

# TLP2168

## 1. Applications

- Programmable Logic Controllers (PLCs)
- Factory Automation (FA)
- Measuring Instruments

## 2. General

The TLP2168 consists of high-intensity infrared LED optically coupled to a high-gain, high-speed photoreceptor chip. The TLP2168 guarantees operation at up to 125 °C and on supplies from 2.7 V to 5.5 V. It is offered in the SO8 package. With two LED-photoreceptor pairs, the TLP2168 helps save board space. An internal noise shield provides superior common-mode transient immunity for improved noise immunity.

## 3. Features

- (1) Inverter logic type (open collector output)
- (2) Package: SO8
- (3) Operating temperature: -40 to 125 °C
- (4) Supply voltage: 2.7 to 5.5 V
- (5) Data transfer rate: 20 MBd (typ.)(NRZ)
- (6) Threshold input current: 5.0 mA (max)
- (7) Supply current: 8 mA (max)
- (8) Common-mode transient immunity:  $\pm 15$  kV/ $\mu$ s (min)
- (9) Isolation voltage: 2500 Vrms (min)
- (10) Safety standards

UL-recognized: UL 1577, File No.E67349

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

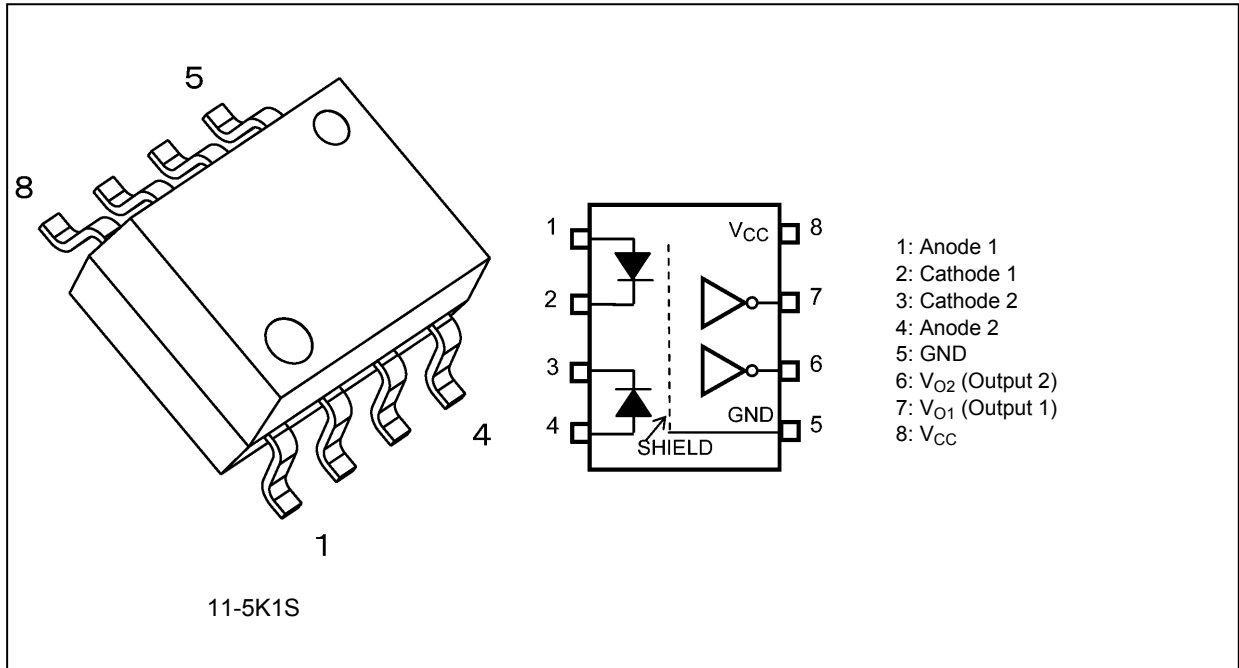
VDE-approved: EN 60747-5-5 (**Note 1**)

Note 1: When a VDE approved type is needed, please designate the **Option (V4)**.

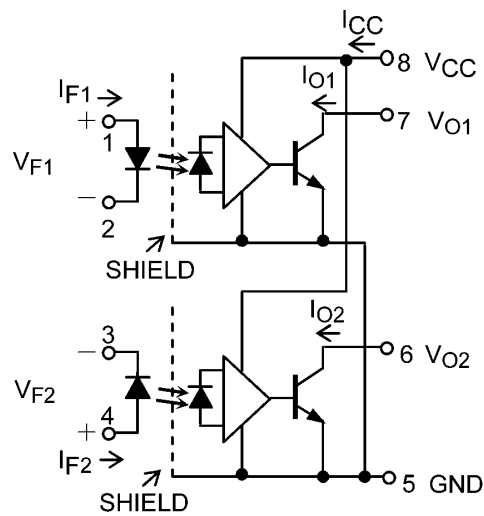
Start of commercial production

2010-09

## 4. Packaging and Pin Configuration



## 5. Internal Circuit



## 6. Principle of Operation

### 6.1. Truth Table

Input	LED 1 (2)	Output 1 (2)
H	ON	L
L	OFF	H

### 6.2. Mechanical Parameters

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

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

	Characteristics	Symbol	Note	Rating	Unit
LED	Input forward current	$I_F$	(Note 1)	25	mA
	Input forward current derating ( $T_a \geq 110\text{ }^\circ\text{C}$ )	$\Delta I_F/\Delta T_a$	(Note 1)	-0.67	mA/°C
	Input forward current (pulsed)	$I_{FP}$	(Note 1), (Note 2)	40	mA
	Input forward current derating (pulsed) ( $T_a \geq 110\text{ }^\circ\text{C}$ )	$\Delta I_{FP}/\Delta T_a$	(Note 1)	-1.0	mA/°C
	Input reverse voltage	$V_R$	(Note 1)	5	V
	Input power dissipation	$P_D$	(Note 1)	40	mW
	Input power dissipation derating ( $T_a \geq 110\text{ }^\circ\text{C}$ )	$\Delta P_D/\Delta T_a$		-1.0	mW/°C
Detector	Output current	$I_O$	(Note 1)	25	mA
	Output voltage	$V_O$	(Note 1)	6	V
	Supply voltage	$V_{CC}$		6	V
	Output power dissipation	$P_O$	(Note 1)	40	mW
	Output power dissipation derating ( $T_a \geq 110\text{ }^\circ\text{C}$ )	$\Delta P_O/\Delta T_a$	(Note 1)	-1.0	mW/°C
Common	Operating temperature	$T_{opr}$		-40 to 125	°C
	Storage temperature	$T_{stg}$		-55 to 150	°C
	Lead soldering temperature (10 s)	$T_{sol}$		260	°C
	Isolation voltage AC, 60 s, R.H. $\leq 60\%$	$BV_S$	(Note 3)	2500	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: Each channel

