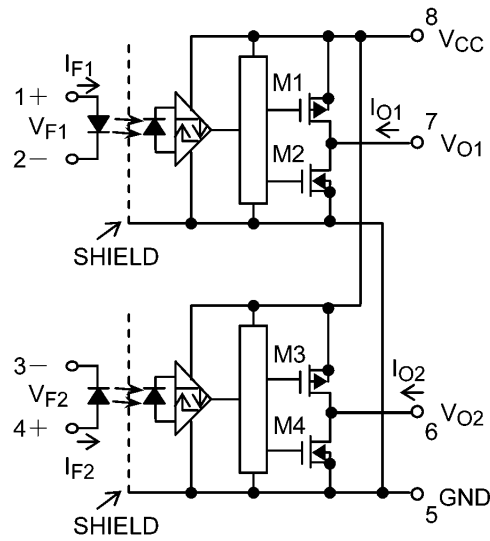
VDE-under application: Option (V4) EN60747-5-5 (approval pending) **(Note)**

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

## 4. Packaging and Pin Assignment



**5. Internal Circuit (Note)**



Note: A 0.1- $\mu$ F bypass capacitor must be connected between pin 8 and pin 5.

**6. Principle of Operation**

**6.1. Truth Table**

Input	LED1(2)	M1(3)	M2(4)	Output1(2)
H	ON	OFF	ON	L
L	OFF	ON	OFF	H

**6.2. Mechanical Parameters**

Characteristics	Min	Unit
Creepage distances	4.2	mm
Clearance	4.2	
Internal isolation thickness	—	

**7. Absolute Maximum Ratings (Note) (Unless otherwise specified, T<sub>a</sub> = 25 °C)**

	Characteristics	Symbol	Note	Rating	Unit
LED	Input forward current	I <sub>F</sub>	(Note 1)	10	mA
	Input forward current derating (T <sub>a</sub> ≥ 110 °C)	ΔI <sub>F</sub> /ΔT <sub>a</sub>	(Note 1)	-0.13	mA/°C
	Input forward current (pulsed)	I <sub>FP</sub>	(Note 1), (Note 2)	40	mA
	Input forward current derating (pulsed) (T <sub>a</sub> ≥ 110 °C)	ΔI <sub>FP</sub> /ΔT <sub>a</sub>	(Note 1)	-1.0	mA/°C
	Peak transient input forward current	I <sub>FPT</sub>	(Note 1), (Note 3)	1	A
	Peak transient input forward current derating (T <sub>a</sub> ≥ 110 °C)	ΔI <sub>FPT</sub> /ΔT <sub>a</sub>	(Note 1)	-25	mA/°C
	Input power dissipation	P <sub>D</sub>	(Note 1)	20	mW
	Input power dissipation derating (T <sub>a</sub> ≥ 110 °C)	ΔP <sub>D</sub> /ΔT <sub>a</sub>	(Note 1)	-0.5	mW/°C
	Input reverse voltage	V <sub>R</sub>	(Note 1)	5	V
Detector	Output current	I <sub>O</sub>	(Note 1)	10	mA
	Output voltage	V <sub>O</sub>	(Note 1)	6	V
	Supply voltage	V <sub>CC</sub>		6	
	Output power dissipation	P <sub>O</sub>	(Note 1)	20	mW
	Output power dissipation derating (T <sub>a</sub> ≥ 110 °C)	ΔP <sub>O</sub> /ΔT <sub>a</sub>	(Note 1)	-0.5	mW/°C
Common	Operating temperature	T <sub>opr</sub>		-40 to 125	°C
	Storage temperature	T <sub>stg</sub>		-55 to 150	
	Lead soldering temperature (10 s)	T <sub>sol</sub>		260	
	Isolation voltage (AC, 1 min, R.H. ≤ 60 %)	BV <sub>S</sub>	(Note 4)	2500	

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: Each channel

Note 2: Pulse width (PW) ≤ 1 ms, duty = 50 %

Note 3: Pulse width (PW) ≤ 1 μs, 300 pps

Note 4: 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
Input on-state current	I <sub>F(ON)</sub>	(Note 1), (Note 2)	2	—	6	mA
Input off-state voltage	V <sub>F(OFF)</sub>	(Note 1)	0	—	0.8	V
Supply voltage	V <sub>CC</sub>	(Note 3)	2.7	3.3 / 5.0	5.5	
Operating temperature	T <sub>opr</sub>	(Note 3)	-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 8 (V<sub>CC</sub>) and pin 5 (GND) 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: Each channel

Note 2: The rise and fall times of the input on-current should be less than 0.5 μs.

