

# TLP2703

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## 1. Applications

- Communications Equipment
- Industrial Inverters
- Home Electric Appliances

## 2. General

The Toshiba TLP2703 consists of a high-output GaAs light-emitting diode coupled with a high-speed photodiode transistor chip.

It is housed in a thin SO6L package with a thickness of 2.3 mm (max). The TLP2703 guarantees an isolation voltage of 5 kVrms (min) and is compliant with international safety standards for reinforced insulation.

Due to the use of a high-speed, high-gain detector element, the TLP2703 provides a current transfer ratio of 900 % (@  $I_F = 0.5$  mA) minimum over -40 to 125 °C and thus is ideal for applications which require low input current and high-speed data transmission. The TLP2703 supports a data rate of 100 kbps, and fills a gap in our product line between general-purpose transistor-output photocouplers and IC-output photocouplers with a data rate of 1 Mbps.

## 3. Features

- (1) Package: SO6L
- (2) Operating temperature: -40 to 125 °C
- (3) Current transfer ratio: 900 % (min) @  $I_F = 0.5$  mA
- (4) Maximum output current: 80 mA
- (5) Propagation delay time:  $t_{pHL} = 15$   $\mu$ s (max),  $t_{pLH} = 50$   $\mu$ s (max) @  $R_L = 4.7$  k $\Omega$ ,  $I_F = 0.5$  mA,  $T_a = 25$  °C
- (6) Isolation voltage: 5000 Vrms (min)
- (7) Safety standards

UL-approved: UL1577, File No.E67349

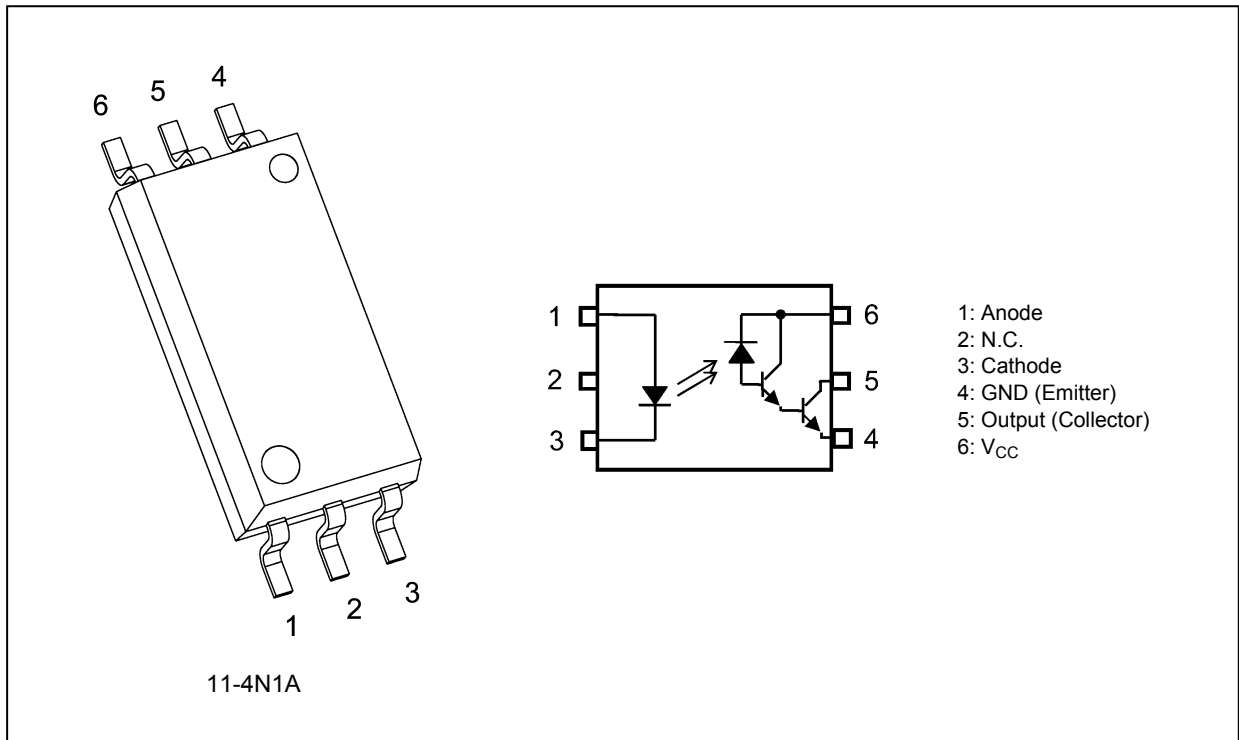
cUL-approved: CSA Component Acceptance Service No.5A File No.E67349

VDE-approved: EN60747-5-5, EN60065 or EN60950-1 (**Note 1**)

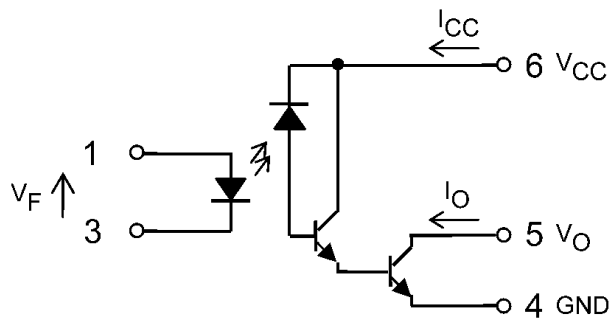
: EN62368-1 (Pending) (**Note 1**)

Note 1: When a VDE approved type is needed, please designate the **Option (D4)**.

**4. Packaging and Pin Assignment**



**5. Internal Circuit (Note)**



Note: A 0.1- $\mu$ F 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	Dimension	Unit
Package height	2.3 (max)	mm
Creepage distances	8.0 (min)	
Clearance distances	8.0 (min)	
Internal isolation thickness	0.4 (min)	

**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>		20	mA
	Input forward current derating (T <sub>a</sub> ≥ 100 °C)	ΔI <sub>F</sub> /ΔT <sub>a</sub>		-0.2	mA/°C
	Input forward current (pulsed)	I <sub>FP</sub>	(Note 1)	40	mA
	Input forward current derating (pulsed) (T <sub>a</sub> ≥ 100 °C)	ΔI <sub>FP</sub> /ΔT <sub>a</sub>		-0.8	mA/°C
	Peak transient input forward current	I <sub>FPT</sub>	(Note 2)	1	A
	Peak transient input forward current derating (T <sub>a</sub> ≥ 100 °C)	ΔI <sub>FPT</sub> /ΔT <sub>a</sub>		-20	mA/°C
	Input power dissipation	P <sub>D</sub>		100	mW
	Input power dissipation derating (T <sub>a</sub> ≥ 100 °C)	ΔP <sub>D</sub> /ΔT <sub>a</sub>		-2	mW/°C
	Input reverse voltage	V <sub>R</sub>		5	V
Detector	Output current	I <sub>O</sub>		80	mA
	Output current derating (T <sub>a</sub> ≥ 100 °C)	ΔI <sub>O</sub> /ΔT <sub>a</sub>		-1.6	mA/°C
	Output voltage	V <sub>O</sub>		-0.5 to 18	V
	Supply voltage	V <sub>CC</sub>		-0.5 to 18	
	Output power dissipation	P <sub>O</sub>		100	mW
	Output power dissipation derating (T <sub>a</sub> ≥ 100 °C)	ΔP <sub>O</sub> /ΔT <sub>a</sub>		-2.0	mW/°C
Common	Operating temperature	T <sub>opr</sub>		-40 to 125	°C
	Storage temperature	T <sub>stg</sub>		-55 to 125	
	Lead soldering temperature (10 s)	T <sub>sol</sub>		260	
	Isolation voltage (AC, 60 s, R.H. ≤ 60 %)	BV <sub>S</sub>	(Note 3)	5000	

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, 2 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 <sub>F(ON)</sub>		0.5	1.6	15	mA
Input off-state voltage	V <sub>F(OFF)</sub>		0	—	0.8	V
Supply voltage	V <sub>CC</sub>	(Note 1)	4.5	—	18	
Operating temperature	T <sub>opr</sub>	(Note 1)	-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 data sheet should also be considered.

