

# TLP2404

IPM (Intelligent Power Module)

Industrial Inverter

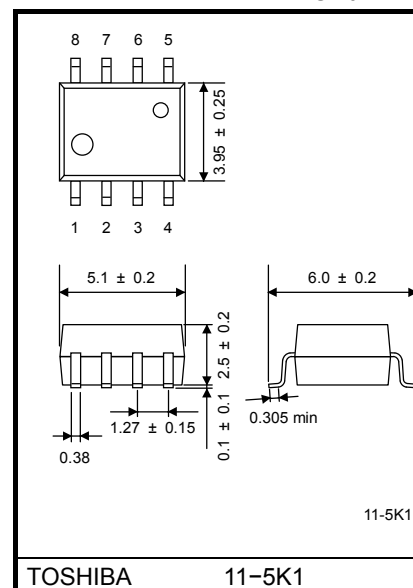
Operate at high ambient temperatures up to 125°C

The Toshiba TLP2404 consists of GaAlAs infrared light emitting diodes and integrated high gain, high-speed photodetectors. The TLP2404 is housed in the SO8 package. The output stage is an open collector type.

The photodetector has an internal Faraday shield that provides a guaranteed common-mode transient immunity of  $\pm 15 \text{ kV}/\mu\text{s}$ . TLP2404 guarantees minimum and maximum of propagation delay time, switching speed dispersion, and high common mode transient immunity. Therefore TLP2404 is suitable for isolation interface between IPM (Intelligent Power Module) and control IC circuits in motor control application.

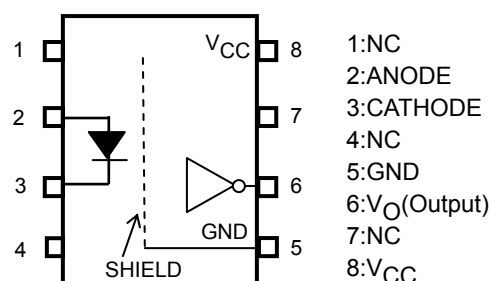
- Inverter logic type (Open collector output)
- Package type: SO8
- Guaranteed performance over temperature: -40 to 125°C
- Power supply voltage: -0.5 to 30 V
- Threshold Input Current:  $I_{FHL} = 5.0 \text{ mA}(\text{max})$
- Propagation delay time ( $t_{pHL}/t_{pLH}$ ):  $t_{pHL} = 400\text{ns}(\text{max})$   
 $t_{pLH} = 550\text{ns}(\text{max})$
- Switching Time Dispersion ( $|t_{pHL} - t_{pLH}|$ ):  $400\text{ns}(\text{max})$
- Common mode transient immunity:  $\pm 15\text{kV}/\mu\text{s}(\text{min})$
- Isolation voltage:  $3750\text{Vrms}(\text{min})$
- UL approved : UL1577, File No.E67349
- c-UL approved  
:CSA Component Acceptance Service No. 5A, File No.E67349
- Option (V4)  
VDE approved : EN60747-5-2 Certificate No.40029841  
Maximum operating insulation voltage :  $565 \text{ Vpk}$   
Highest permissible over-voltage :  $6000 \text{ Vpk}$   
( Note ) When a EN60747-5-2 approved type is needed, please designate the "Option(V4)"

Unit: mm



Weight: 0.11 g (Typ.)

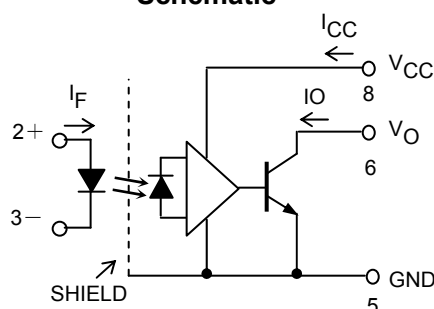
### Pin Configuration (Top View)



### Truth Table

Input	LED	Output
H	ON	L
L	OFF	H

### Schematic



## Absolute Maximum Ratings (Ta = 25°C)

Characteristic		Symbol	Rating	Unit
LED	Forward Current	$I_F$	25	mA
	Forward Current Derating (Ta ≥ 110°C)	$\Delta I_F / ^\circ\text{C}$	-0.67	mA/°C
	Peak Transient Forward Current (Note 1)	$I_{FPT}$	50	mA
	Peak Transient Forward Current Derating (Ta ≥ 110°C)	$\Delta I_{FPT} / ^\circ\text{C}$	-1.34	mA/°C
	Reverse Voltage	$V_R$	5	V
Detector	Output Current (Ta ≤ 125°C)	$I_O$	15	mA
	Output Voltage	$V_O$	-0.5 to 30	V
	Supply Voltage	$V_{CC}$	-0.5 to 30	V
	Output Power Dissipation	$P_O$	80	mW
	Output Power Dissipation Derating (Ta ≥ 110°C)	$\Delta P_O / ^\circ\text{C}$	-2.0	mW/°C
Operating Temperature Range		$T_{opr}$	-40 to 125	°C
Storage Temperature Range		$T_{stg}$	-55 to 150	°C
Lead Soldering Temperature (10 s)		$T_{sol}$	260	°C
Isolation Voltage (AC, 1 min., R.H. ≤ 60%, Ta = 25°C) (Note 2)		$BV_s$	3750	$V_{rms}$

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 ≤ 1ms, duty=50%.

