Photocouplers Infrared LED & Photo IC

TLP2703

1. Applications

- Communications Equipment
- Industrial Inverters
- Home Electric Appliances

2. General

The Toshiba TLP2703 consists of a high-output infrared LED 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 ℃ 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 ℃

(3) Current transfer ratio: 900 % (min) @I_F = 0.5 mA

(4) Maximum output current: 80 mA

(5) Propagation delay time: t_{pHL} = 15 μs (max), t_{pLH} = 50 μs (max) @ R_L = 4.7 kΩ, I_F = 0.5 mA, T_a = 25 ℃

(6) Isolation voltage: 5000 Vrms (min)

(7) Safety standards

UL-recognized: UL 1577, File No.E67349

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

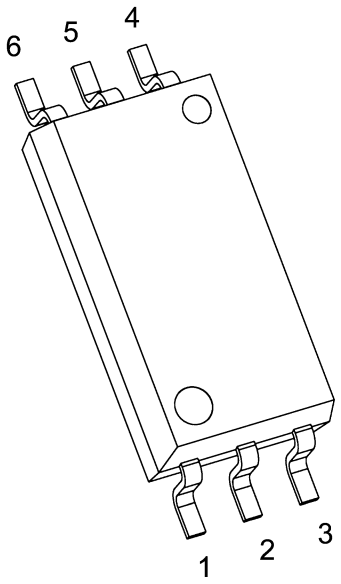
VDE-approved: EN 60747-5-5, EN 62368-1 **(Note 1)**

CQC-approved: GB4943.1, GB8898 Japan and Thailand Factory

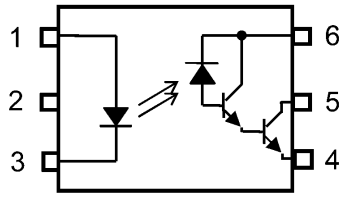
Note 1: When a VDE approved type is needed, please designate the **Option (D4)**.

Start of commercial production
2014-06

4. Packaging and Pin Assignment

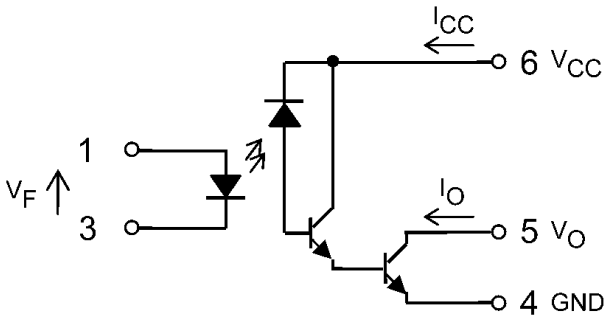


11-4N1A



1: Anode
2: N.C.
3: Cathode
4: GND (Emitter)
5: Output (Collector)
6: V_{CC}

5. Internal Circuit (Note)



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

6. Principle of Operation

6.1. Truth Table

Input	LED	Output
H	ON	L
L	OFF	H

6.2. Mechanical Parameters

Characteristics	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_a = 25 °C)

	Characteristics		Symbol	Note	Rating	Unit
LED	Input forward current		I_F		20	mA
	Input forward current derating	($T_a \geq$ 100 °C)	$\Delta I_F/\Delta T_a$		-0.2	mA/°C
	Input forward current (pulsed)		I_{FP}	(Note 1)	40	mA
	Input forward current derating (pulsed)	($T_a \geq$ 100 °C)	$\Delta I_{FP}/\Delta T_a$		-0.8	mA/°C
	Peak transient input forward current		I_{FPT}	(Note 2)	1	A
	Peak transient input forward current derating	($T_a \geq$ 100 °C)	$\Delta I_{FPT}/\Delta T_a$		-20	mA/°C
	Input power dissipation		P_D		100	mW
	Input power dissipation derating	($T_a \geq$ 100 °C)	$\Delta P_D/\Delta T_a$		-2	mW/°C
	Input reverse voltage		V_R		5	V
Detector	Output current		I_O		80	mA
	Output current derating	($T_a \geq$ 100 °C)	$\Delta I_O/\Delta T_a$		-1.6	mA/°C
	Output voltage		V_O		-0.5 to 18	V
	Supply voltage		V_{CC}		-0.5 to 18	
	Output power dissipation		P_O		100	mW
	Output power dissipation derating	($T_a \geq$ 100 °C)	$\Delta P_O/\Delta T_a$		-2.0	mW/°C
Common	Operating temperature		T_{opr}		-40 to 125	°C
	Storage temperature		T_{stg}		-55 to 125	
	Lead soldering temperature	(10 s)	T_{sol}		260	
	Isolation voltage	(AC, 60 s, R.H. ≤ 60 %)	BV_S	(Note 3)	5000	Vrms

Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings.
Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

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

Note 2: Pulse width (PW) ≤ 1 μs, 300 pps

Note 3: This device is considered as a two-terminal device: Pins 1, 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	$I_{F(ON)}$		0.5	1.6	15	mA
Input off-state voltage	$V_{F(OFF)}$		0	—	0.8	V
Operating temperature	T_{opr}	(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 = Open	—	0.01	10	μA
Low-level supply current	I_{CCL}	I_F = 1.6 mA, V_{CC} = 5 V, V_O = 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. ≤ 60 %	10^{12}	10^{14}	—	Ω
Isolation voltage	BV_S	(Note 1)	AC, 60 s	5000	—	—	Vrms

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 kΩ, T_a = 25 °C	—	3.0	15	μs
				I_F = 0.5 mA, R_L = 4.7 kΩ			20	
				I_F = 12 mA, R_L = 270 Ω, T_a = 25 °C	—	0.34	1	
				I_F = 12 mA, R_L = 270 Ω			2	
				I_F = 1.6 mA, R_L = 2.2 kΩ, T_a = 25 °C	—	1.25	5	
				I_F = 1.6 mA, R_L = 2.2 kΩ			10	
Propagation delay time (L/H)	t_{pLH}			I_F = 0.5 mA, R_L = 4.7 kΩ, T_a = 25 °C	—	20.5	50	
				I_F = 0.5 mA, R_L = 4.7 kΩ			90	
				I_F = 12 mA, R_L = 270 Ω, T_a = 25 °C	—	2.4	7	
				I_F = 12 mA, R_L = 270 Ω			10	
				I_F = 1.6 mA, R_L = 2.2 kΩ, T_a = 25 °C	—	11.5	25	
				I_F = 1.6 mA, R_L = 2.2 kΩ			50	
High-level common-mode transient immunity	CM_H	(Note 1)	Fig. 12.1.2	I_F = 0 mA, R_L = 4.1 kΩ, T_a = 25 °C, V_{CM} = 1000 V, $V_{O(min)}$ = 3.0 V	±15	±30	—	kV/μs
Low-level common-mode transient immunity	CM_L	(Note 2)		I_F = 10 mA, R_L = 4.1 kΩ, T_a = 25 °C, V_{CM} = 1000 V, $V_{O(max)}$ = 0.4 V	±15	±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