Note: A ceramic capacitor (0.1 μF) should be connected between pin 4 and pin 6 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: Denotes the operating range, not the recommended operating condition.

**9. Electrical Characteristics (Note) (Unless otherwise specified,  $T_a = -40$  to  $125$  °C)**

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Input forward voltage	$V_F$	$I_F = 1.6$ mA, $T_a = 25$ °C	1.30	1.47	1.60	V
Input forward voltage temperature coefficient	$\Delta V_F / \Delta T_a$	$I_F = 1.6$ 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	—	45	—	pF
High-level output current	$I_{OH}$	$V_F = 0.8$ V, $V_{CC} = V_O = 18$ V	—	0.05	100	μA
		$V_F = 0.8$ V, $V_{CC} = V_O = 18$ V, $T_a = 110$ °C	—	—	50	μA
High-level supply current	$I_{CCH}$	$I_F = 0$ mA, $V_{CC} = 5$ V, $V_O = \text{Open}$	—	0.01	10	μA
Low-level supply current	$I_{CCL}$	$I_F = 1.6$ mA, $V_{CC} = 5$ V, $V_O = \text{Open}$	0.1	0.5	1.5	mA
Current transfer ratio	$I_O / I_F$	$I_F = 0.5$ mA, $V_{CC} = 4.5$ V, $V_O = 0.4$ V	900	2500	8000	%
		$I_F = 1.6$ mA, $V_{CC} = 4.5$ V, $V_O = 0.4$ V	800	1900	5000	
		$I_F = 5$ mA, $V_{CC} = 4.5$ V, $V_O = 0.4$ V	500	1100	—	
Low-level output voltage	$V_{OL}$	$I_F = 1.6$ mA, $V_{CC} = 4.5$ V, $I_O = 6.4$ mA	—	0.09	0.3	V
		$I_F = 5$ mA, $V_{CC} = 4.5$ V, $I_O = 15$ mA	—	0.12	0.3	
		$I_F = 12$ mA, $V_{CC} = 4.5$ V, $I_O = 24$ mA	—	0.15	0.3	

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

**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. $\leq 60$ %	$1 \times 10^{12}$	$10^{14}$	—	Ω
Isolation voltage	$BV_S$	(Note 1)	AC, 60 s	5000	—	—	V <sub>rms</sub>
			AC, 1 s in oil	—	10000	—	
			DC, 60 s in oil	—	10000	—	V <sub>dc</sub>

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

**11. Switching Characteristics**  
 (Unless otherwise specified,  $T_a = -40$  to  $125$  °C,  $V_{CC} = 5$  V)

Characteristics	Symbol	Note	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Propagation delay time (H/L)	$t_{pHL}$		Fig. 12.1.1	$I_F = 0.5$ mA, $R_L = 4.7$ k $\Omega$ , $T_a = 25$ °C	—	3.0	15	$\mu$ s
				$I_F = 0.5$ mA, $R_L = 4.7$ k $\Omega$			20	
				$I_F = 12$ mA, $R_L = 270$ $\Omega$ , $T_a = 25$ °C	—	0.34	1	
				$I_F = 12$ mA, $R_L = 270$ $\Omega$			2	
				$I_F = 1.6$ mA, $R_L = 2.2$ k $\Omega$ , $T_a = 25$ °C	—	1.25	5	
				$I_F = 1.6$ mA, $R_L = 2.2$ k $\Omega$			10	
Propagation delay time (L/H)	$t_{pLH}$			$I_F = 0.5$ mA, $R_L = 4.7$ k $\Omega$ , $T_a = 25$ °C	—	20.5	50	
				$I_F = 0.5$ mA, $R_L = 4.7$ k $\Omega$			90	
				$I_F = 12$ mA, $R_L = 270$ $\Omega$ , $T_a = 25$ °C	—	2.4	7	
				$I_F = 12$ mA, $R_L = 270$ $\Omega$			10	
				$I_F = 1.6$ mA, $R_L = 2.2$ k $\Omega$ , $T_a = 25$ °C	—	11.5	25	
				$I_F = 1.6$ mA, $R_L = 2.2$ k $\Omega$			50	
Common-mode transient immunity at output high	$CM_H$	(Note 1)	Fig. 12.1.2	$I_F = 0$ mA, $R_L = 4.1$ k $\Omega$ , $T_a = 25$ °C, $V_{CM} = 1000$ V, $V_{O(min)} = 3.0$ V	$\pm 15$	$\pm 30$	—	kV/ $\mu$ s
Common-mode transient immunity at output low	$CM_L$	(Note 2)		$I_F = 10$ mA, $R_L = 4.1$ k $\Omega$ , $T_a = 25$ °C, $V_{CM} = 1000$ V, $V_{O(max)} = 0.4$ V	$\pm 15$	$\pm 30$	—	

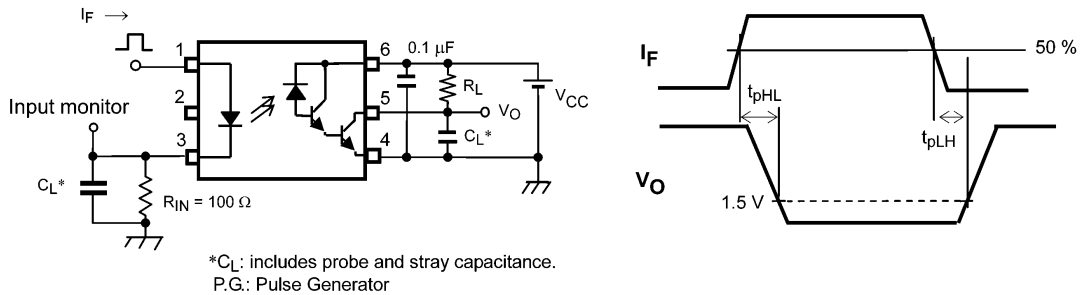
Note 1:  $CM_H$  is the maximum rate of rise of the common mode voltage that can be sustained with the output voltage in the logic high state ( $V_O > 3.0$  V).

Note 2:  $CM_L$  is the maximum rate of fall of the common mode voltage that can be sustained with the output voltage in the logic low state ( $V_O < 0.4$  V).