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

## Recommended Operating Conditions

Characteristic	Symbol	Min	Typ.	Max	Unit
Input Current , High Level	$I_{FH}$	7.5	-	15	mA
Input Voltage , Low Level	$V_{FL}$	0	-	0.8	V
Supply Voltage*	$V_{CC}$	4.5	-	30	V
Operating Temperature	$T_{opr}$	-40	-	125	°C

\* This item denotes operating range, not meaning of recommended operating conditions.

Note: Recommended operating conditions are given as a design guideline to obtain expected performance of the device. Additionally, each item is an independent guideline respectively. In developing designs using this product, please confirm specified characteristics shown in this document.

## Electrical Characteristics

(Unless otherwise specified, Ta = -40 to 125°C, VCC = 4.5 to 30V)

Characteristic		Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
LED	Forward voltage	V <sub>F</sub>	—	I <sub>F</sub> = 10 mA, Ta = 25 °C	1.40	1.57	1.80	V
	Forward voltage temperature coefficient	ΔV <sub>F</sub> / ΔTa	—	I <sub>F</sub> = 10 mA	—	-1.8	—	mV / °C
	Reverse current	I <sub>R</sub>	—	V <sub>R</sub> = 5 V, Ta = 25 °C	—	—	10	μA
	Capacitance between terminals	C <sub>T</sub>	—	V <sub>F</sub> = 0V, f = 1 MHz	—	60	—	pF
Detector	High level output current	I <sub>OH</sub>	1	V <sub>F</sub> = 0.8 V, V <sub>O</sub> < V <sub>CC</sub>	—	—	50	μA
	Low level output voltage	V <sub>OL</sub>	2	I <sub>F</sub> = 10 mA, I <sub>O</sub> = 2.4 mA	—	0.2	0.6	V
	Low level supply current	I <sub>CCL</sub>	3	I <sub>F</sub> = 10 mA	—	—	1.3	mA
	High level supply current	I <sub>CCH</sub>	4	I <sub>F</sub> = 0 mA	—	—	1.3	mA
	Output current	I <sub>O</sub>	5	I <sub>F</sub> = 10 mA, V <sub>O</sub> = 0.6 V	4.0	—	—	mA
Input current logic LOW output		I <sub>FHL</sub>	—	I <sub>O</sub> = 0.75 mA, V <sub>O</sub> < 0.8 V	—	1.0	5	mA
Input voltage logic HIGH output		V <sub>FLH</sub>	—	I <sub>O</sub> = 0.75 mA, V <sub>O</sub> > 2.0 V	0.8	—	—	V

\*All typical values are at Ta=25°C, VCC=5 V unless otherwise specified

## Isolation Characteristics (Ta = 25°C)

Characteristic	Symbol	Test Conditions	Min	Typ.	Max	Unit
Capacitance input to output	C <sub>S</sub>	V <sub>S</sub> = 0V, f = 1 MHz (Note 2)	—	0.8	—	pF
Isolation resistance	R <sub>S</sub>	R.H. ≤ 60%, V <sub>S</sub> = 500 V (Note 2)	1×10 <sup>12</sup>	10 <sup>14</sup>	—	Ω
Isolation voltage	BV <sub>S</sub>	AC, 1 minute	3750	—	—	V <sub>rms</sub>
		AC, 1 second, in oil	—	10000	—	
		DC, 1 minute, in oil	—	10000	—	Vdc

## Switching Characteristics

(Unless otherwise specified,  $T_a = -40$  to  $125^\circ\text{C}$ ,  $V_{CC} = 15\text{V}$ )

Characteristic	Symbol	Test Circuit	Test Condition		Min	Typ.	Max	Unit
Propagation delay time (H→L)	t <sub>pHL</sub>	6	I <sub>F</sub> = 10 mA, R <sub>L</sub> = 20kΩ  (Note4)	C <sub>L</sub> =100pF	30	150	400	ns
				C <sub>L</sub> =10pF	—	90	—	
Propagation delay time (L→H)	t <sub>pLH</sub>			C <sub>L</sub> =100pF	150	350	550	
				C <sub>L</sub> =10pF	—	100	—	
Switching Time Dispersion between ON and OFF	t <sub>pLH</sub> -t <sub>pHL</sub>			CL=100pF	—	—	400	
Propagation Delay Skew (Note 5)	t <sub>pLH</sub> -t <sub>pHL</sub>	-50	—		450			
Common mode transient immunity at high output level	CM <sub>H</sub>	7	V <sub>CM</sub> = 1500 V <sub>p-p</sub> , I <sub>F</sub> = 0 mA, R <sub>L</sub> = 20 kΩ , Ta=25°C		15	—	—	kV/μs
Common mode transient Immunity at low output level	CM <sub>L</sub>		V <sub>CM</sub> = 1500 V <sub>p-p</sub> , I <sub>F</sub> = 10 mA R <sub>L</sub> = 20 kΩ , Ta=25°C		-15	—	—	kV/μs

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

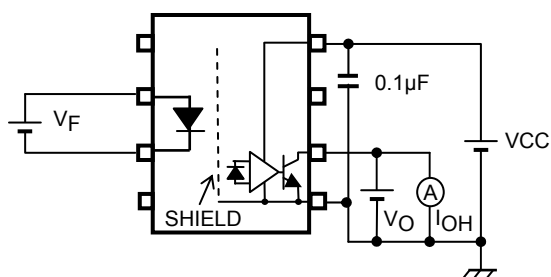
Note 3 : A ceramic capacitor ( $0.1\text{ }\mu\text{F}$ ) should be connected from pin 8 ( $V_{CC}$ ) to pin 5 (GND) to stabilize the operation of the high gain linear amplifier. Failure to provide the bypass may impair the switching property.