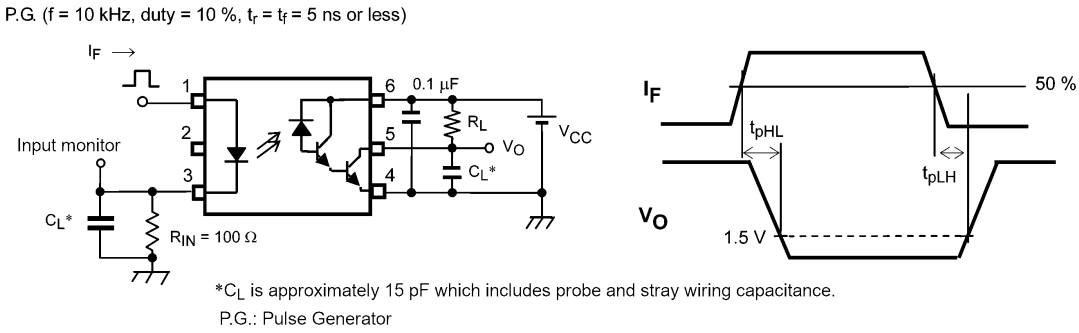


Fig. 12.1.1 Switching Time Test Circuit and Waveform

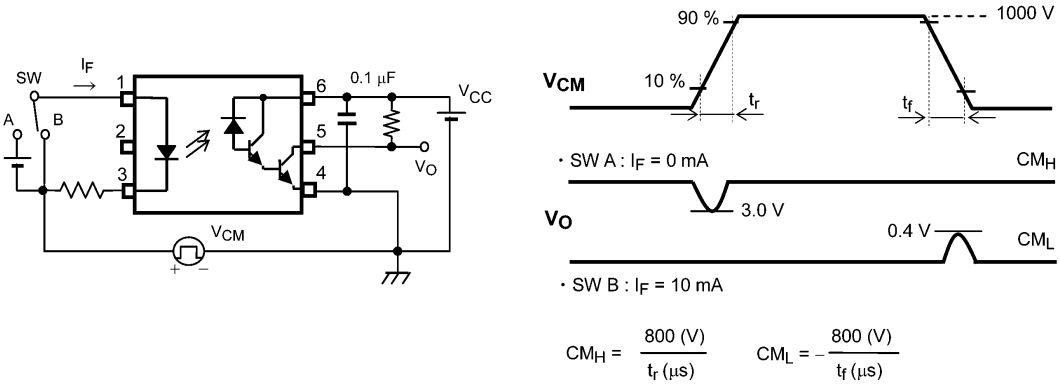


Fig. 12.1.2 Common-Mode Transient Immunity Test Circuit and Waveform

12.2. Characteristics Curves (Note)

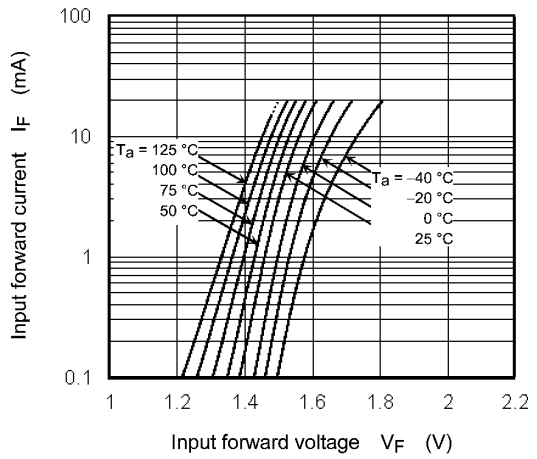


Fig. 12.2.1 I_F - T_a

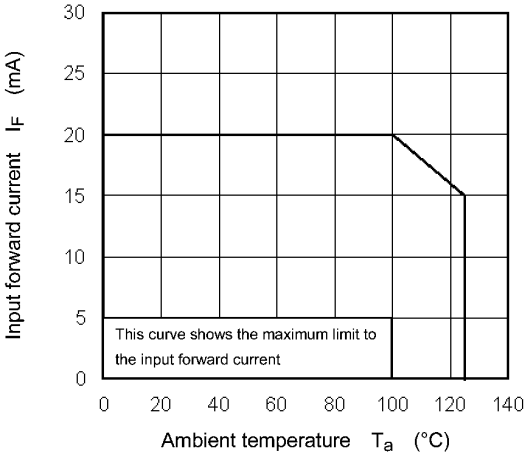


Fig. 12.2.2 I_F - V_F

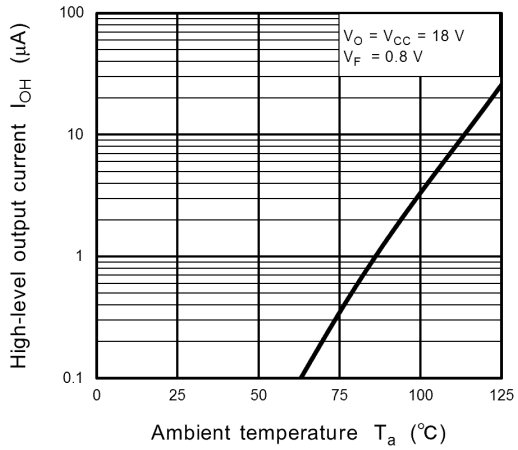


Fig. 12.2.3 I_{OH} - T_a

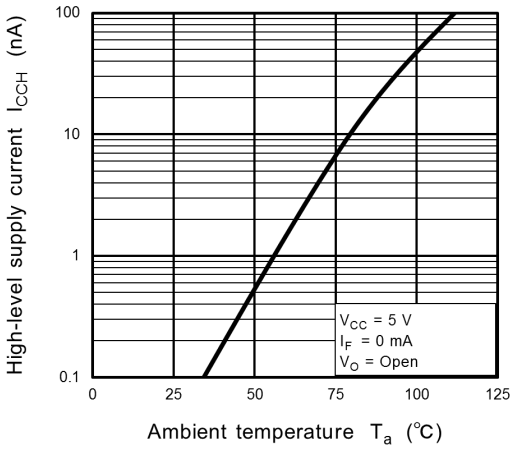


Fig. 12.2.4 I_{CCH} - T_a

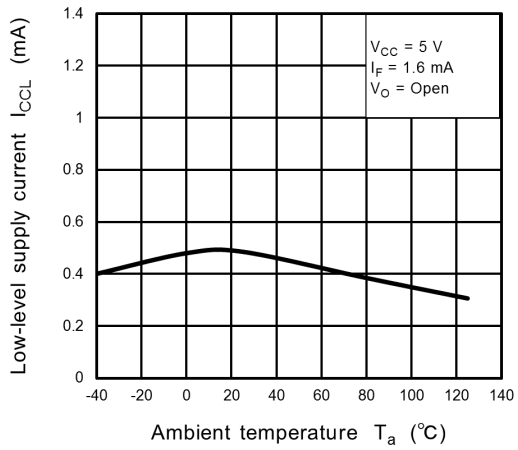


Fig. 12.2.5 I_{CCL} - T_a

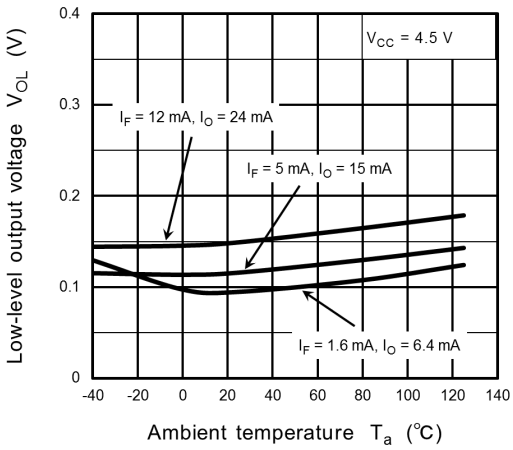


Fig. 12.2.6 V_{OL} - T_a