Note 3: 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	$V_F$	(Note 1)		$I_F = 2$ mA, $T_a = 25$ °C	1.35	1.50	1.65	V
Input forward voltage temperature coefficient	$\Delta V_F / \Delta T_a$	(Note 1)		$I_F = 2$ mA	—	-2.0	—	mV/°C
Input reverse current	$I_R$	(Note 1)		$V_R = 5$ V, $T_a = 25$ °C	—	—	10	μA
Input capacitance	$C_t$	(Note 1)		$V = 0$ V, $f = 1$ MHz, $T_a = 25$ °C	—	20	—	pF
Low-level output voltage	$V_{OL}$	(Note 1)	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	$V_{OH}$	(Note 1)	Fig. 12.1.2	$V_F = 0.8$ V, $I_O = -20$ μA, $V_{CC} = 3.3$ V	3.2	3.29	—	
				$V_F = 0.8$ V, $I_O = -20$ μA, $V_{CC} = 5.0$ V	4.9	4.99	—	
				$V_F = 0.8$ V, $I_O = -3.2$ mA, $V_{CC} = 3.3$ V	2.3	3.15	—	
				$V_F = 0.8$ V, $I_O = -3.2$ mA, $V_{CC} = 5.0$ V	4.0	4.87	—	
Low-level supply current	$I_{CCL}$		Fig. 12.1.3	$I_{F1} = I_{F2} = 2$ mA	—	1.6	2	mA
High-level supply current	$I_{CCH}$		Fig. 12.1.4	$I_{F1} = I_{F2} = 0$ mA	—	1.3	2	
Threshold input current (H/L)	$I_{FHL}$	(Note 1)		$I_O = 3.2$ mA, $V_O < 0.4$ V, $T_a = -40$ to $105$ °C	—	0.4	1.3	
				$I_O = 3.2$ mA, $V_O < 0.4$ V, $T_a = -40$ to $125$ °C	—	0.4	1.6	

Note: All typical values are at  $V_{CC} = 5.0$  V,  $T_a = 25$  °C.

Note 1: Each channel

**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)	$V = 0$ V, $f = 1$ MHz	—	0.8	—	pF
Isolation resistance	$R_S$	(Note 1)	$V = 500$ V, R.H. $\leq 60$ %	$1 \times 10^{12}$	$1 \times 10^{14}$	—	Ω
Isolation voltage	$BV_S$	(Note 1)	AC, 1 min	2500	—	—	Vrms
			AC, 1 s in oil	—	5000	—	
			DC, 1 min in oil	—	5000	—	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 (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	$I_F = 0 \rightarrow 2$ mA, $R_T = 1.68$ k $\Omega$ , $C_L = 15$ pF	—	49	80	ns
Propagation delay time (L/H)	$t_{pLH}$	(Note 1), (Note 3)		$I_F = 2 \rightarrow 0$ mA, $R_T = 1.68$ k $\Omega$ , $C_L = 15$ pF	—	44	80	
Pulse width distortion	$ \mathbf{t_{pHL} - t_{pLH}} $	(Note 1), (Note 3)		$I_F = 2$ mA, $R_T = 1.68$ k $\Omega$ , $C_L = 15$ pF	—	5	25	
Propagation delay skew (device to device)	$t_{psk}$	(Note 1), (Note 2), (Note 3)		$I_F = 2$ mA, $R_T = 1.68$ k $\Omega$ , $C_L = 15$ pF	-30	—	30	
Fall time	$t_f$	(Note 1), (Note 3)		$I_F = 0 \rightarrow 2$ mA, $R_T = 1.68$ k $\Omega$ , $C_L = 15$ pF	—	3	—	
Rise time	$t_r$	(Note 1), (Note 3)		$I_F = 2 \rightarrow 0$ mA, $R_T = 1.68$ k $\Omega$ , $C_L = 15$ pF	—	3	—	
Common-mode transient immunity at output high	$CM_H$	(Note 3)	Fig. 12.1.6	$I_F = 0$ mA, $V_{CC} = 3.3 / 5$ V, $V_{CM} = 1000$ V <sub>p-p</sub> , $R_T = 1.68$ k $\Omega$ , $T_a = 25$ °C	$\pm 20$	$\pm 25$	—	kV/ $\mu$ s
Common-mode transient immunity at output low	$CM_L$	(Note 3)		$I_F = 2$ mA, $V_{CC} = 3.3 / 5$ V, $V_{CM} = 1000$ V <sub>p-p</sub> , $R_T = 1.68$ k $\Omega$ , $T_a = 25$ °C	$\pm 20$	$\pm 25$	—	

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

Note: Each channel

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

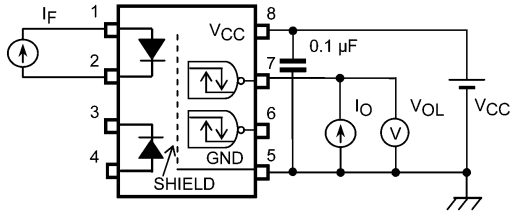
Note 2: The propagation delay skew,  $t_{psk}$ , is equal to the magnitude of the worst-case difference in  $t_{pHL}$  and/or  $t_{pLH}$  that will be seen between units at the same given conditions (supply voltage, input current, temperature, etc).