The total lead length between capacitor and coupler should not exceed 1 cm.

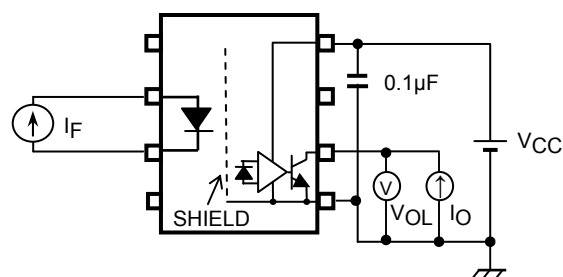
Note 4:  $f = 10\text{ kHz}$ , duty = 10%, input current  $t_r = t_f =$  less than 5ns,

Note 5: Propagation delay skew is defined as the propagation delay time of the largest or smallest  $t_{pLH}$  minus the largest or smallest  $t_{pHL}$  of multiple samples. Evaluations of these samples are conducted under identical test conditions (supply voltage, input current, temperature, etc).

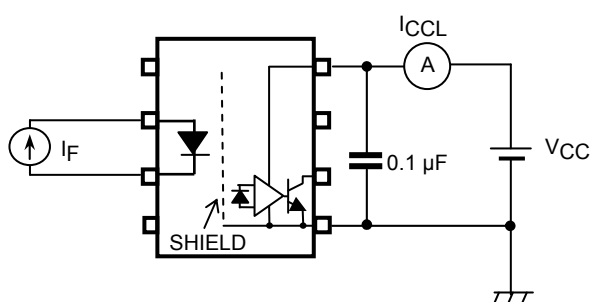
Test Circuit 1:  $I_{OH}$



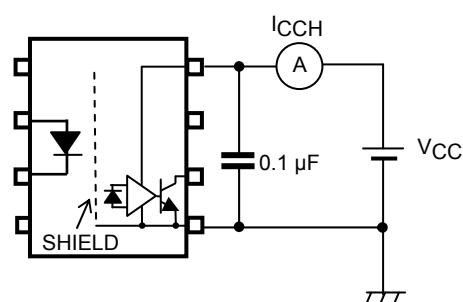
Test Circuit 2:  $V_{OL}$



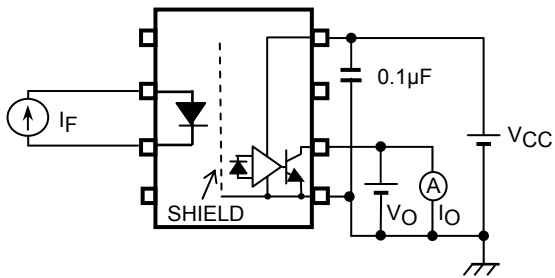
Test Circuit 3:  $I_{CCL}$



Test Circuit 4:  $I_{CCH}$



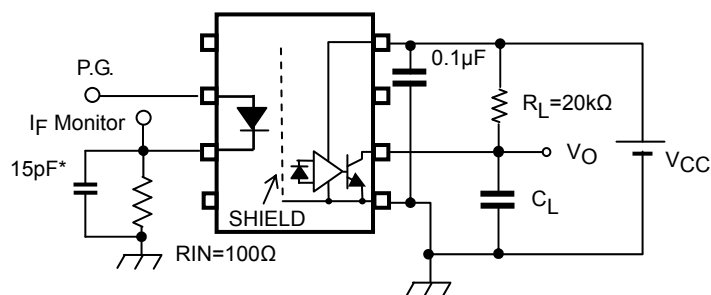
## Test Circuit 5: $I_O$



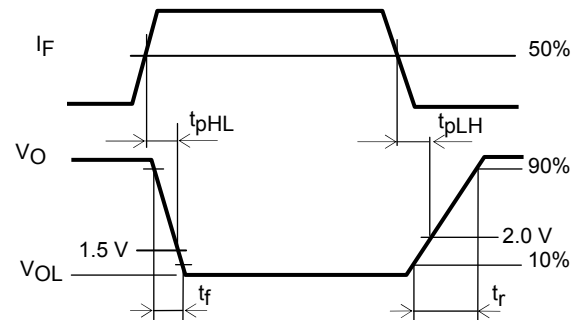
## Test Circuit 6: $t_{pHL}$ , $t_{pLH}$ , $|t_{pHL}-t_{pLH}|$

$I_F=10\text{mA(P.G)}$

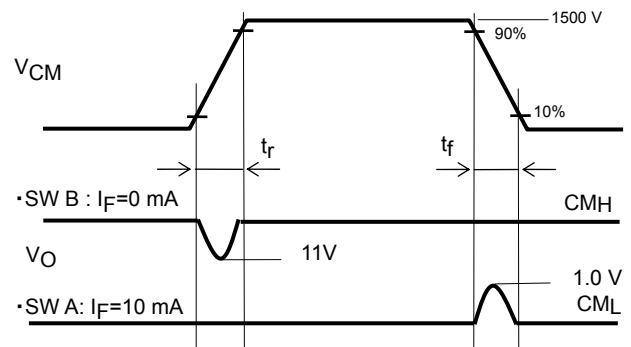
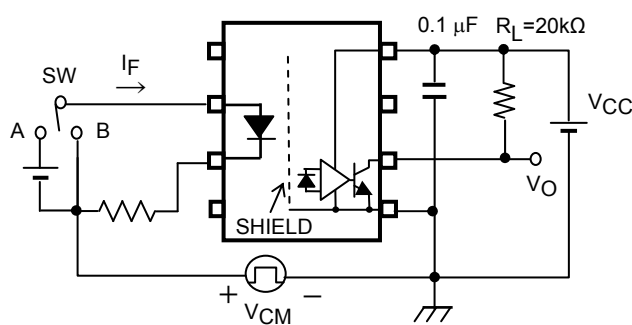
( $f=10\text{kHz}$ , duty=10%,  $t_r = t_f = \text{less than } 5\text{ns}$ )