Note 2: Pulse width (PW)  $\leq 1\text{ ms}$ , duty = 50 %

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
Input on-state current	$I_{F(ON)}$	(Note 1), (Note 2)	7.5	—	14	mA
Input off-state voltage	$V_{F(OFF)}$	(Note 1)	0	—	0.8	V
Supply voltage	$V_{CC}$	(Note 3)	2.7	3.3/5.0	5.5	
Operating temperature	$T_{opr}$		-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  $\mu\text{F}$ ) should be connected between pin 8 and pin 5 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  $\mu\text{s}$ .

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)	—	$I_F = 10$ mA, $T_a = 25$ °C	1.4	1.57	1.8	V
Input forward voltage temperature coefficient	$\Delta V_F / \Delta T_a$	(Note 1)	—	$I_F = 10$ mA	—	-2.0	—	mV/°C
Input reverse current	$I_R$	(Note 1)	—	$V_R = 5$ V, $T_a = 25$ °C	—	—	10	$\mu$ A
Input capacitance	$C_t$	(Note 1)	—	$V = 0$ V, $f = 1$ MHz, $T_a = 25$ °C	—	60	—	pF
High-level output current	$I_{OH}$	(Note 1)	Fig. 12.1.1	$V_F = 0.8$ V, $V_O = 5.5$ V, $V_{CC} = 5.5$ V	—	—	50	$\mu$ A
				$V_F = 0.8$ V, $V_O = 5.5$ V, $V_{CC} = 5.5$ V, $T_a = 25$ °C	—	—	10	
Low-level output voltage	$V_{OL}$	(Note 1)	Fig. 12.1.2	$I_F = 10$ mA, $I_O = 13$ mA (Sinking)	—	0.2	0.6	V
Low-level supply current	$I_{CCL}$		Fig. 12.1.3	$I_{F1} = I_{F2} = 10$ mA	—	3.8	8	mA
High-level supply current	$I_{CCH}$		Fig. 12.1.4	$I_F = 0$ mA	—	3.4	8	
Threshold input current (H/L)	$I_{FHL}$	(Note 1)	—	$I_O = 13$ mA (Sinking), $V_O < 0.6$ V	—	1.0	5.0	

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

Note 1: Each channel

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

Characteristics	Symbol	Note	Test Conditions	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. $\leq 60$ %	$10^{12}$	$10^{14}$	—	$\Omega$
Isolation voltage	$BV_S$	(Note 1)	AC, 60 s	2500	—	—	Vrms

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 (Each channel))

Characteristics	Symbol	Note	Test Circuit	Test Condition	Min	Typ.	Max	Unit	
Propagation delay time (H/L)	$t_{pHL}$	(Note 1)	Fig. 12.1.5	$I_F = 0 \rightarrow 7.5$ mA, $R_L = 350$ $\Omega$ , $C_L = 15$ pF	—	35	60	ns	
Propagation delay time (L/H)	$t_{pLH}$	(Note 1)			$I_F = 7.5 \rightarrow 0$ mA, $R_L = 350$ $\Omega$ , $C_L = 15$ pF	—	35		60
Pulse width distortion	$ \mathit{t}_{pHL} - \mathit{t}_{pLH} $	(Note 1)			$I_F = 0 \leftrightarrow 7.5$ mA, $R_L = 350$ $\Omega$ , $C_L = 15$ pF	—	—		35
Propagation delay skew (device to device)	$t_{psk}$	(Note 1), (Note 2)				-40	—		40
Fall time	$t_f$	(Note 1)			$I_F = 0 \rightarrow 7.5$ mA, $R_L = 350$ $\Omega$ , $C_L = 15$ pF	—	30		—
Rise time	$t_r$	(Note 1)			$I_F = 7.5 \rightarrow 0$ mA, $R_L = 350$ $\Omega$ , $C_L = 15$ pF	—	30		—
High-level common-mode transient immunity	$CM_H$		Fig. 12.1.6	$V_{CM} = 1000$ V <sub>p-p</sub> , $I_F = 0$ mA, $V_{CC} = 5$ V, $T_a = 25$ °C	15	—	—	kV/ $\mu$ s	
Low-level common-mode transient immunity	$CM_L$				$V_{CM} = 1000$ V <sub>p-p</sub> , $I_F = 10$ mA, $V_{CC} = 5$ V, $T_a = 25$ °C	-15	—		—

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

Note 1:  $f = 5$  MHz, duty = 50%, input current  $t_r = t_f = 5$  ns or less,  $C_L$  is less than 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.).