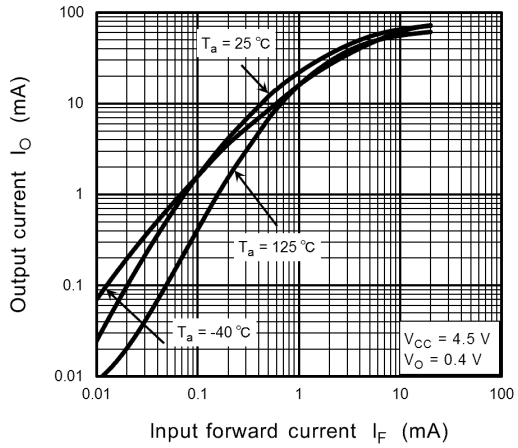


Fig. 12.2.7 I_O - I_F

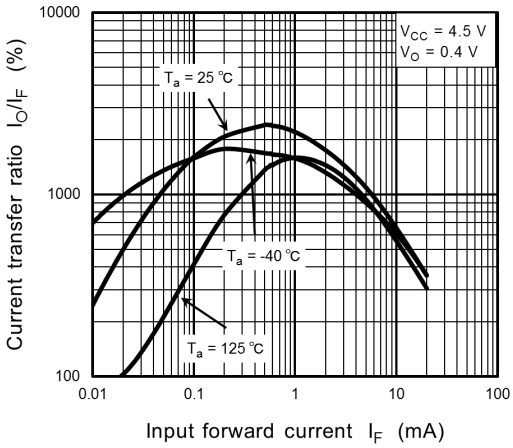


Fig. 12.2.8 I_O/I_F - I_F

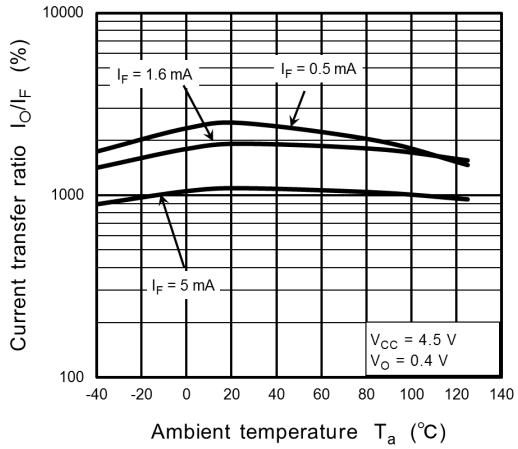


Fig. 12.2.9 I_O/I_F - T_a

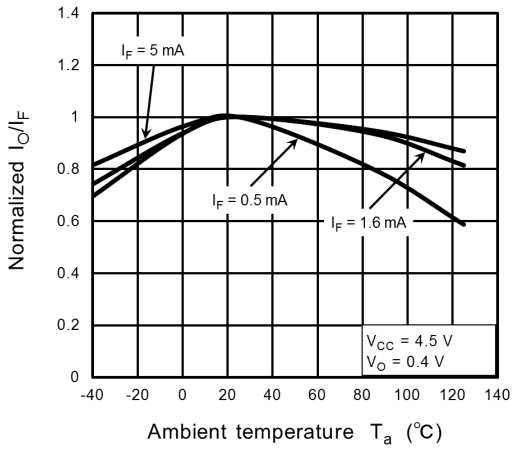


Fig. 12.2.10 I_O/I_F - T_a

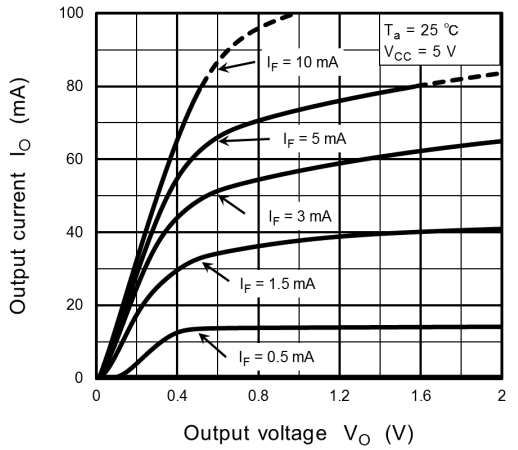


Fig. 12.2.11 I_O - V_O

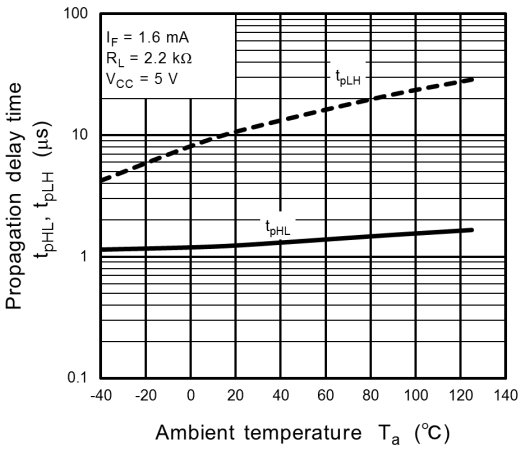


Fig. 12.2.12 t_{pHL},t_{pLH} - T_a

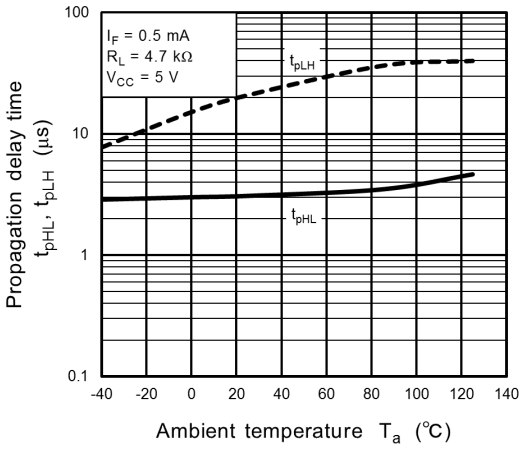


Fig. 12.2.13 t_{pHL},t_{pLH} - T_a

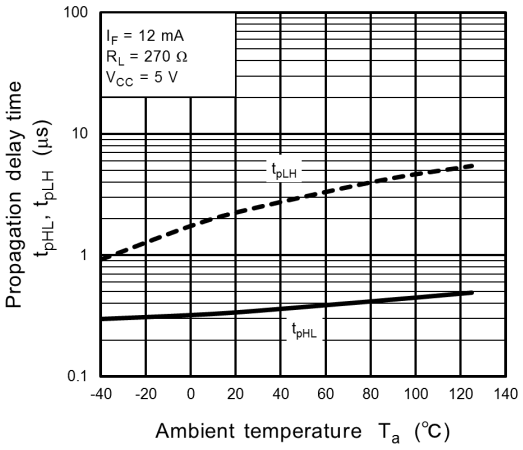


Fig. 12.2.14 t_{pHL},t_{pLH} - T_a

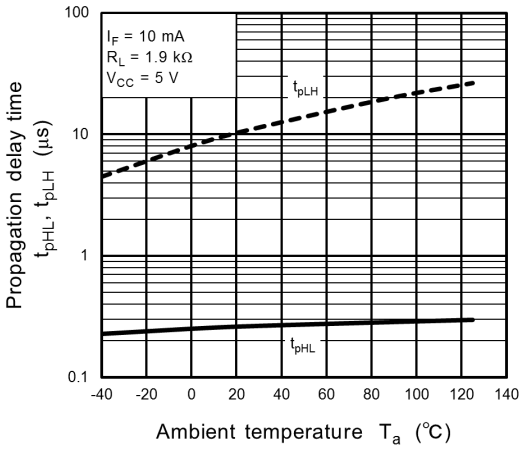


Fig. 12.2.15 t_{pHL},t_{pLH} - T_a