\* probe and stray capacitance  
P.G.: Pulse generator

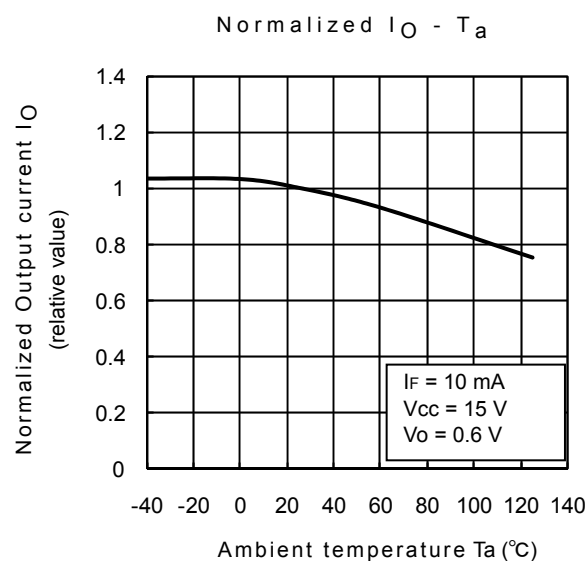
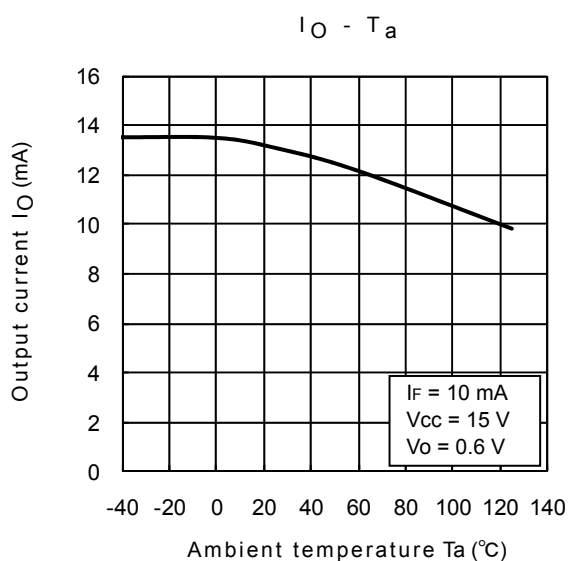
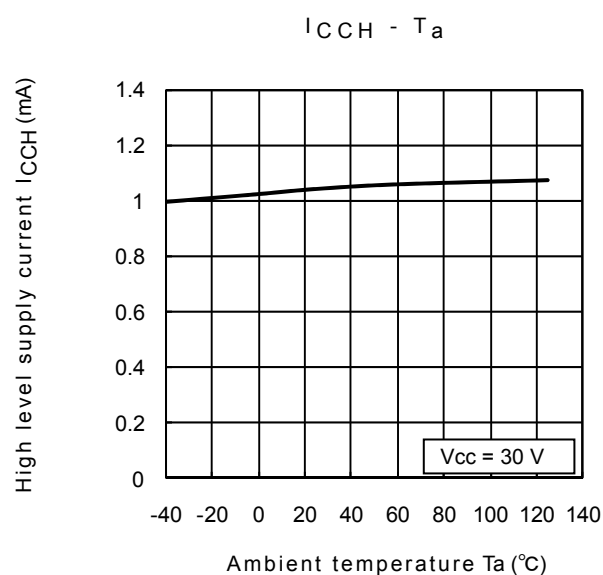
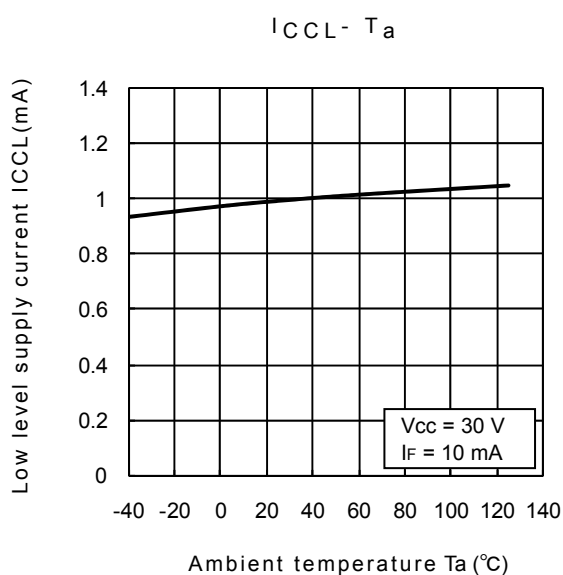
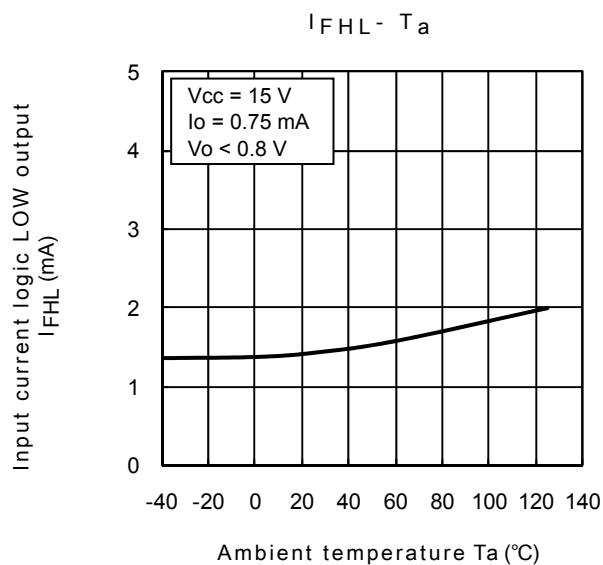
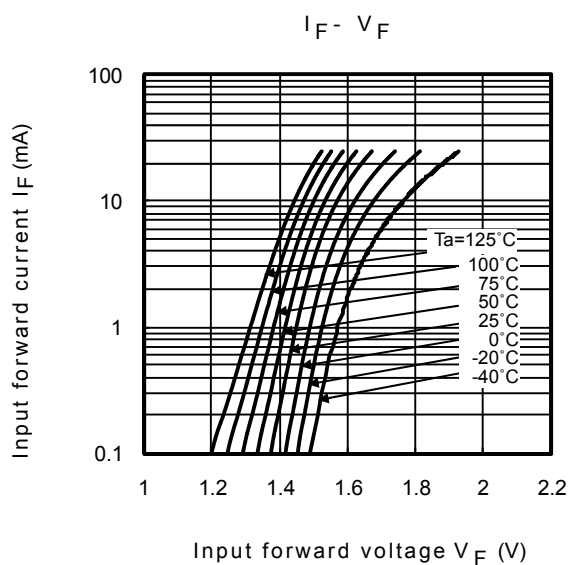