## 12. Test Circuits and Characteristics Curves

### 12.1. Test Circuits

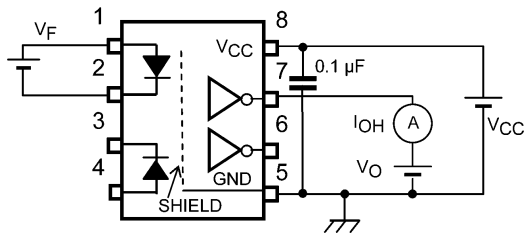


Fig. 12.1.1  $I_{OH}$  Test Circuit

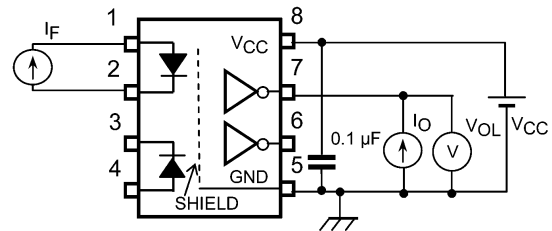


Fig. 12.1.2  $V_{OL}$  Test Circuit

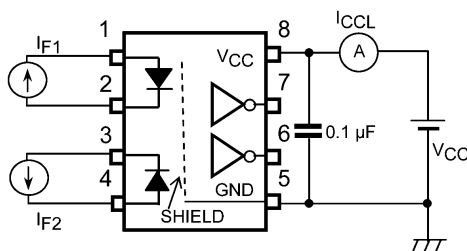


Fig. 12.1.3  $I_{CCL}$  Test Circuit

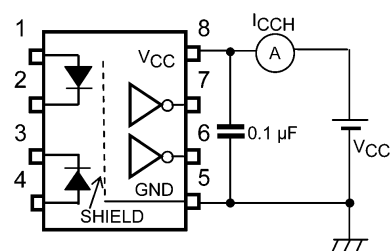


Fig. 12.1.4  $I_{CCH}$  Test Circuit

$I_F = 7.5\text{mA (P.G.)}$   
 $(f = 5\text{MHz, duty} = 50\%, t_r = t_f = 5\text{ns or less})$

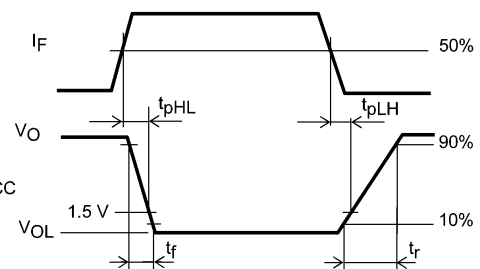
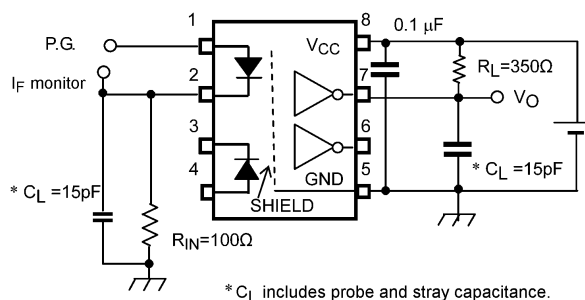
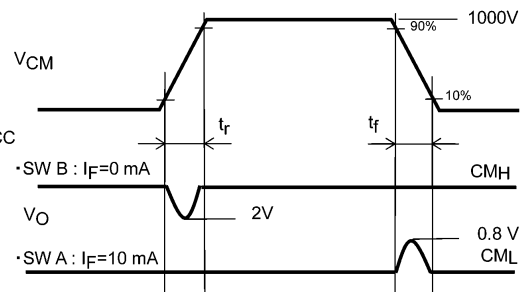
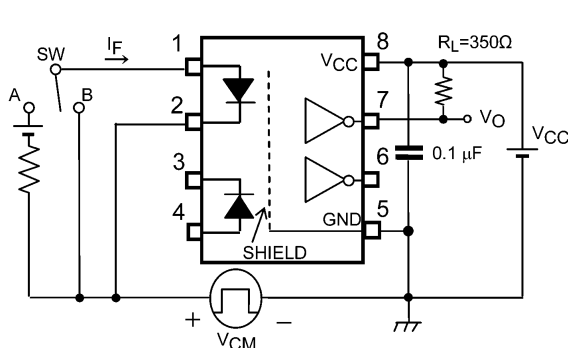


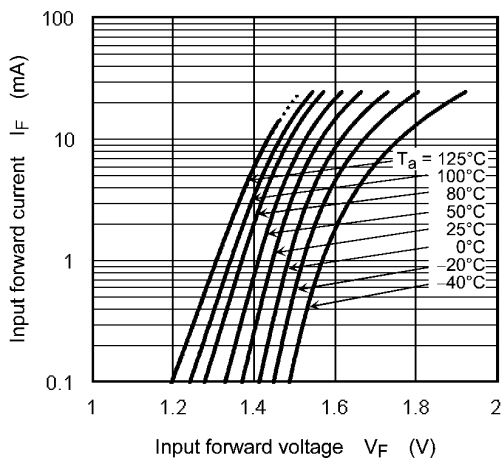
Fig. 12.1.5 Switching Time Test Circuit and Waveform



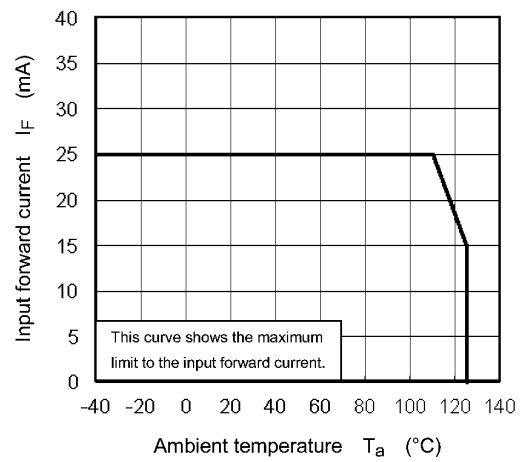
$$CM_H = \frac{800(V)}{t_r (\mu s)} \quad CM_L = - \frac{800(V)}{t_f (\mu s)}$$