Note 3:  $R_T = R_1 + R_2 = 1.68$  k $\Omega$

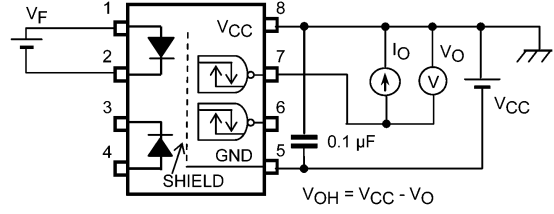
Recommendation input resistance conditions :  $R_1 = R_2 = 840\Omega$

**12. Test Circuits and Characteristics Curves**

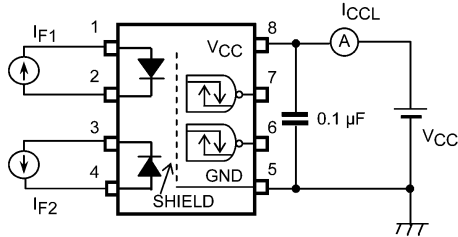
**12.1. Test Circuits**



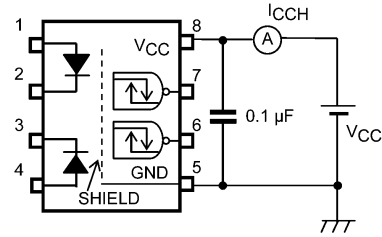
**Fig. 12.1.1 VOL Test Circuit**



**Fig. 12.1.2 VOH Test Circuit**

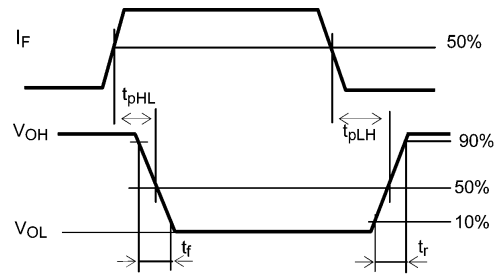
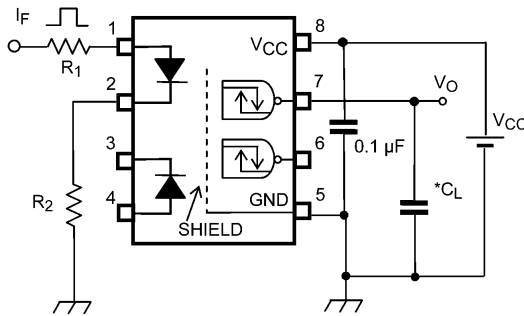


**Fig. 12.1.3 ICCL Test Circuit**



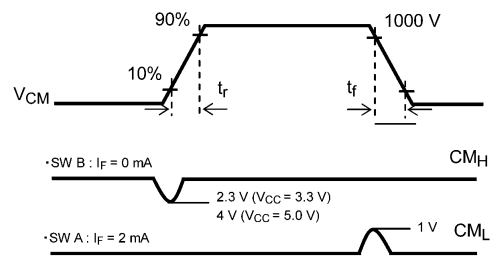
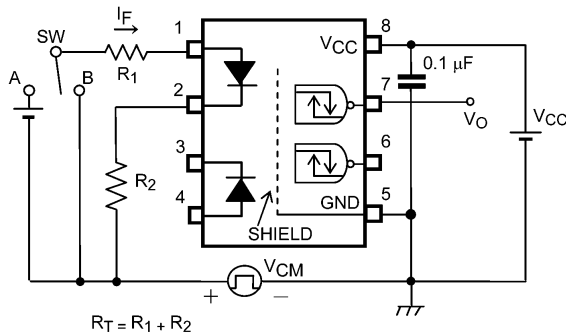
**Fig. 12.1.4 ICCH Test Circuit**

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



P.G.: Pulse generator  
 \*CL 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**