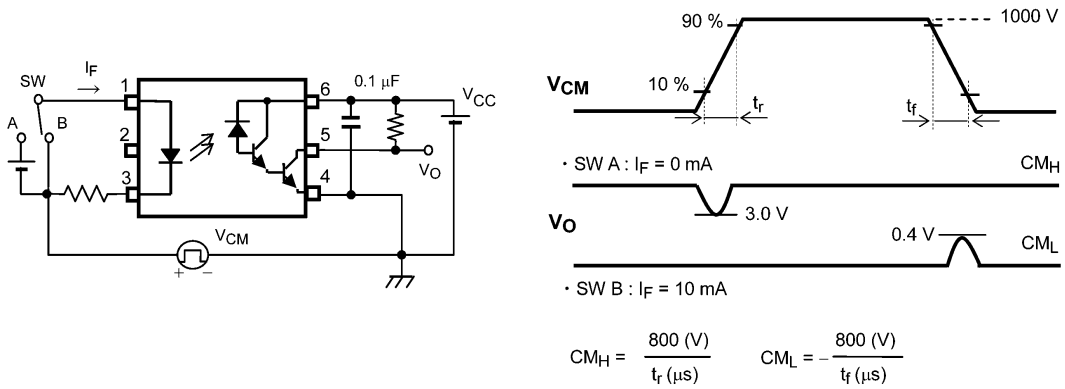
**12. Test Circuits and Characteristics Curves**

**12.1. Test Circuits**

P.G. (f = 10 kHz, duty = 10 %,  $t_r = t_f = 5$  ns or less)