## Test Circuit 7: $CM_H$ , $CM_L$

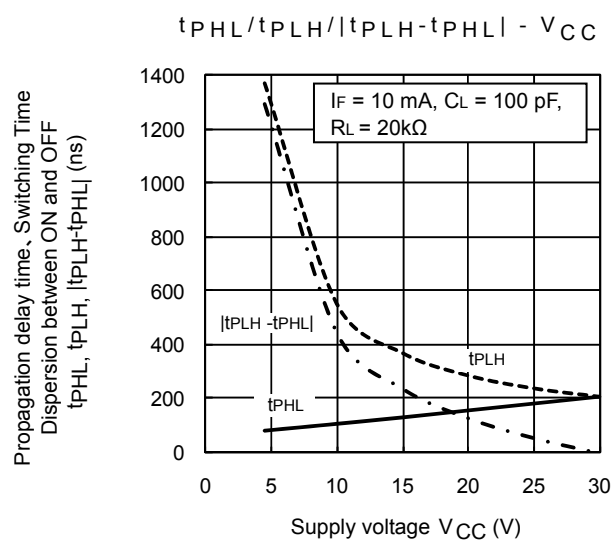
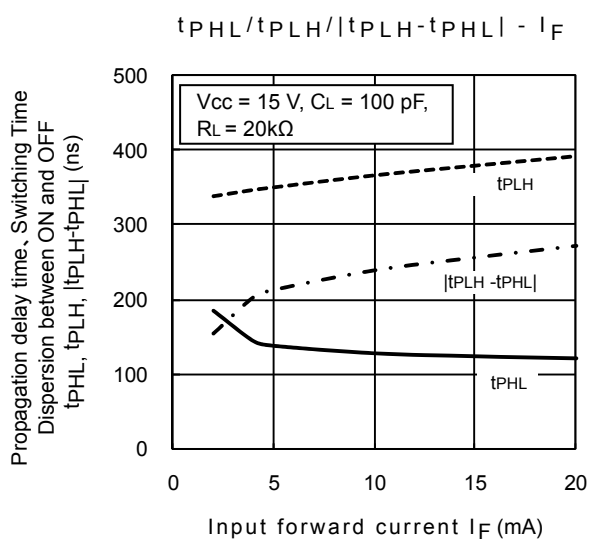
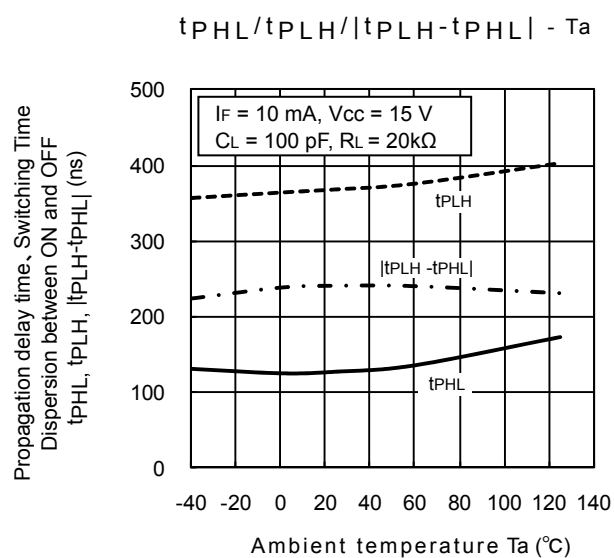
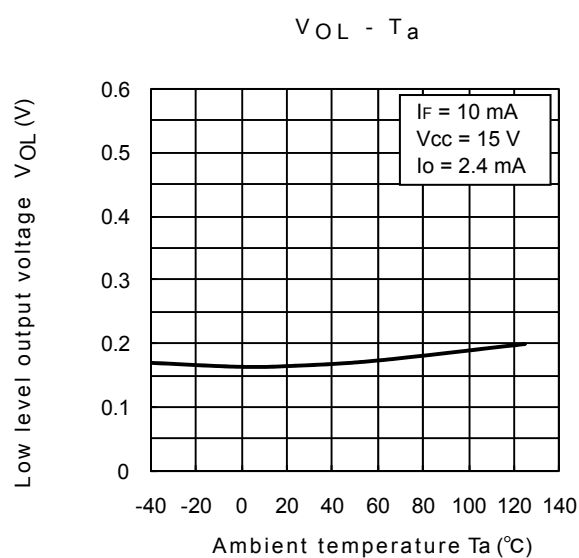
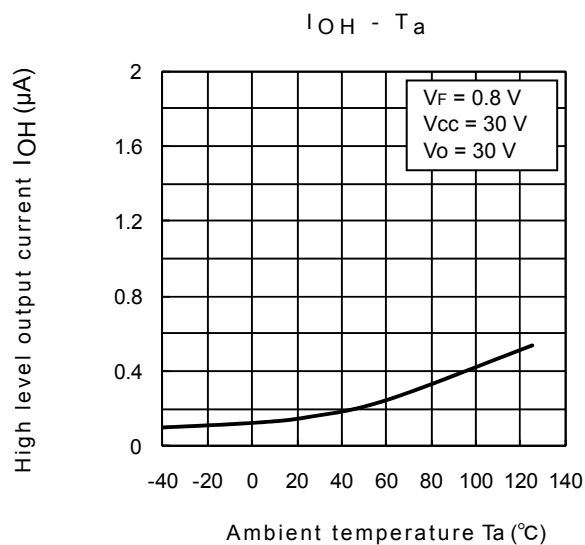
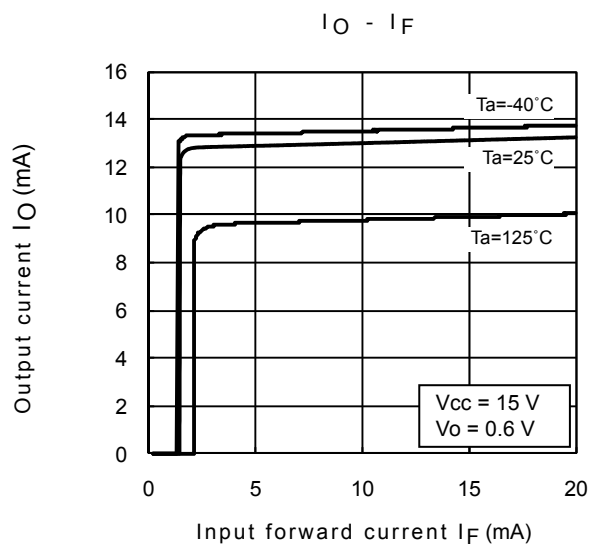