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

**Fig. 12.1.6 Common-Mode Transient Immunity Test Circuit and Waveform**

12.2. Characteristics Curves (Note)

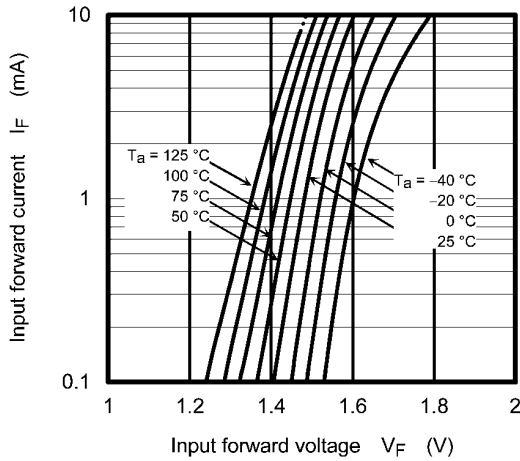


Fig. 12.2.1  $I_F - V_F$

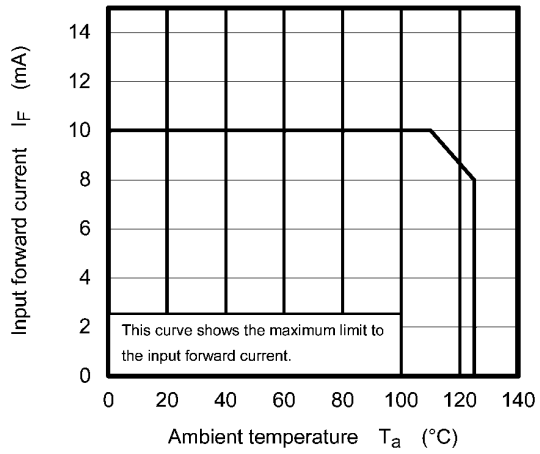


Fig. 12.2.2  $I_F - T_a$

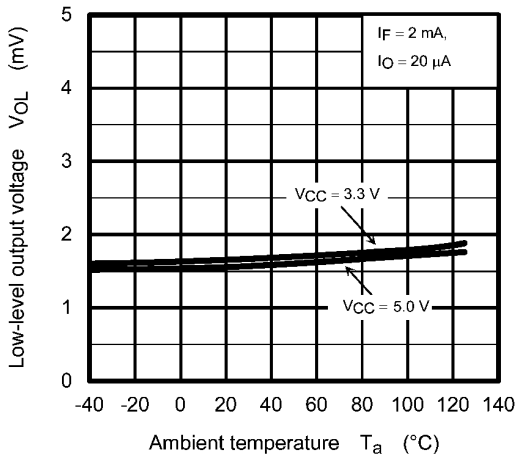


Fig. 12.2.3  $V_{OL} - T_a$

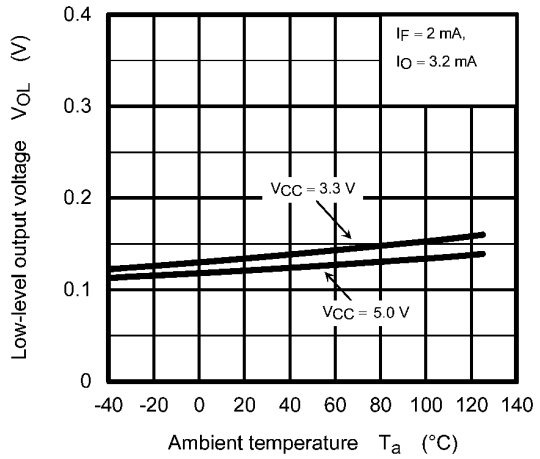


Fig. 12.2.4  $V_{OL} - T_a$

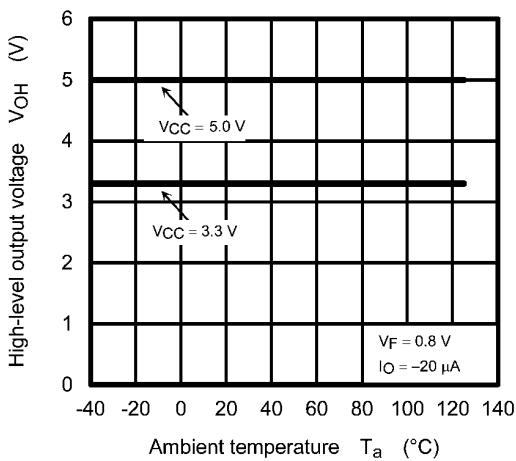


Fig. 12.2.5  $V_{OH} - T_a$

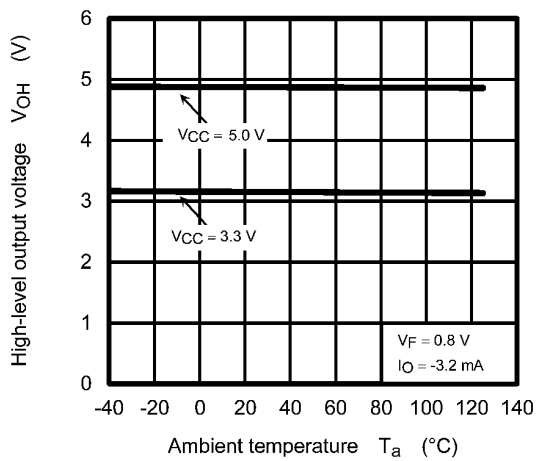