Fig. 12.1.6 Common-Mode Transient Immunity and Waveform

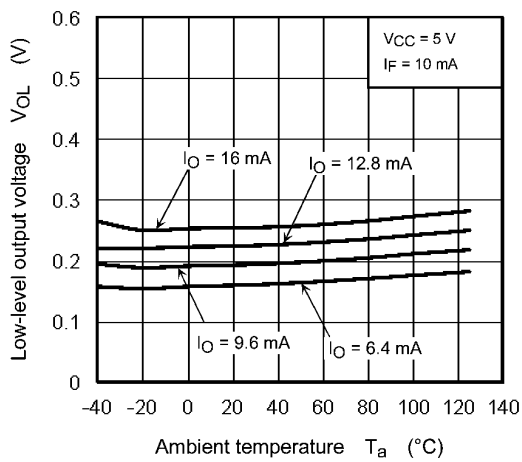
## 12.2. Characteristics Curves (Note)



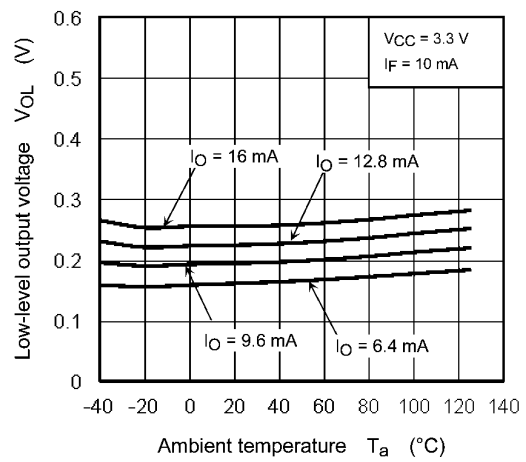
**Fig. 12.2.1  $I_F - V_F$**



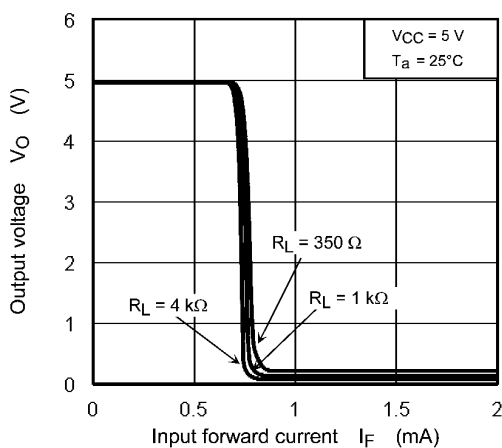
**Fig. 12.2.2  $I_F - T_a$**



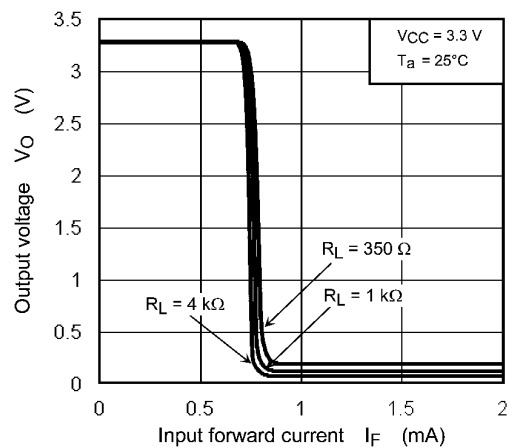
**Fig. 12.2.3  $V_{OL} - T_a$**



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



**Fig. 12.2.5  $V_O - I_F$**



**Fig. 12.2.6  $V_O - I_F$**

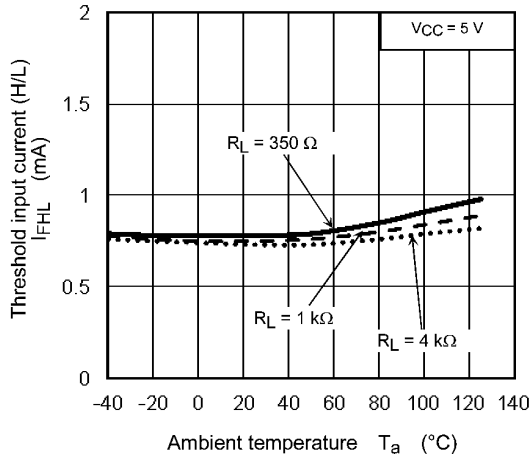


Fig. 12.2.7  $I_{FHL} - T_a$

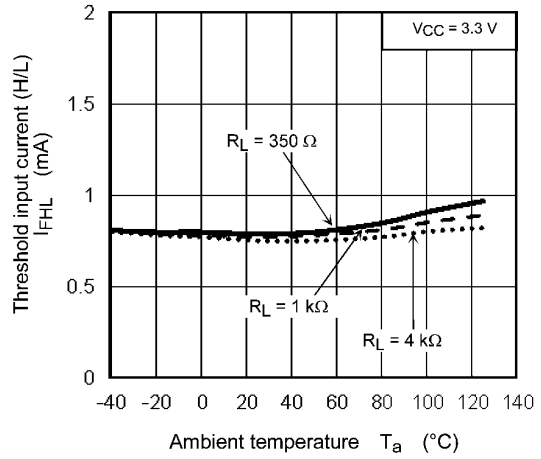


Fig. 12.2.8  $I_{FHL} - T_a$

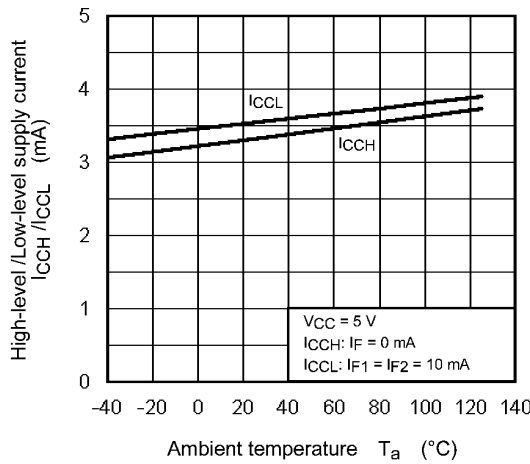


Fig. 12.2.9  $I_{CCH} / I_{CCL} - T_a$

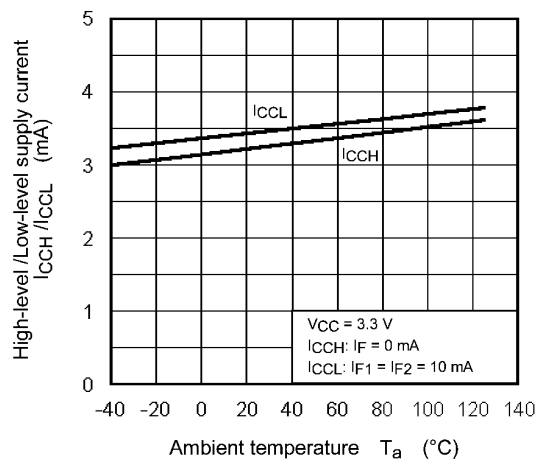


Fig. 12.2.10  $I_{CCH} / I_{CCL} - T_a$

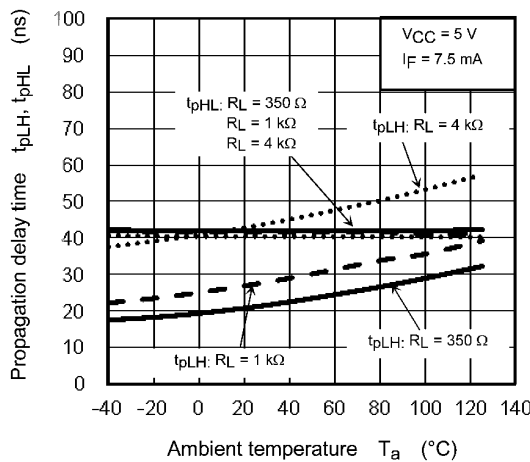