$$CM_H = \frac{1200(V)}{t_r(\mu s)} \quad CM_L = -\frac{1200(V)}{t_f(\mu s)}$$

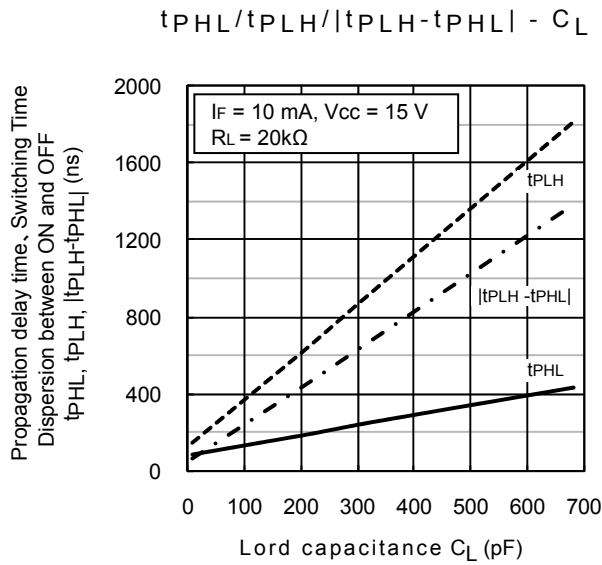
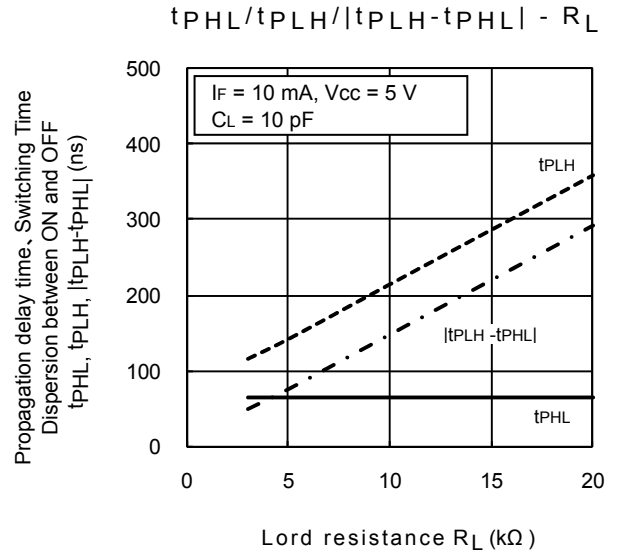
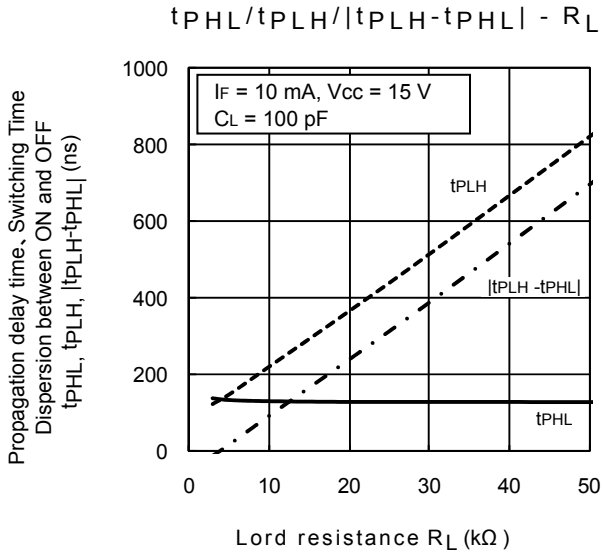
$CM_L$  ( $CM_H$ ) is the maximum rate of fall (rise) of the common mode voltage that can be sustained with the output voltage in the LOW (HIGH) state.