Fig. 12.2.6  $V_{OH} - T_a$

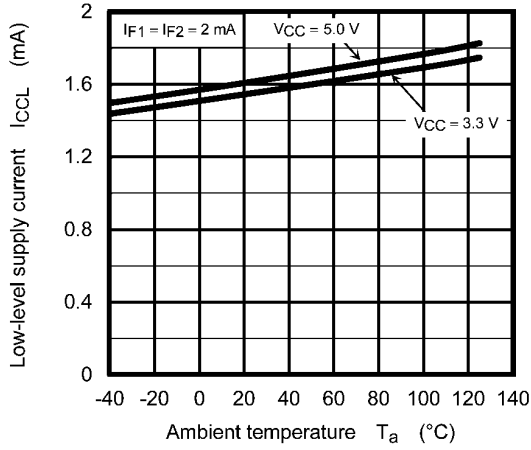


Fig. 12.2.7  $I_{CCL} - T_a$

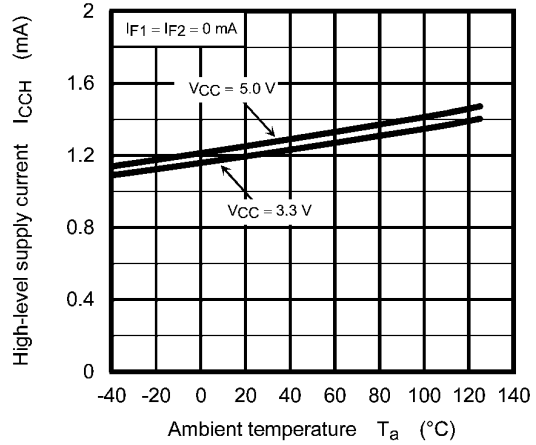


Fig. 12.2.8  $I_{CCH} - T_a$

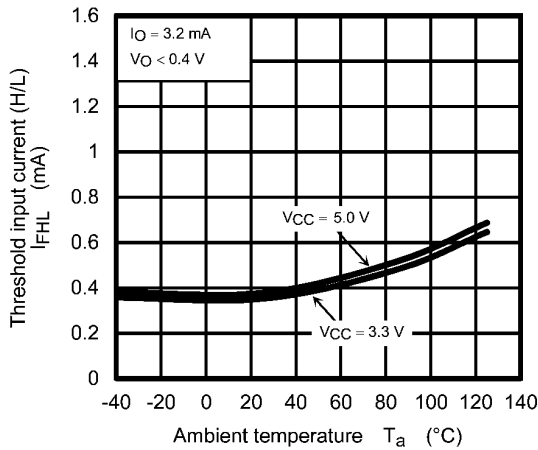


Fig. 12.2.9  $I_{FHL} - T_a$

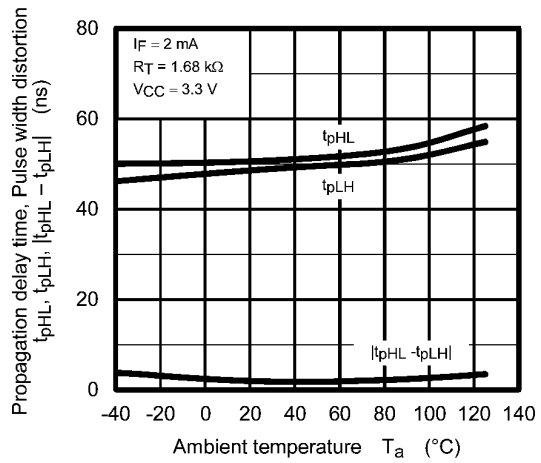


Fig. 12.2.10  $t_{pHL}$ ,  $t_{pLH}$ ,  $|t_{pHL} - t_{pLH}| - T_a$

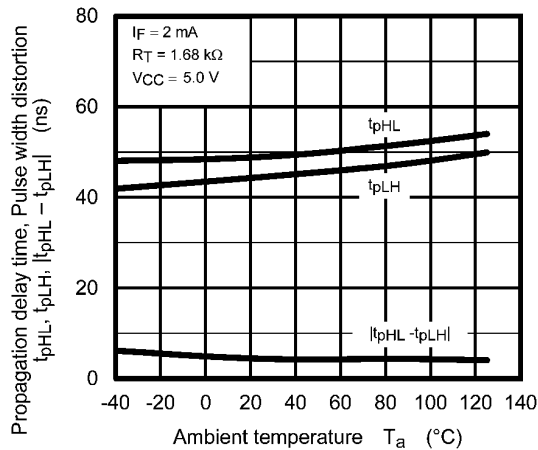


Fig. 12.2.11  $t_{pHL}$ ,  $t_{pLH}$ ,  $|t_{pHL} - t_{pLH}| - T_a$

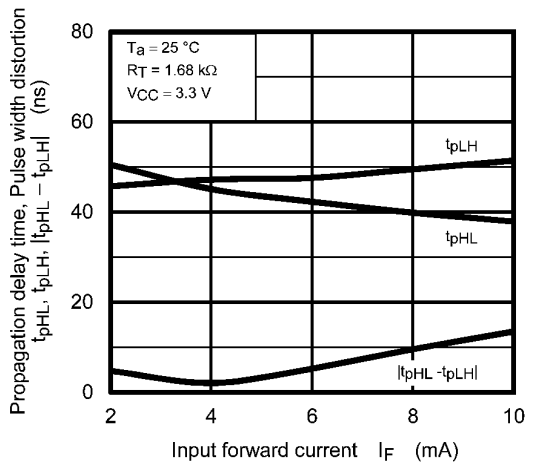
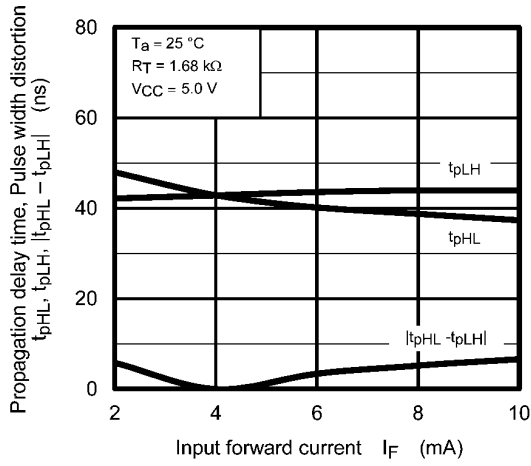