Fig. 12.2.11  $t_{pLH} / t_{pHL} - T_a$

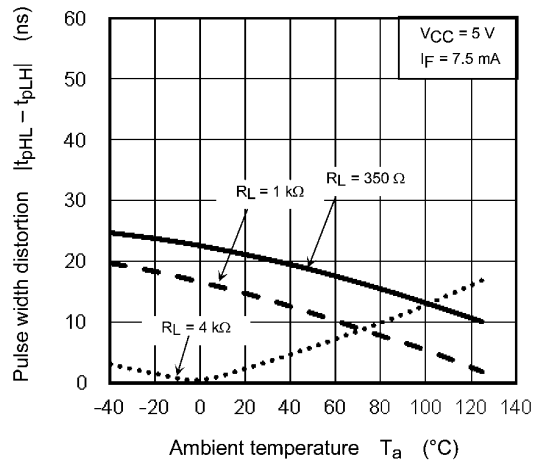


Fig. 12.2.12  $|t_{pHL} - t_{pLH}| - T_a$



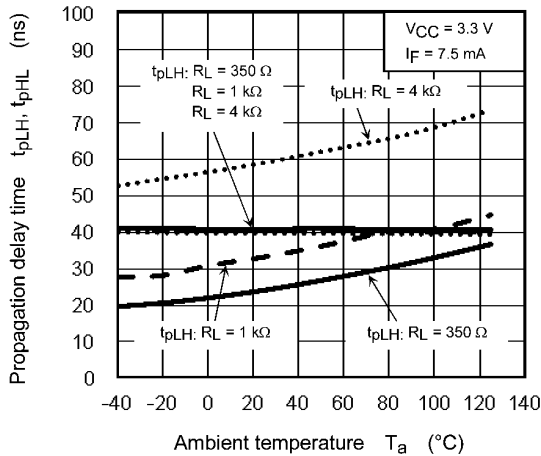


Fig. 12.2.13  $t_{pLH} / t_{pHL} - T_a$

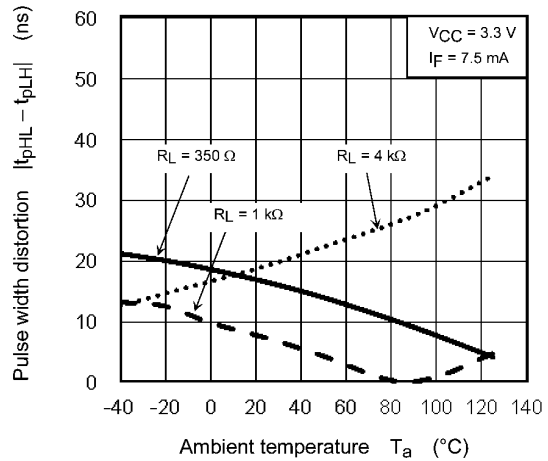


Fig. 12.2.14  $|t_{pHL} - t_{pLH}| - T_a$

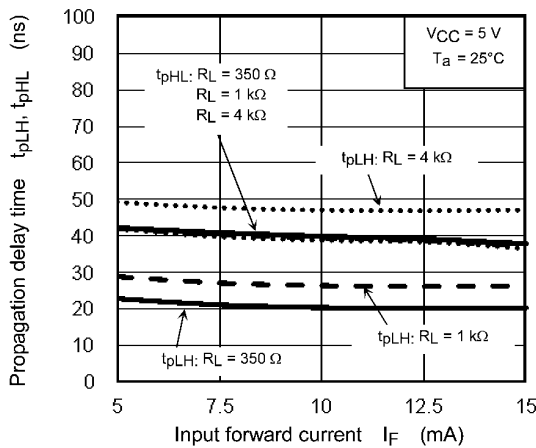


Fig. 12.2.15  $t_{pLH} / t_{pHL} - I_F$

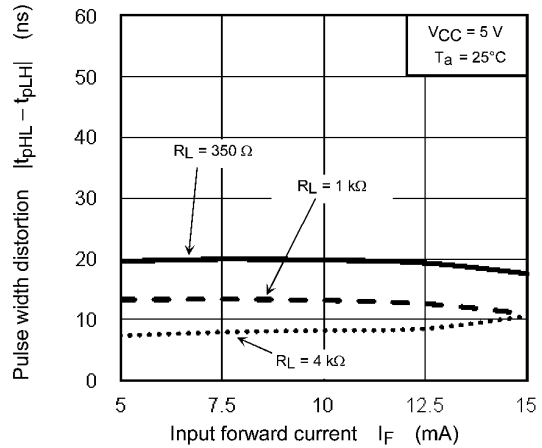


Fig. 12.2.16  $|t_{pHL} - t_{pLH}| - I_F$

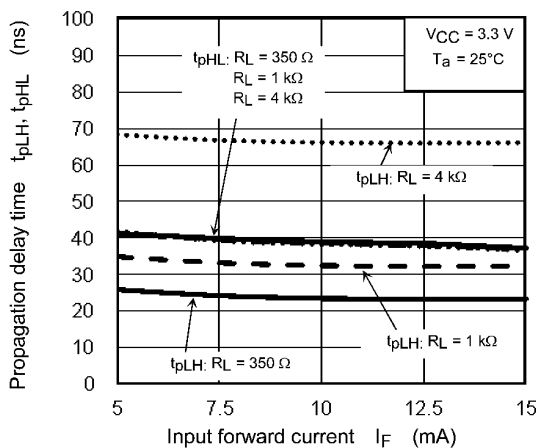


Fig. 12.2.17  $t_{pLH} / t_{pHL} - I_F$

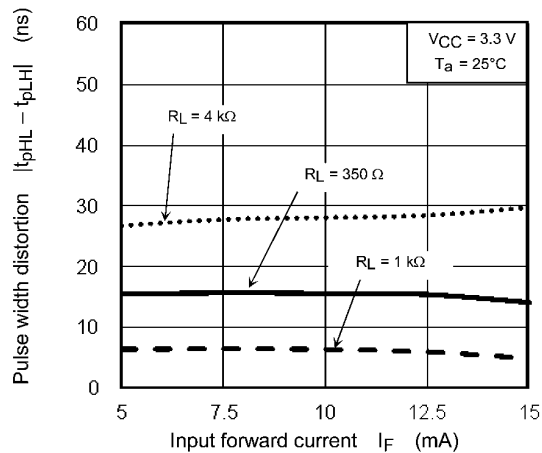


Fig. 12.2.18  $|t_{pHL} - t_{pLH}| - I_F$

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.

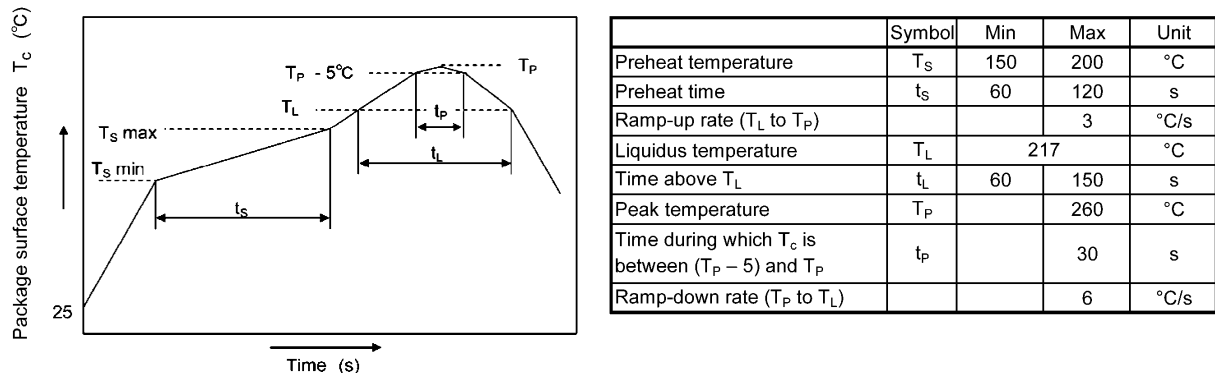
- When using soldering reflow.

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.