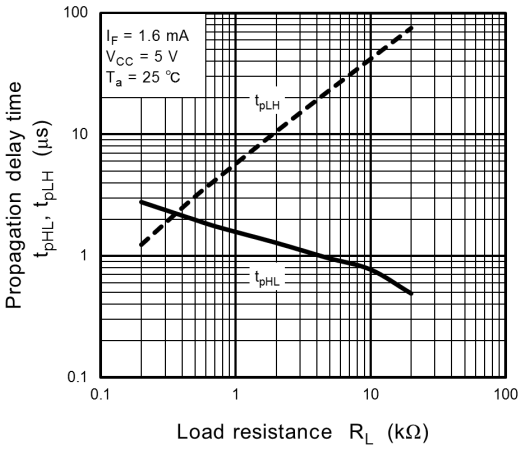


Fig. 12.2.16 t_{pHL},t_{pLH} - R_L

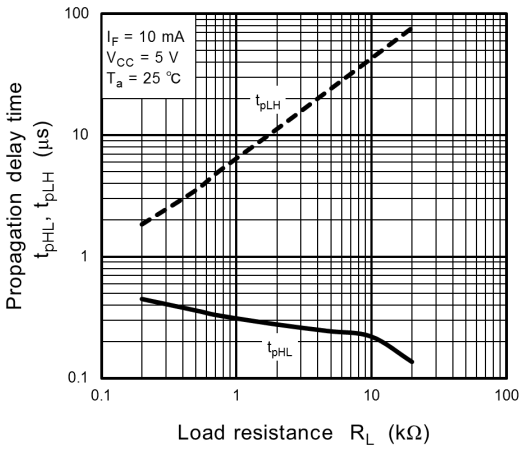


Fig. 12.2.17 t_{pHL},t_{pLH} - R_L

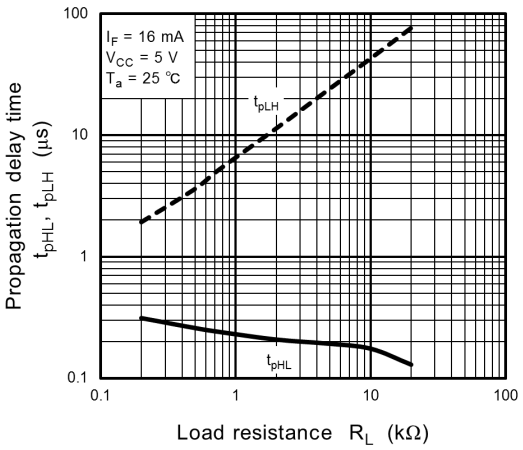


Fig. 12.2.18 t_{pHL},t_{pLH} - R_L

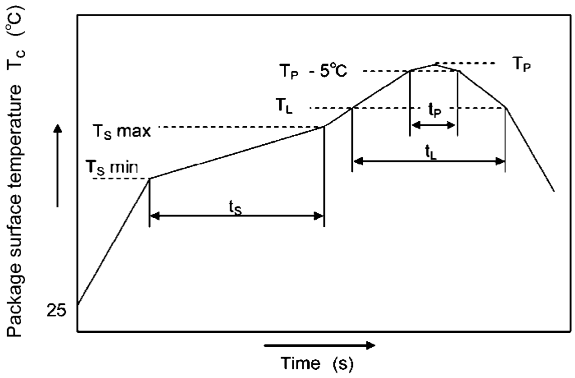
Note: The above characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.

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.



	Symbol	Min	Max	Unit
Preheat temperature	T_S	150	200	°C
Preheat time	t_S	60	120	s
Ramp-up rate (T_L to T_P)			3	°C/s
Liquidus temperature	T_L	217		°C
Time above T_L	t_L	60	150	s
Peak temperature	T_P		260	°C