**Fig. 12.1.1 Switching Time Test Circuit and Waveform**



**Fig. 12.1.2 Common-Mode Transient Immunity Test Circuit and Waveform**

12.2. Characteristics Curves (Note)

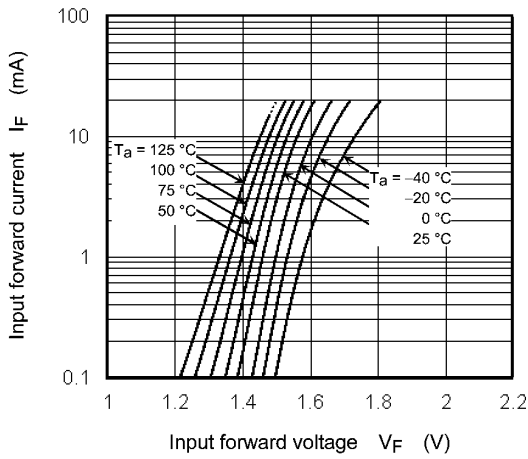


Fig. 12.2.1  $I_F - T_a$

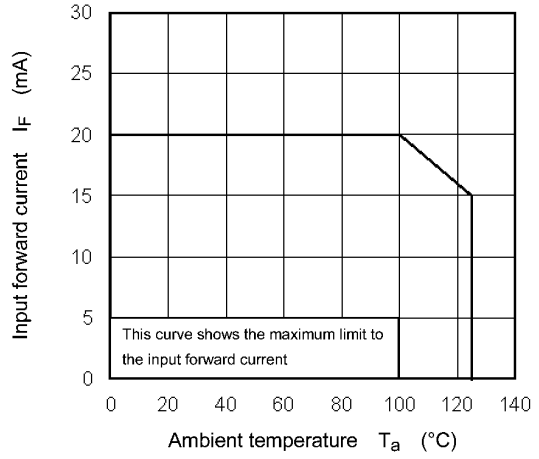


Fig. 12.2.2  $I_F - V_F$

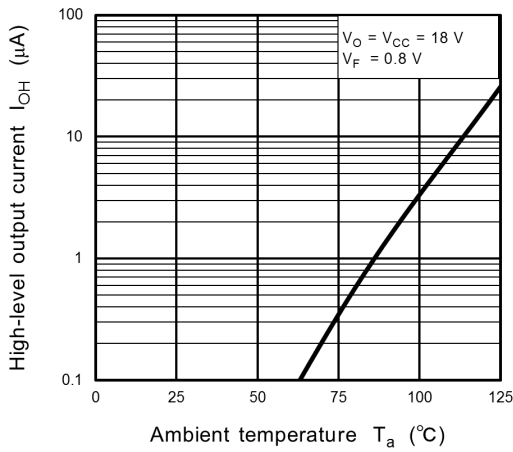


Fig. 12.2.3  $I_{OH} - T_a$

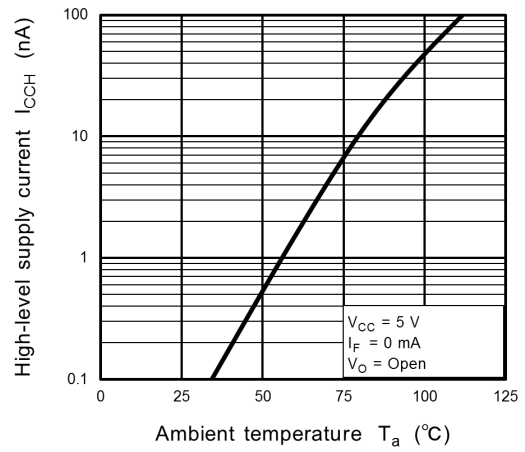


Fig. 12.2.4  $I_{CCH} - T_a$

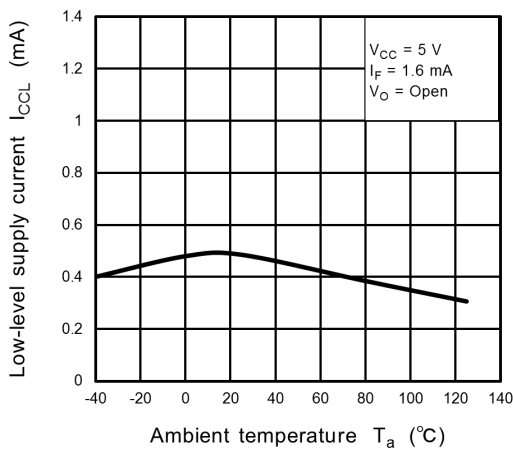


Fig. 12.2.5  $I_{CCL} - T_a$

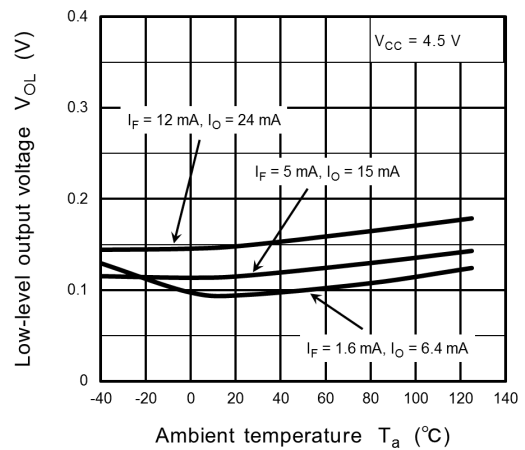


Fig. 12.2.6  $V_{OL} - T_a$

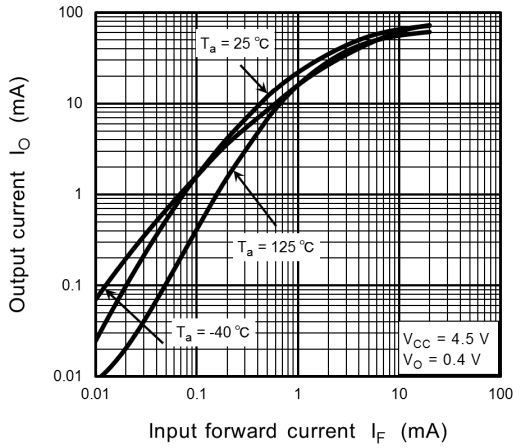


Fig. 12.2.7  $I_O - I_F$

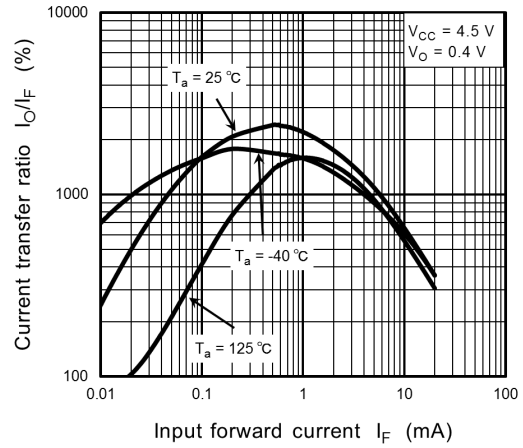


Fig. 12.2.8  $I_O/I_F - I_F$

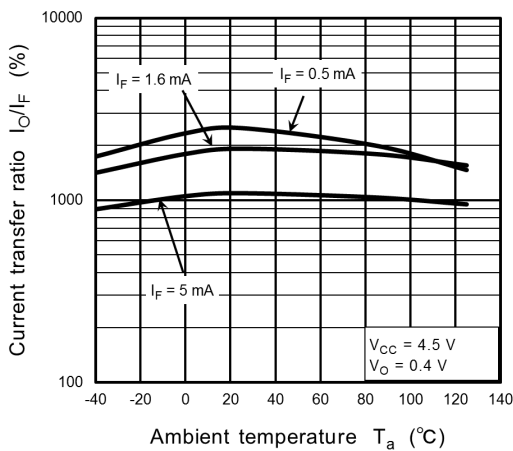


Fig. 12.2.9  $I_O/I_F - T_a$

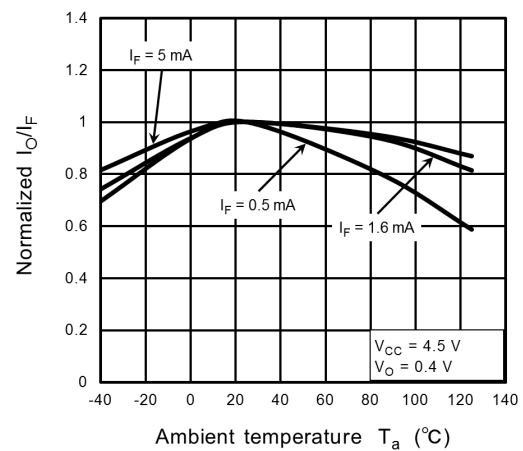


Fig. 12.2.10  $I_O/I_F - T_a$

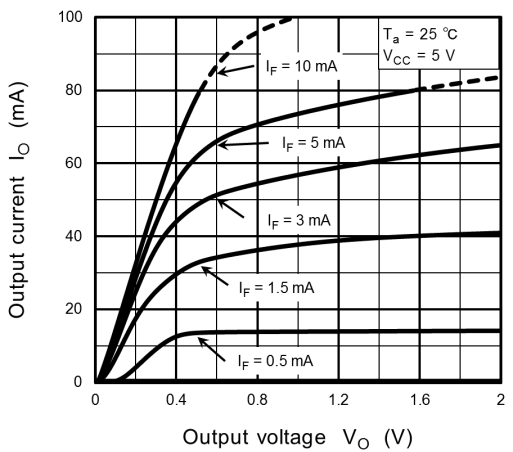


Fig. 12.2.11  $I_O - V_O$

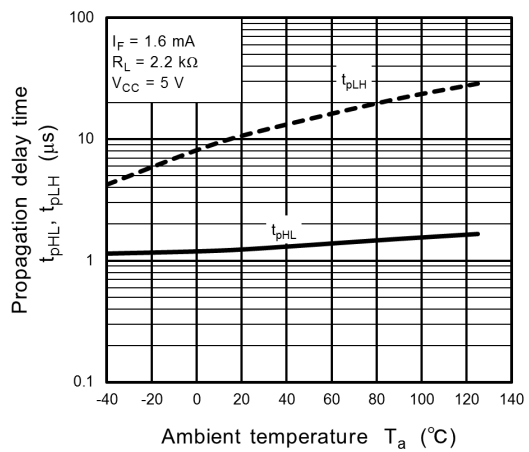
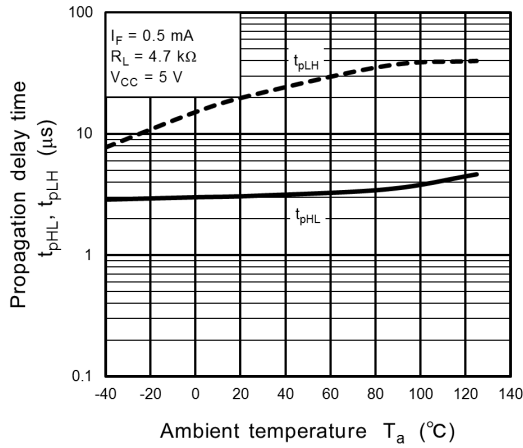
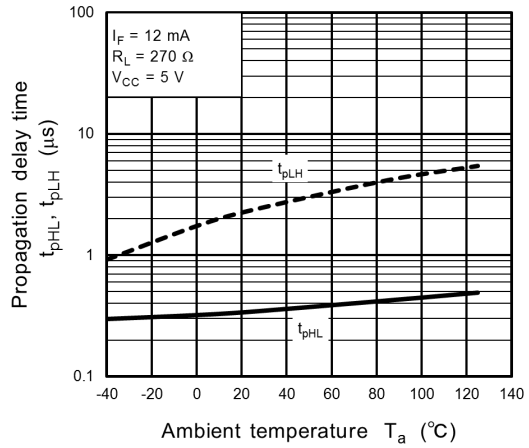