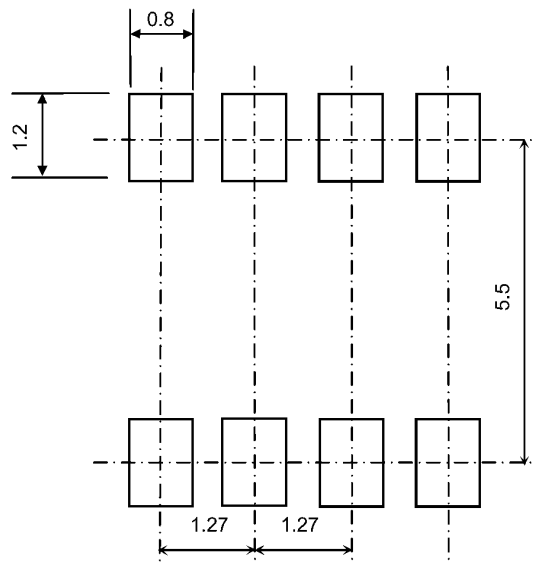
**Fig. 13.1.1 An Example of a Temperature Profile When Lead(Pb)-free Solder Is Used**

- 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

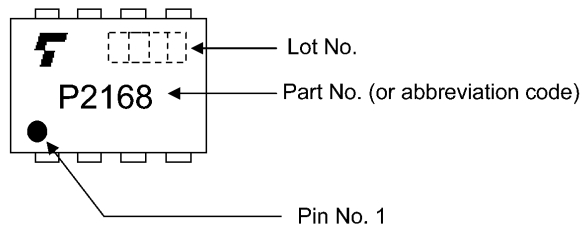
- Avoid storage locations where devices may be exposed to moisture or direct sunlight.
- Follow the precautions printed on the packing label of the device for transportation and storage.
- Keep the storage location temperature and humidity within a range of 5 °C to 35 °C and 45 % to 75 %, respectively.
- 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. EN 60747-5-5 Option (V4) Specification

- Part number: TLP2168 (**Note 1**)
- The following part naming conventions are used for the devices that have been qualified according to option (V4) of EN 60747.