Time during which T_c is between (T_P – 5) and T_P	t_P		30	s
Ramp-down rate (T_P to T_L)			6	°C/s

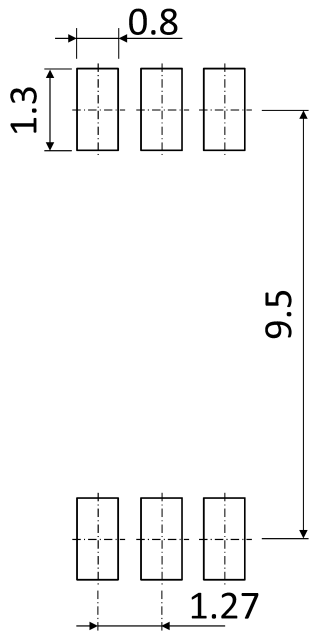
Fig. 13.1.1 An Example of a Temperature Profile When Lead(Pb)-Free Solder Is Used

- When using soldering flow
  Preheat the device at a temperature of 150 °C (package surface temperature) for 60 to 120 seconds.
  Mounting condition of 260 °C within 10 seconds is recommended.
  Flow soldering must be performed once.
- When using soldering Iron
  Complete soldering within 10 seconds for lead temperature not exceeding 260 °C or within 3 seconds not exceeding 350 °C
  Heating by soldering iron must be done only once per lead.