Fig. 12.2.12  $t_{pHL}, t_{pLH} - T_a$

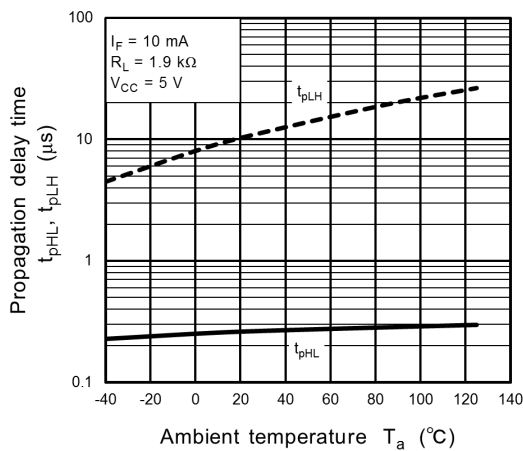




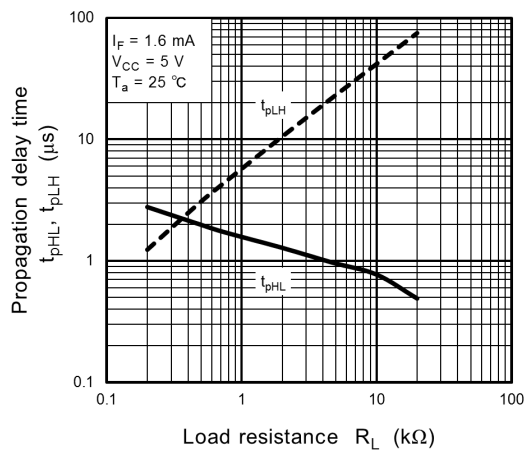
**Fig. 12.2.13**  $t_{pHL}, t_{pLH} - T_a$



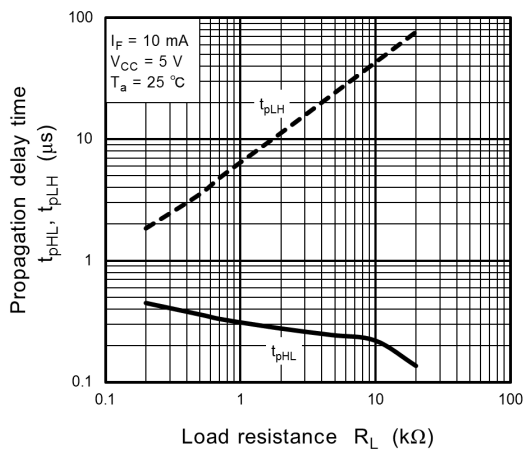
**Fig. 12.2.14**  $t_{pHL}, t_{pLH} - T_a$



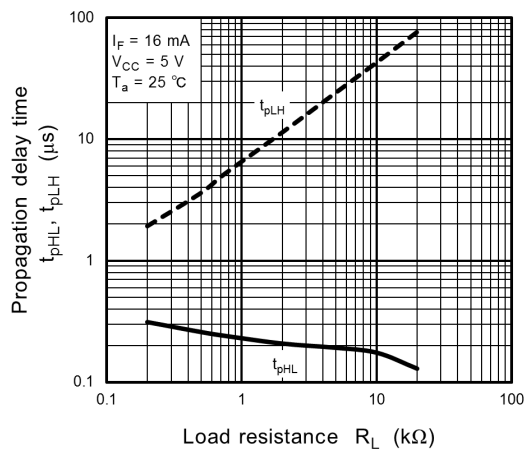
**Fig. 12.2.15**  $t_{pHL}, t_{pLH} - T_a$



**Fig. 12.2.16**  $t_{pHL}, t_{pLH} - R_L$



**Fig. 12.2.17**  $t_{pHL}, t_{pLH} - R_L$



**Fig. 12.2.18**  $t_{pHL}, t_{pLH} - R_L$

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.

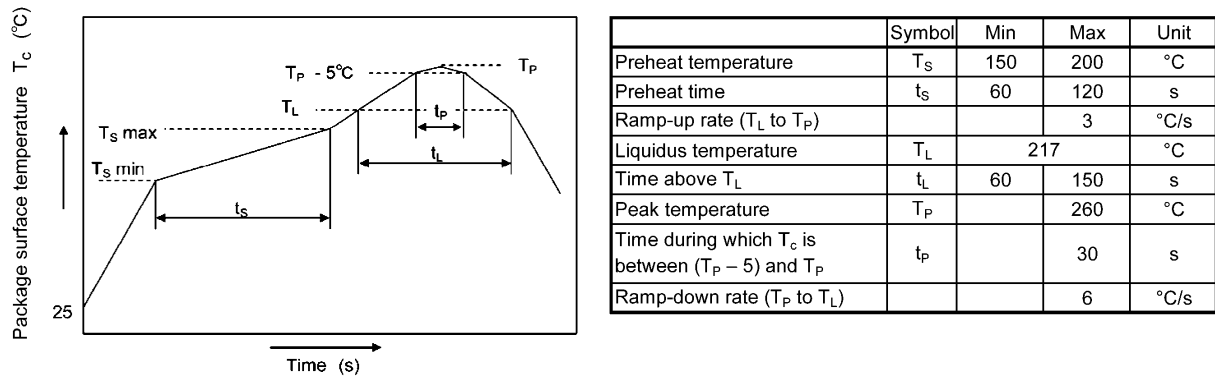
- When using soldering reflow.

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.



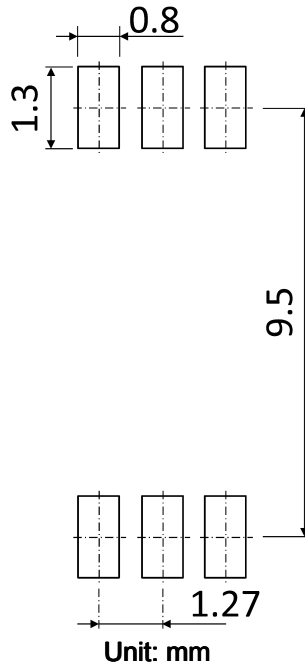
**Fig. 13.1.1 An Example of a Temperature Profile When Lead(Pb)-Free Solder Is Used**

- 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.

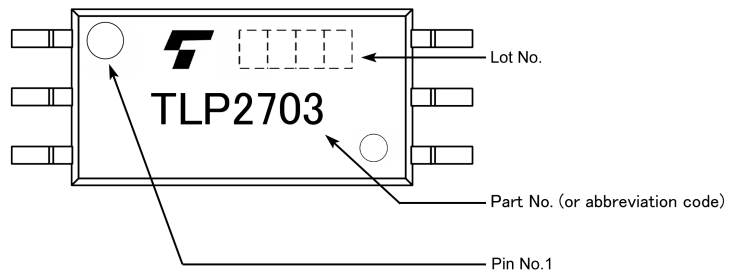
#### 13.2. Precautions for General Storage

- 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)



15. Marking



**16. EN60747-5-5 Option (D4) Specification**

- Part number: TLP2703 (**Note 1**)
- The following part naming conventions are used for the devices that have been qualified according to option (D4) of EN60747.