\*: The above graphs show typical characteristics.



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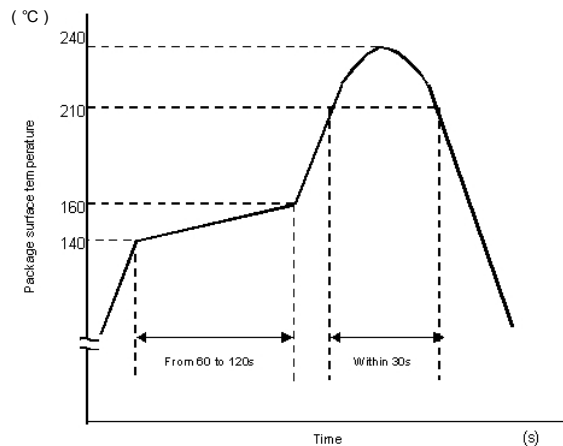


## PRECAUTIONS OF SURFACE MOUNTING TYPE PHOTOCOUPLER SOLDERING & GENERAL STORAGE

### (1) Precautions for Soldering

#### 1) When Using Soldering Reflow

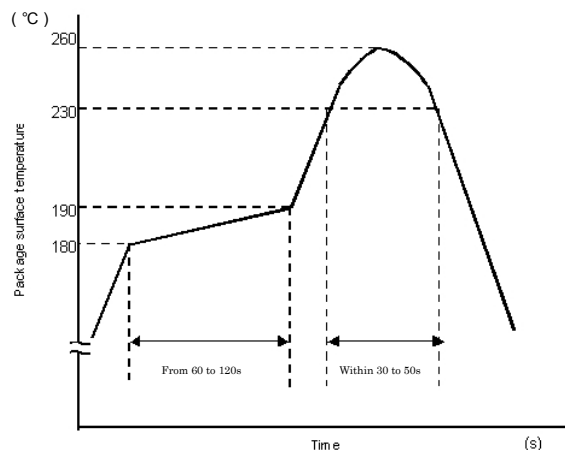
- An example of a temperature profile when Sn-Pb eutectic solder is used:



This profile is based on the device's maximum heat resistance guaranteed value.

Set the preheat temperature/heating temperature to the optimum temperature corresponding to the solder paste type used by the customer within the described profile.

- An example of a temperature profile when lead(Pb)-free solder is used:



This profile is based on the device's maximum heat resistance guaranteed value.

Set the preheat temperature/heating temperature to the optimum temperature corresponding to the solder paste type used by the customer within the described profile.

- 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.

#### 2) 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 or less within 10 seconds is recommended.
- Flow soldering must be performed once

#### 3) 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 only once per 1 lead

**(2) Precautions for General Storage**

- 1) Do not store devices at any place where they will be exposed to moisture or direct sunlight.
- 2) When transportation or storage of devices, follow the cautions indicated on the carton box.
- 3) The storage area temperature should be kept within a temperature range of 5 °C to 35 °C, and relative humidity should be maintained at between 45% and 75%.
- 4) Do not store devices in the presence of harmful (especially corrosive) gases, or in dusty conditions.
- 5) Use storage areas where there is minimal temperature fluctuation. Because rapid temperature changes can cause condensation to occur on stored devices, resulting in lead oxidation or corrosion, as a result, the solderability of the leads will be degraded.
- 6) When repacking devices, use anti-static containers.
- 7) Do not apply any external force or load directly to devices while they are in storage.
- 8) If devices have been stored for more than two years, even though the above conditions have been followed, it is recommended that solderability of them should be tested before they are used.

## Specification for Embossed-Tape Packing (TP) for SO8 Coupler

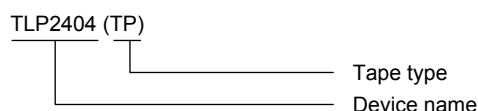
### 1. Applicable Package

Package	Product Type
SO8	Photocoupler

### 2. Product Naming System

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

(Example)



### 3. Tape Dimensions

#### 3.1 Orientation of Device in Relation to Direction of Tape Movement

Device orientation in the recesses is as shown in Figure 1.