Example: TLP2168(V4-TP,F)

V4: EN 60747 option

TP: Tape type

F: [[G]]/RoHS COMPATIBLE (**Note 2**)

Note 1: Use TOSHIBA standard type number for safety standard application.

e.g., TLP2168(V4-TP,F) → TLP2168

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 electronic equipment.

Description	Symbol	Rating	Unit
Application classification for rated mains voltage $\leq 150$ Vrms for rated mains voltage $\leq 300$ Vrms		I-IV I-III	—
Climatic classification		40 / 125 / 21	—
Pollution degree		2	—
Maximum operating insulation voltage	$V_{IORM}$	565	Vpeak
Input to output test voltage, Method A $V_{pr} = 1.6 \times V_{IORM}$ , type and sample test $t_p = 10$ s, partial discharge $< 5$ pC	$V_{pr}$	904	Vpeak
Input to output test voltage, Method B $V_{pr} = 1.875 \times V_{IORM}$ , 100 % production test $t_p = 1$ s, partial discharge $< 5$ pC	$V_{pr}$	1059	Vpeak
Highest permissible overvoltage (transient overvoltage, $t_{pr} = 60$ s)	$V_{TR}$	4000	Vpeak
Safety limiting values (max. permissible ratings in case of fault, also refer to thermal derating curve) current (input current $I_F$ , $P_{SO} = 0$ ) power (output or total power dissipation) temperature	$I_{si}$ $P_{SO}$ $T_s$	250 400 150	mA mW °C
Insulation resistance $V_{IO} = 500$ V, $T_a = 25$ °C $V_{IO} = 500$ V, $T_a = 100$ °C $V_{IO} = 500$ V, $T_a = T_s$	$R_{si}$	$\geq 10^{12}$ $\geq 10^{11}$ $\geq 10^9$	$\Omega$

Fig. 16.1 EN 60747 Isolation Characteristics



Fig. 16.2 Marking on Packing

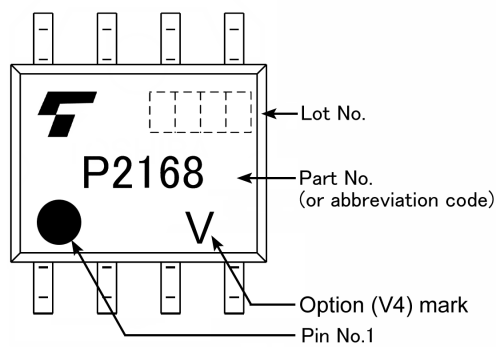


Fig. 16.3 Marking Example(Note 1)

Note 1: The above marking is applied to the photocouplers that have been qualified according to option (V4) of EN 60747.