Fig. 12.2.12  $t_{pHL}$ ,  $t_{pLH}$ ,  $|t_{pHL} - t_{pLH}| - I_F$





**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**

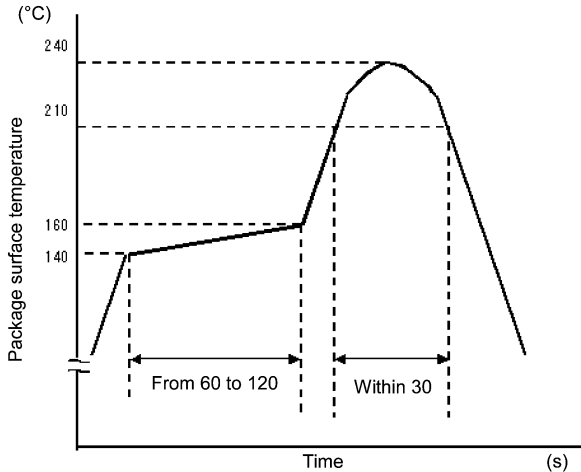
**13.1. Precautions for Soldering**

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.

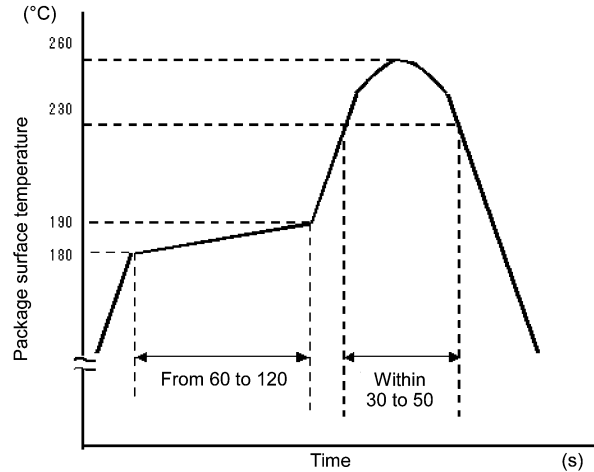
- When using soldering reflow (See Fig. 13.1.1 and 13.1.2)

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)

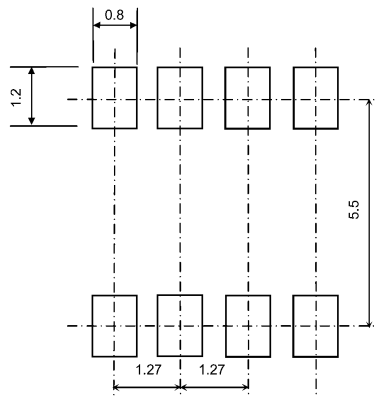
Complete soldering within 10 seconds for lead temperature not exceeding 260 °C or within 3 seconds not exceeding 350 °C

Heating by soldering iron must be done only once per lead.

**13.2. Precautions for General Storage**

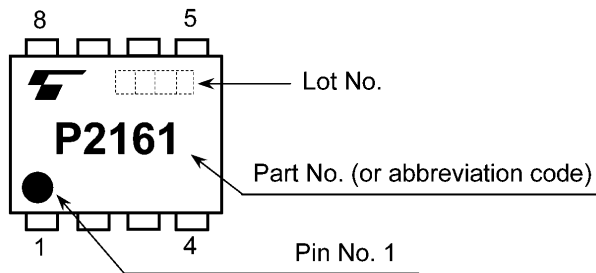
- Avoid storage locations where devices may be exposed to moisture or direct sunlight
- Follow the precautions printed on the packing label of the device for transportation and storage.
- Keep the storage location temperature and humidity within a range of 5 °C to 35 °C and 45 % to 75 %, respectively.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



Unit: mm

15. Marking



## 16. Embossed-Tape Packing (TP) Specification for Mini-Flat Photocouplers

### 16.1. Applicable Package

Package Name	Product Type
SO8	Photocoupler

### 16.2. Product Naming Conventions

Type of package used for shipment is denoted by a symbol suffix after a part number. The method of classification is as below.

Example) TLP2161 (TP,F)

Part number: TLP2161

Tape type: TP

[[G]]/RoHS COMPATIBLE: F (Note)

Note: 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.