Example: TLP2703(D4-TP,E(T

D4: EN60747 option

TP: Tape type

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

T: Domestic ID (Country/Region of origin: Thailand)

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

e.g., TLP2703(D4-TP,E(T → TLP2703

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 ≤ 600 Vrms for rated mains voltage ≤ 1000 Vrms		I-IV I-III	—
Climatic classification		55 / 125 / 21	—
Pollution degree		2	—
Maximum operating insulation voltage	V <sub>IORM</sub>	1230	V <sub>peak</sub>
Input to output test voltage, Method A V <sub>pr</sub> = 1.6 × V <sub>IORM</sub> , type and sample test t <sub>p</sub> = 10 s, partial discharge < 5 pC	V <sub>pr</sub>	1970	V <sub>peak</sub>
Input to output test voltage, Method B V <sub>pr</sub> = 1.875 × V <sub>IORM</sub> , 100 % production test t <sub>p</sub> = 1 s, partial discharge < 5 pC	V <sub>pr</sub>	2310	V <sub>peak</sub>
Highest permissible overvoltage (transient overvoltage, t <sub>pr</sub> = 60 s)	V <sub>TR</sub>	8000	V <sub>peak</sub>
Safety limiting values (max. permissible ratings in case of fault, also refer to thermal derating curve) current (input current I <sub>F</sub> , P <sub>SO</sub> = 0) power (output or total power dissipation) temperature	I <sub>si</sub> P <sub>so</sub> T <sub>s</sub>	250 400 150	mA mW °C
Insulation resistance V <sub>IO</sub> = 500 V, T <sub>a</sub> = 25 °C V <sub>IO</sub> = 500 V, T <sub>a</sub> = 100 °C V <sub>IO</sub> = 500 V, T <sub>a</sub> = T <sub>s</sub>	R <sub>si</sub>	≥ 10 <sup>12</sup> ≥ 10 <sup>11</sup> ≥ 10 <sup>9</sup>	Ω

**Fig. 16.1 EN60747 Isolation Characteristics**

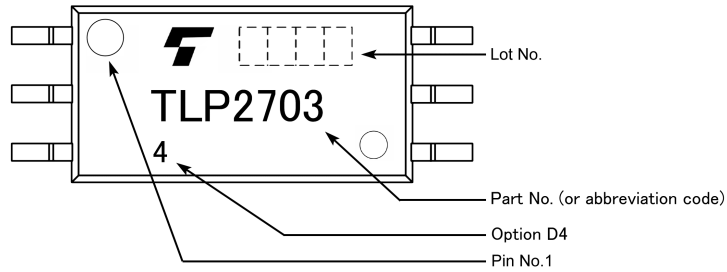
Minimum creepage distance	Cr	8.0 mm
Minimum clearance	Cl	8.0 mm
Minimum insulation thickness	ti	0.4 mm
Comparative tracking index	CTI	175

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

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.

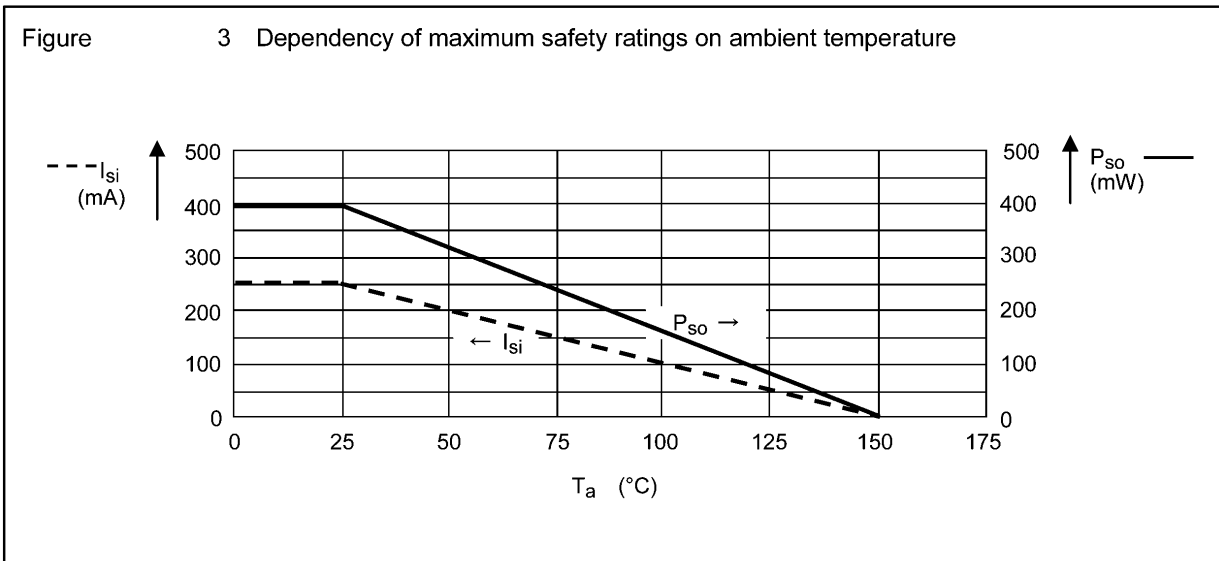
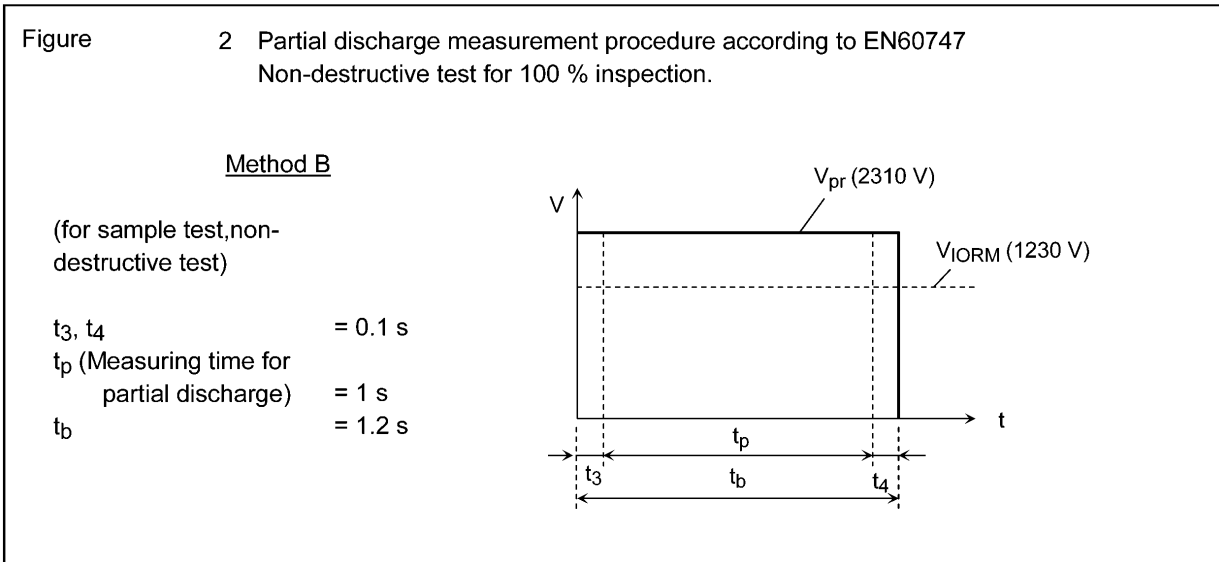
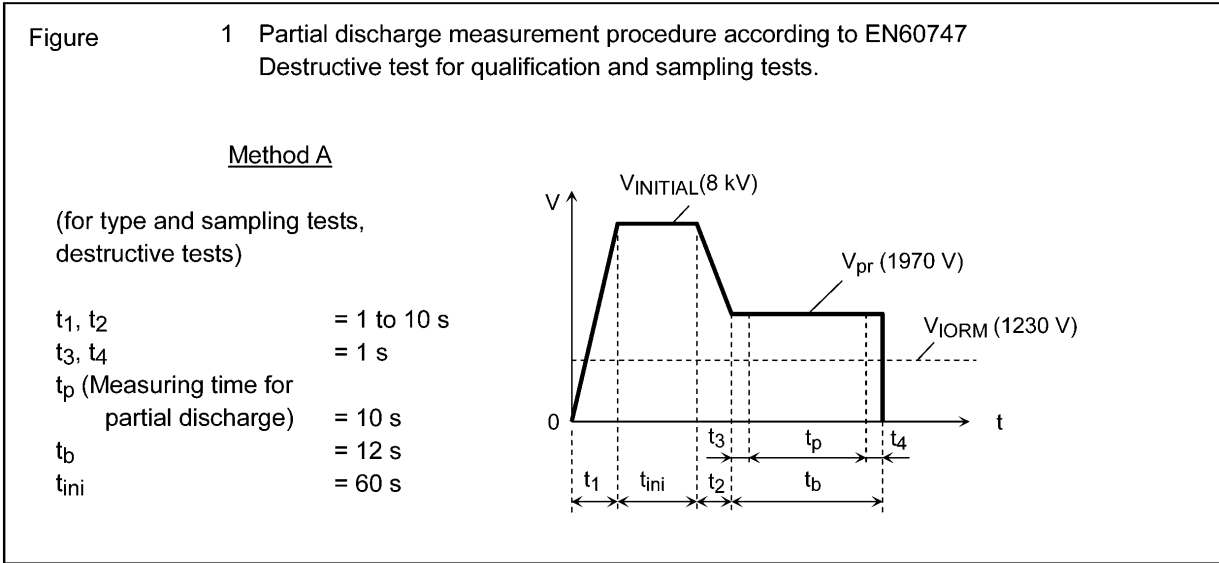