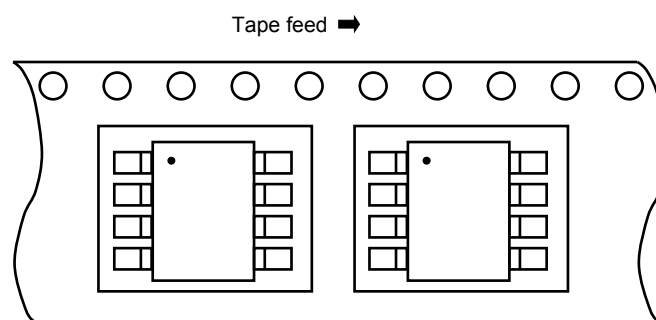


Figure 1 Device Orientation

#### 3.2 Tape Packing Quantity: 2500 devices per reel

#### 3.3 Empty Device Recesses Are as Shown in Table 1.

Table 1 Empty Device Recesses

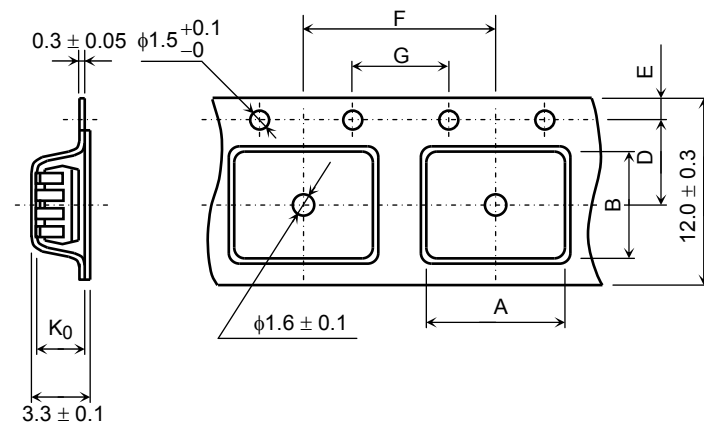
	Standard	Remarks
Occurrences of 2 or more successive empty device recesses	0	Within any given 40-mm section of tape, not including leader and trailer
Single empty device recesses	6 devices (max) per reel	Not including leader and trailer

#### 3.4 Start and End of Tape

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

### 3.5 Tape Specification

- (1) Tape material: Plastic (protection against electrostatics)
- (2) Dimensions: The tape dimensions are as shown in Figure 2 and table 2.



**Figure 2 Tape Forms**

**Table 2 Tape Dimensions**

Unit: mm  
Unless otherwise specified:  $\pm 0.1$

Symbol	Dimension	Remark
A	6.5	—
B	5.6	—
D	5.5	Center line of indented square hole and sprocket hole
E	1.75	Distance between tape edge and hole center
F	8.0	Cumulative error $\begin{smallmatrix} +0.1 \\ -0.3 \end{smallmatrix}$ (max) per 10 feed holes
G	4.0	Cumulative error $\begin{smallmatrix} +0.1 \\ -0.3 \end{smallmatrix}$ (max) per 10 feed holes
K <sub>0</sub>	3.1	Internal space

## 3.6 Reel

- (1) Material: Plastic
- (2) Dimensions: The reel dimensions are as shown in Figure 3 and Table 3.

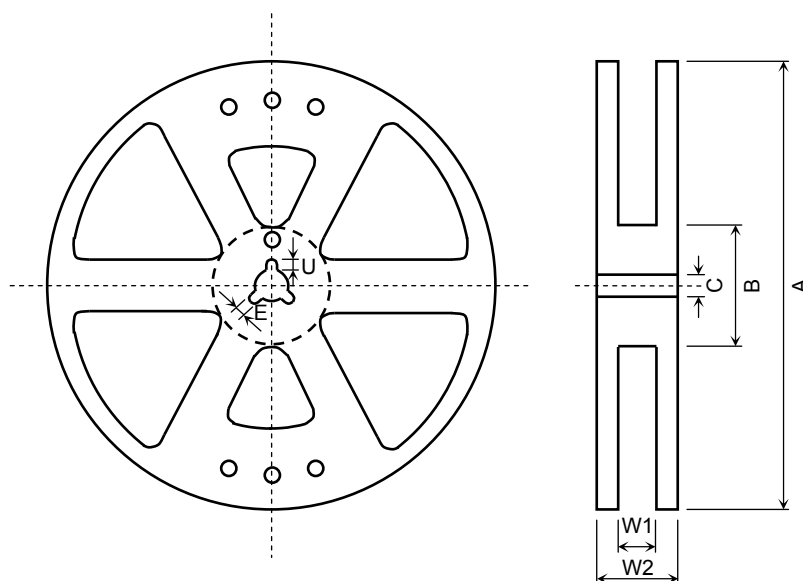


Figure 3 Reel Form

Table 3 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	$17.5 \pm 1.0$

## 4. Packing

Either one reel or five reels of photocoupler are packed in a shipping carton.

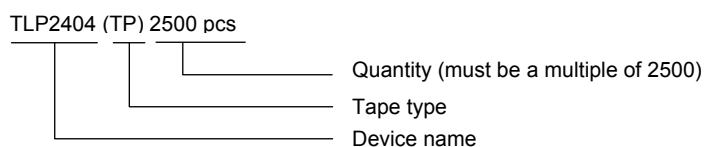
## 5. Label Indication

The carton bears a label indicating the product number, the symbol representing classification of standard, the quantity, the lot number and the Toshiba company name.

## 6. Ordering Method

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

(Example)



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