13.2. Precautions for General Storage

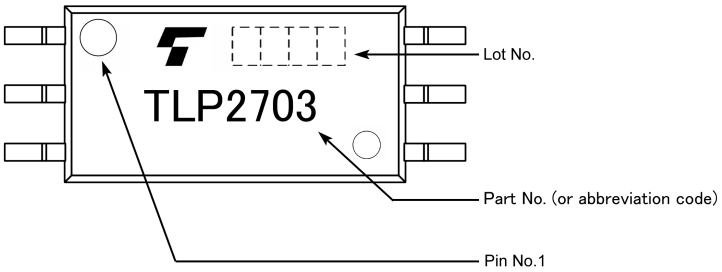
- Avoid storage locations where devices may be exposed to moisture or direct sunlight.
- Follow the precautions printed on the packing label of the device for transportation and storage.
- Keep the storage location temperature and humidity within a range of 5 °C to 35 °C and 45 % to 75 %, respectively.
- Do not store the products in locations with poisonous gases (especially corrosive gases) or in dusty conditions.
- Store the products in locations with minimal temperature fluctuations. Rapid temperature changes during storage can cause condensation, resulting in lead oxidation or corrosion, which will deteriorate the solderability of the leads.
- When restoring devices after removal from their packing, use anti-static containers.
- Do not allow loads to be applied directly to devices while they are in storage.
- If devices have been stored for more than two years under normal storage conditions, it is recommended that you check the leads for ease of soldering prior to use.

14. Land Pattern Dimensions (for reference only)



Unit: mm

15. Marking



16. EN 60747-5-5 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 EN 60747.

  Example: TLP2703(D4-TP,E

  D4: EN 60747 option
  TP: Tape type
  E: [[G]]/RoHS COMPATIBLE **(Note 2)**

Note 1: Use TOSHIBA standard type number for safety standard application.
e.g., TLP2703(D4-TP,E → 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_{IORM}	1230	Vpeak
Input to output test voltage, Method A V_{pr} = 1.6 × V_{IORM}, type and sample test t_p = 10 s, partial discharge < 5 pC	V_{pr}	1970	Vpeak
Input to output test voltage, Method B V_{pr} =1.875 × V_{IORM}, 100 % production test t_p = 1 s, partial discharge < 5 pC	V_{pr}	2310	Vpeak
Highest permissible overvoltage (transient overvoltage, t_{pr} = 60 s)	V_{TR}	8000	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}	≥ 10^{12} ≥ 10^{11} ≥ 10^9	Ω

Fig. 16.1 EN 60747 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

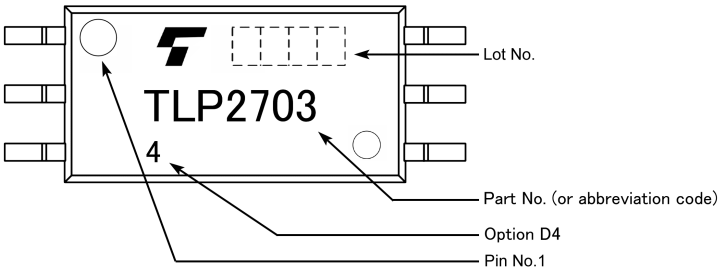


Fig. 16.4 Marking Example (Note)

Note: The above marking is applied to the photocouplers that have been qualified according to option (D4) of EN 60747.

Figure 1 Partial discharge measurement procedure according to EN 60747
Destructive test for qualification and sampling tests.

Method A

(for type and sampling tests, destructive tests)

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

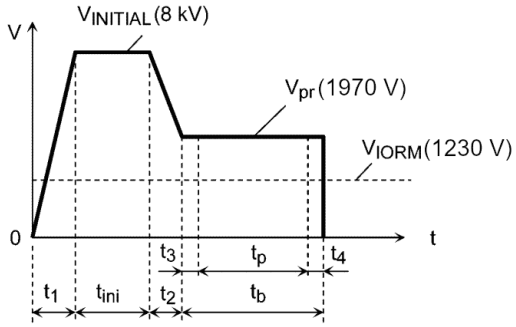


Figure 2 Partial discharge measurement procedure according to EN 60747
Non-destructive test for 100 % inspection.

Method B

(for sample test,non-destructive test)