### 16.3. Tape Dimensions Specification

#### 16.3.1. Orientation of Device in Relation to Direction of Feed

Device orientation in the carrier cavities as shown in Fig. 16.3.1.1

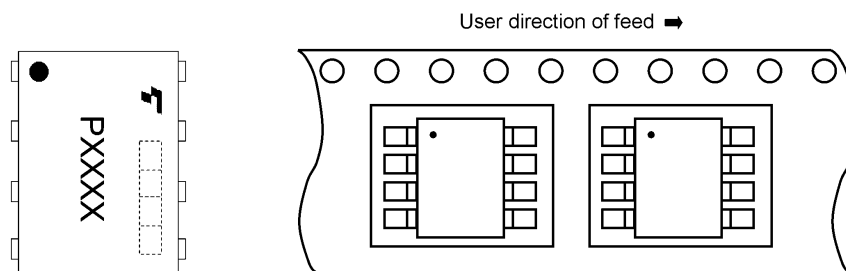


Fig. 16.3.1.1 Device Orientation

#### 16.3.2. Packing Quantity

Reel: 2500 pcs per reel

#### 16.3.3. Empty Cavities

Table 16.3.3.1 Empty Cavities

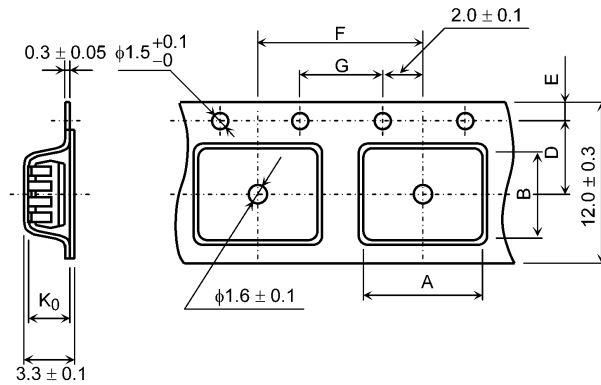
Characteristics	Criterion	Remarks
Occurrences of 2 or more successive empty cavities	0	Within any given 40-mm section of tape, not including leader and trailer
Single empty cavity	6 devices (max) per reel	Not including leader and trailer

#### 16.3.4. Tape Leader and Trailer

The start end of the tape has 50 or more empty cavities. The hub end of the tape has 50 or more empty cavities and two empty turns only for a cover tape.

**16.3.5. Tape Dimensions**

- (1) Tape material: Plastic (for protection against static electricity)
- (2) Dimensions: The tape dimensions area as shown in Table 16.3.5.1



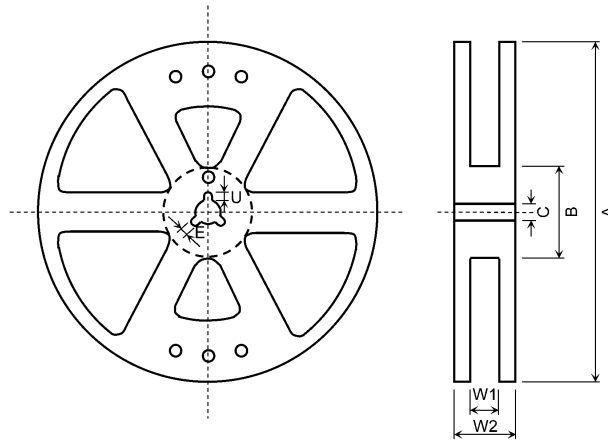
**Fig. 16.3.5.1 Tape Forms**

**Table 16.3.5.1 Tape Dimensions (unit: mm, tolerance:  $\pm 0.1$ )**

Symbol	Dimension	Remark
A	6.5	—
B	5.6	—
D	5.5	Center line of embossed cavity and sprocket hole
E	1.75	Distance between tape edge and sprocket hole center
F	8.0	Cumulative error $+0.1/-0.3$ (max) per 10 empty cavities holes
G	4.0	Cumulative error $+0.1/-0.3$ (max) per 10 sprocket holes
$K_0$	3.1	Internal space

**16.3.6. Reel Specification**

- (1) Material: Plastic
- (2) Dimensions: The reel dimensions are as shown in Table 16.3.6.1