**Fig. 16.3 Marking on Packing for EN60747**



**Fig. 16.4 Marking Example (Note)**

Note: The above marking is applied to the photocouplers that have been qualified according to option (D4) of EN60747.



**Fig. 16.5 Measurement Procedure**

## 17. Specifications for Embossed-Tape Packing

### 17.1. Applicable Package

Package Name	Product Type
SO6L	Long creepage mini flat coupler

### 17.2. 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) TLP2703(TP,E(T

Part number: TLP2703

Tape type: TP

[[G]]/RoHS COMPATIBLE: E (**Note 1**)

Domestic ID (Country/Region of origin: Thailand): T

**Note 1:** 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.

### 17.3. Tape Dimensions Specification

Tape Type	Division	Packing Amount (A unit per reel)
TP	—	1500

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

Device orientation in the carrier cavities as shown in the following figure.

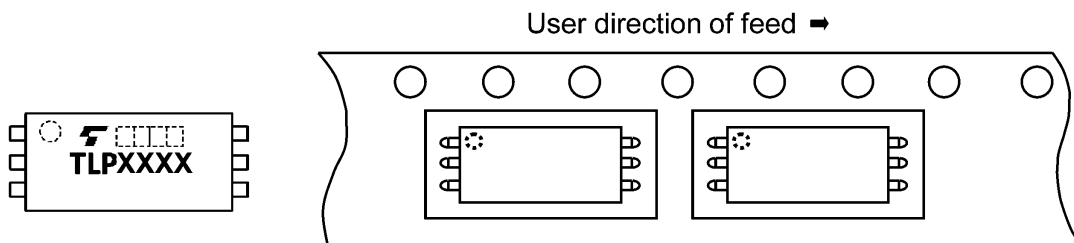


Fig. 17.3.1.1 Orientation of Device in Relation to Direction of Tape Movement

#### 17.3.2. Empty Cavities

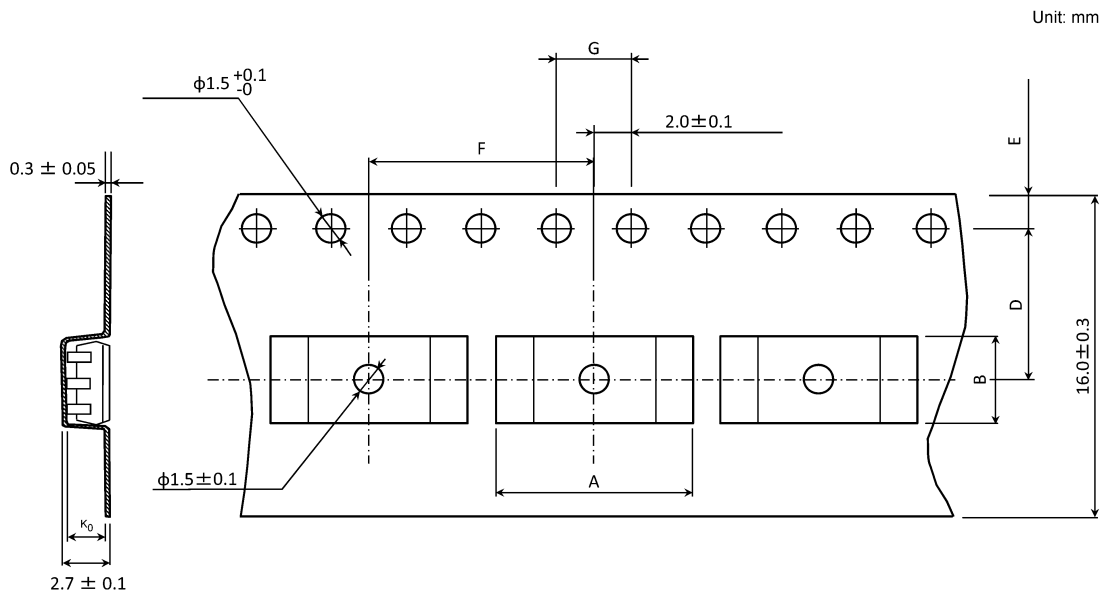
Characteristics	Criterion	Remarks
Occurrences of 2 or more successive empty cavities	0 device	Within any given 40-mm section of tape, not including leader and trailer
Single empty cavity	6 devices (max) per reel	Not including leader and trailer

#### 17.3.3. Tape Leader and Trailer

The start of the tape has 14 or more empty holes. The end of the tape has 34 or more empty holes and a cover tape of 30 mm or longer.