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

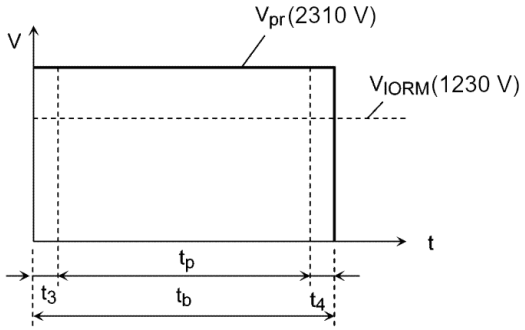


Figure 3 Dependency of maximum safety ratings on ambient temperature

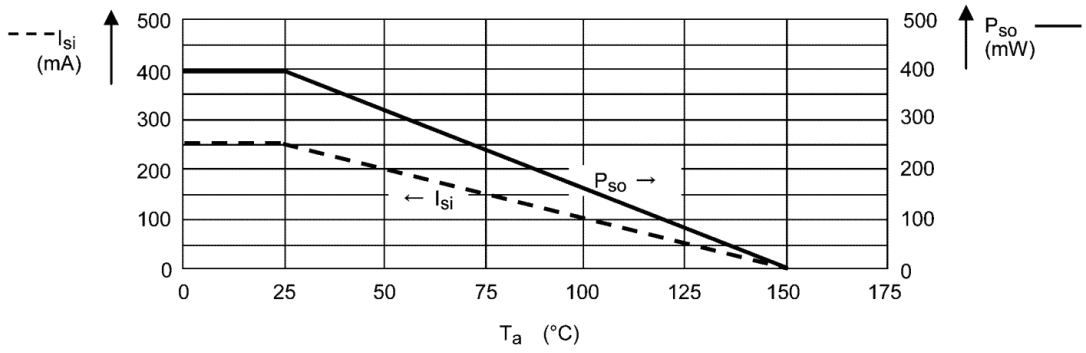


Fig. 16.5 Measurement Procedure

17. Ordering Information

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

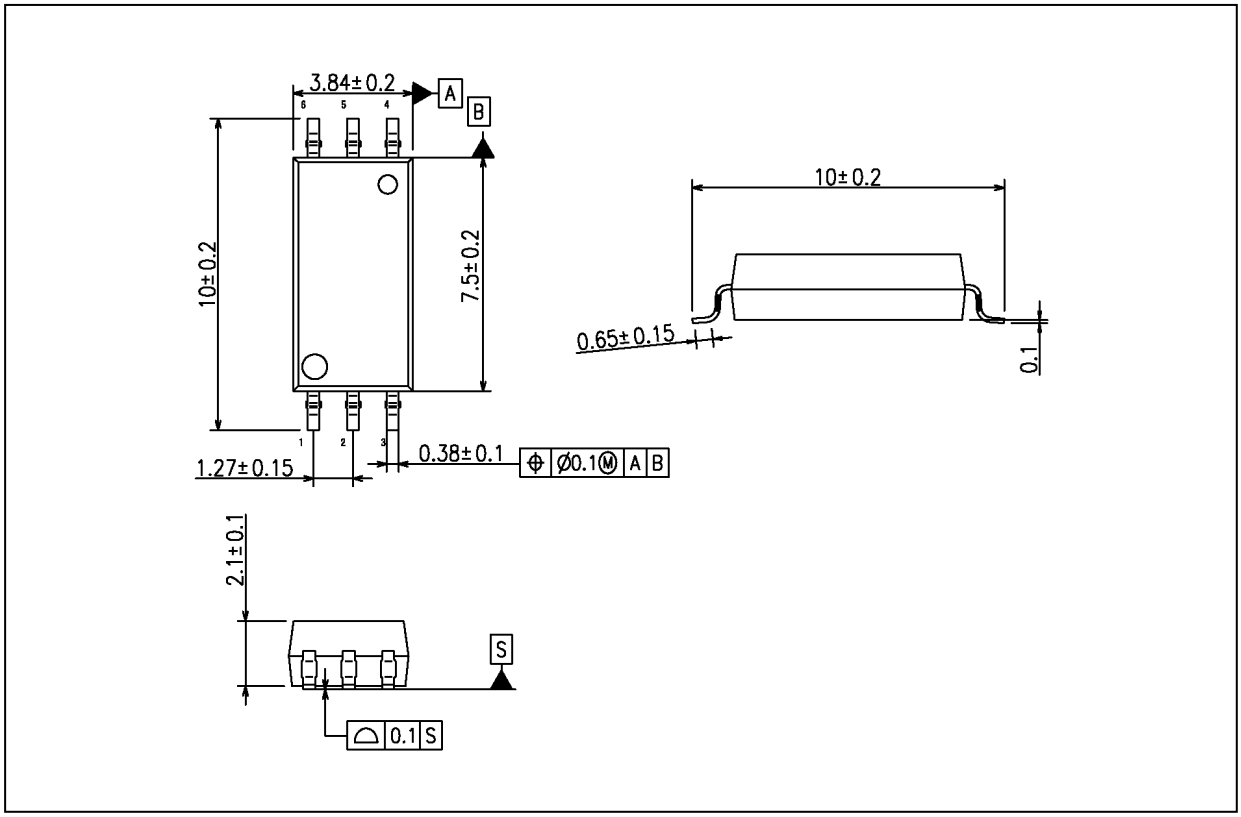
Example) TLP2703(TP,E 1500 pcs

Part number: TLP2703
Tape type: TP
[[G]]/RoHS COMPATIBLE: E **(Note 1)**
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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