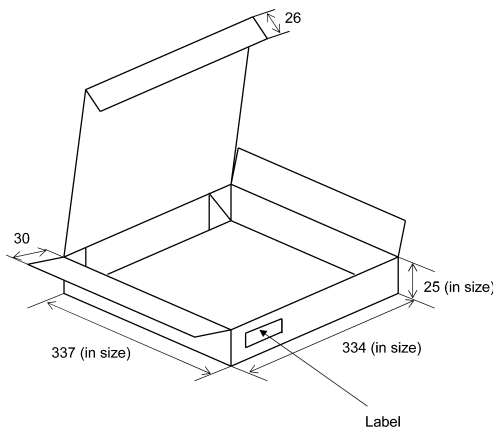
**Fig. 16.3.6.1 Reel Forms**

**Table 16.3.6.1 Reel Dimensions (unit: mm)**

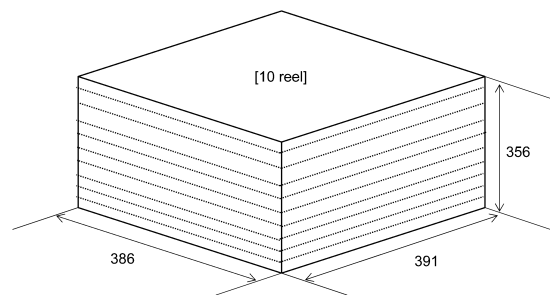
Symbol	Dimension
A	$\phi 330 \pm 2$
B	$\phi 80 \pm 1$
C	$\phi 13 \pm 0.5$
E	$2.0 \pm 0.5$
U	$4.0 \pm 0.5$
W1	$13.5 \pm 0.5$
W2	$17.5 \pm 1.0$

**16.4. Packing (Note)**

Either one reel or ten reels of photocouplers are packed in a shipping carton.



**Fig. 16.4.1 1 reel/carton (unit: mm)**



**Fig. 16.4.2 10 reel/carton (unit: mm)**

Note: Taping reel diameter:  $\phi 330$  mm

**16.5. Label Format**

- (1) Carton: The label provides the part number, quantity, lot number, the Toshiba logo, etc.
- (2) Reel: The label provides the taping name (TP), quantity, lot number, etc.

**16.6. Ordering Information**

When placing an order, please specify the part number, tape type and quantity as shown in the following example.

Example) TLP2161 (TP,F) 2500 pcs

Part number: TLP2161

Tape type: TP

[[G]]/RoHS COMPATIBLE: F (**Note**)

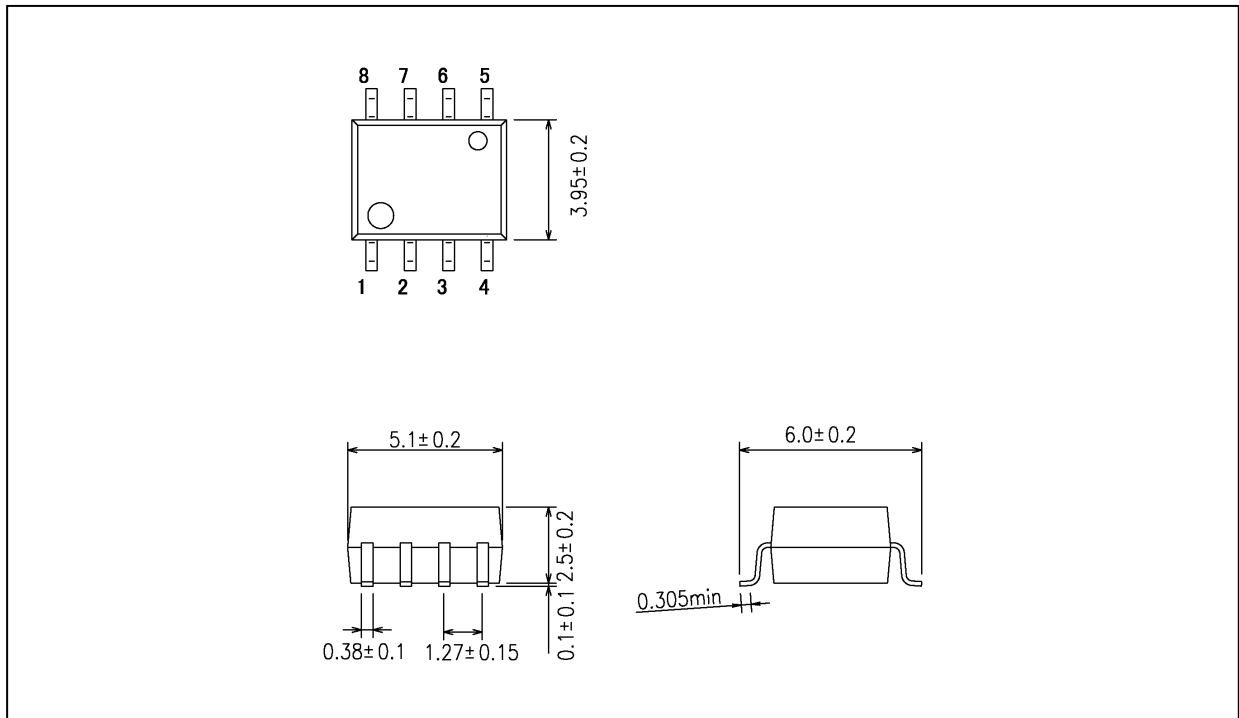
Quantity (must be a multiple of 2500)

Note : 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.

**Package Dimensions**

Unit: mm



Weight: 0.11 g (typ.)

Package Name(s)
TOSHIBA: 11-5K1S



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