**17.3.4. Tape Dimensions**

Tape material: Plastic (for protection against static electricity)



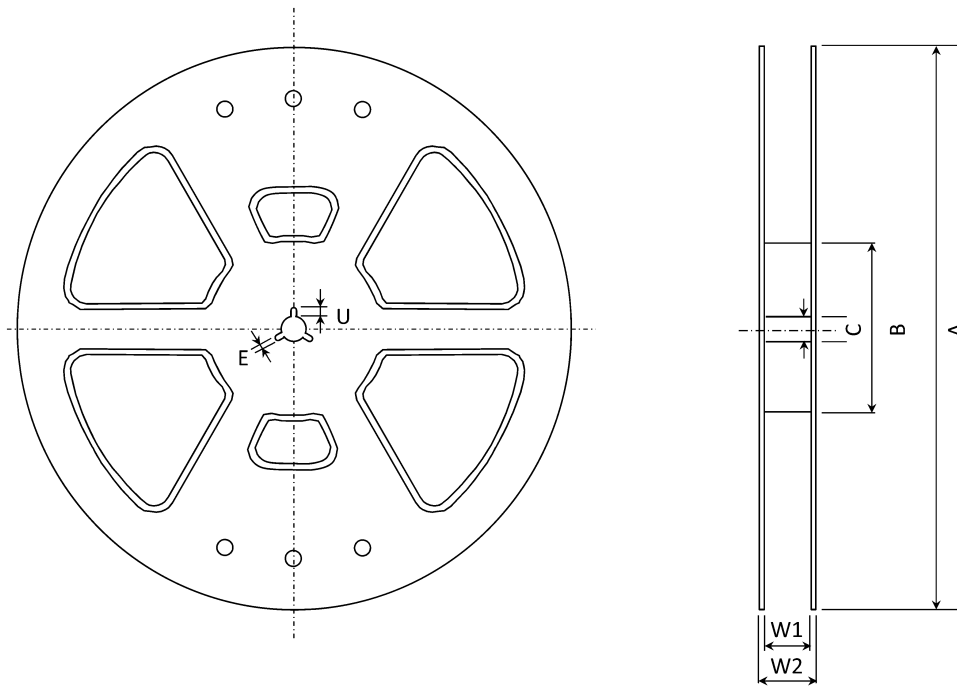
**Table Tape Dimensions (unit: mm, tolerance: ±0.1)**

Symbol	Dimension	Remark
A	10.4	—
B	4.24	—
D	7.5	Center line of embossed cavity and sprocket hole
E	1.75	Distance between tape edge and sprocket hole center
F	12.0	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 <sub>0</sub>	2.4	Internal space



**17.3.5. Reel Specification**

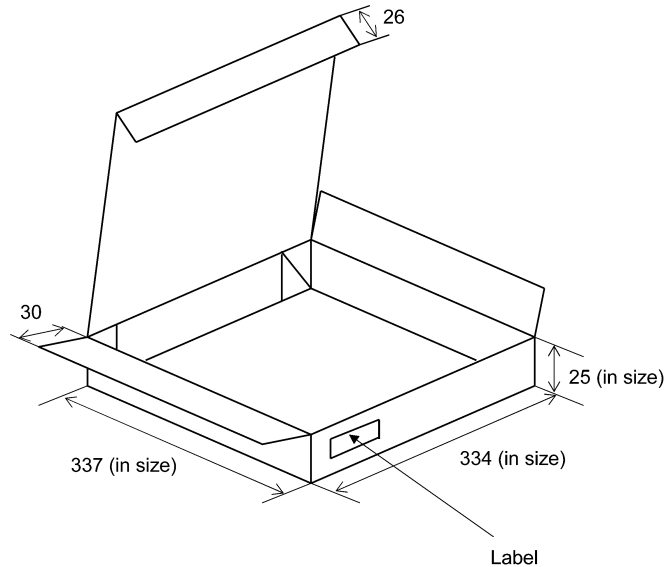
Material: Plastic (for protection against static electricity)



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

Symbol	Dimension
A	$\phi 330 \pm 2.0$
B	$\phi 100 \pm 1.0$
C	$\phi 13 \pm 0.5$
E	$2.0 \pm 0.5$
U	$4.0 \pm 0.5$
W1	$17.4 \pm 1.0$
W2	$21.4 \pm 1.0$

**17.4. Packing (Note)**



**1 reel/carton (unit: mm)**

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

**17.5. Label Format**

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

**17.6. Ordering Information**

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

Example) TLP2703(TP,E(T 1500 pcs

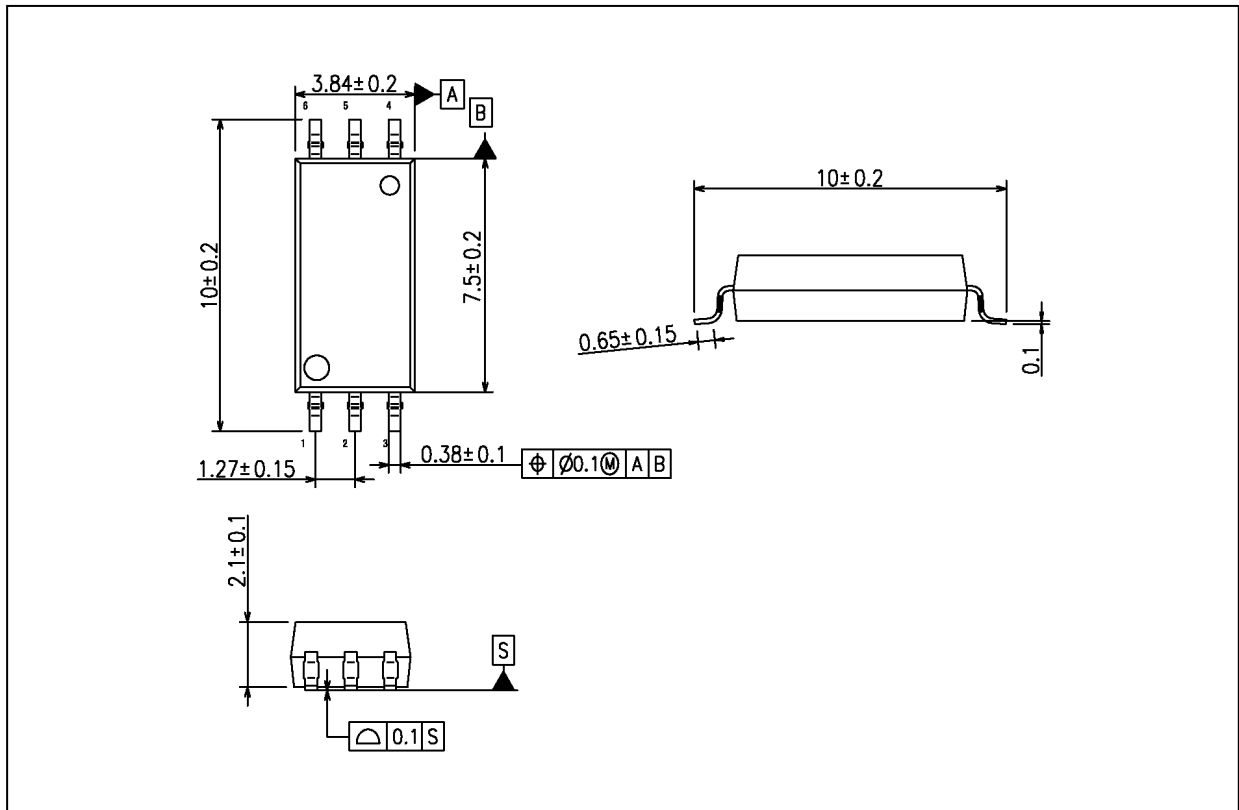
- Part number: TLP2703
- Tape type: TP (12-mm pitch)
- [[G]]/RoHS COMPATIBLE: E (**Note 1**)
- Domestic ID (Country/Region of origin: Thailand): T
- Quantity (must be a multiple of 1500): 1500 pcs

Note 1: 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.

**Package Dimensions**

Unit: mm



Weight: 0.126 g (typ.)

Package Name(s)
TOSHIBA: 11-4N1A

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