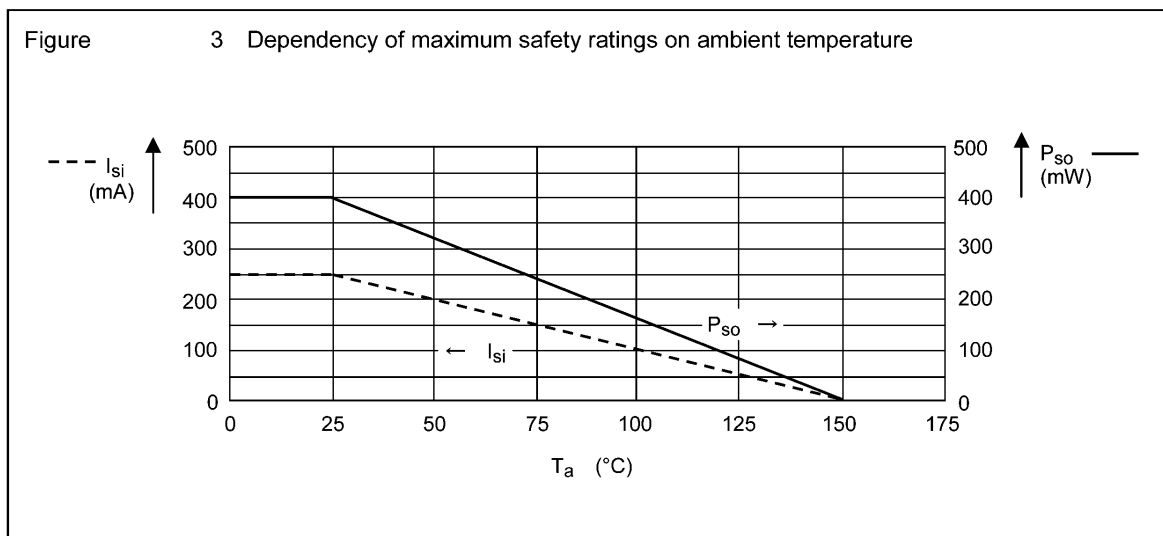
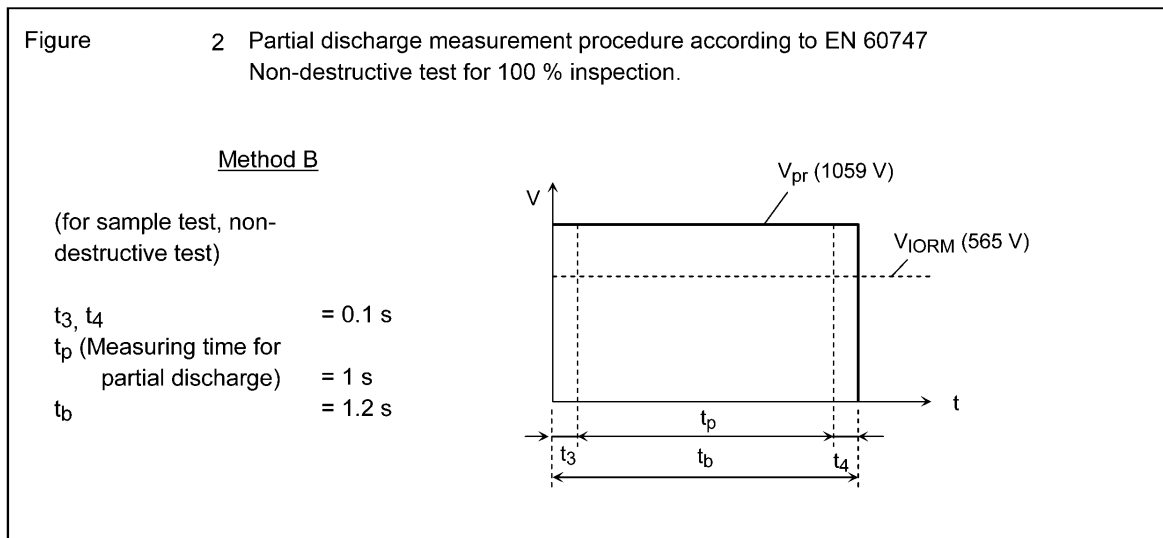
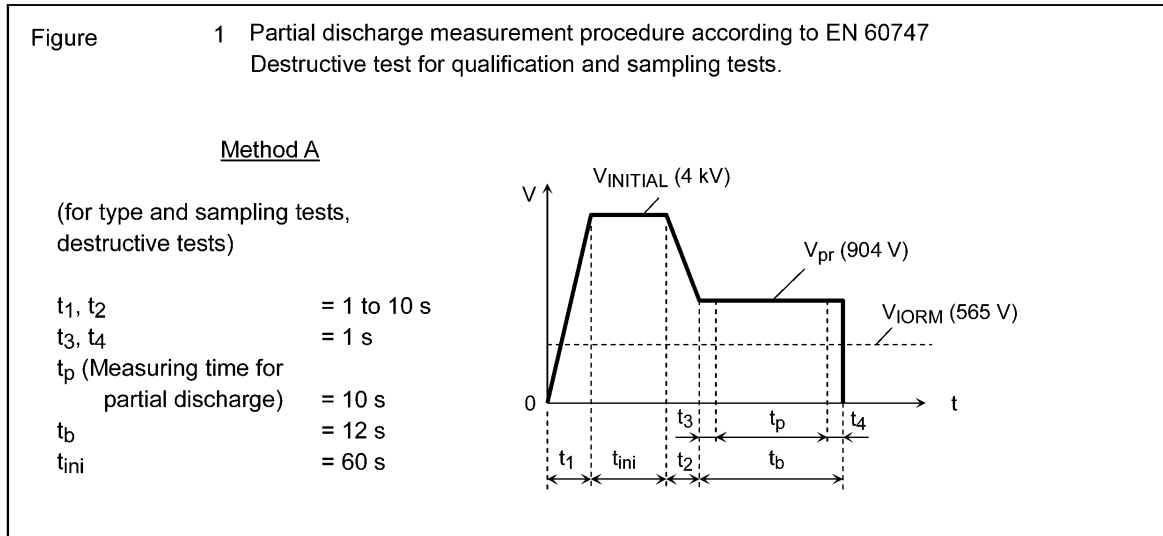
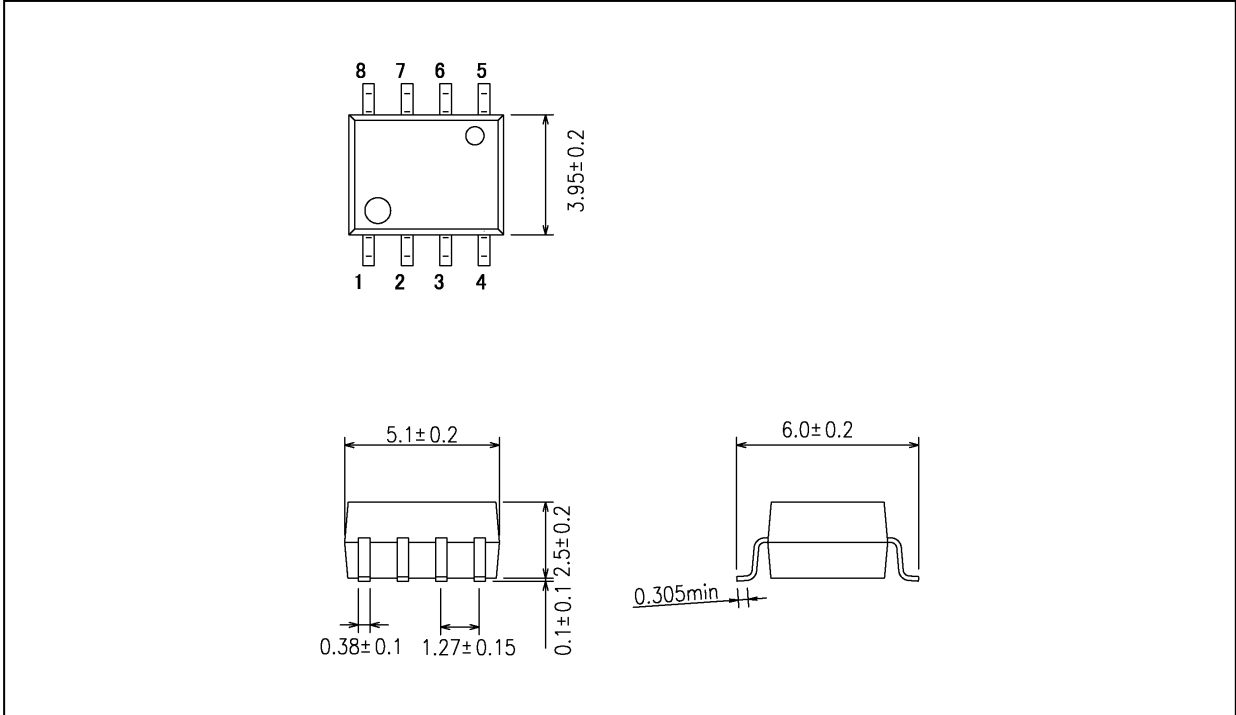


Fig. 16.4 Measurement Procedure

Package Dimensions

Unit: mm



Weight: 0.11 g (typ.)

Package Name(s)
TOSHIBA: 11-5K1S

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