

TLP2403

1. Applications

- High-Speed Digital Interfacing for Instrumentation and Control Devices
- Simplex/Multiplex Data Transmission

2. General

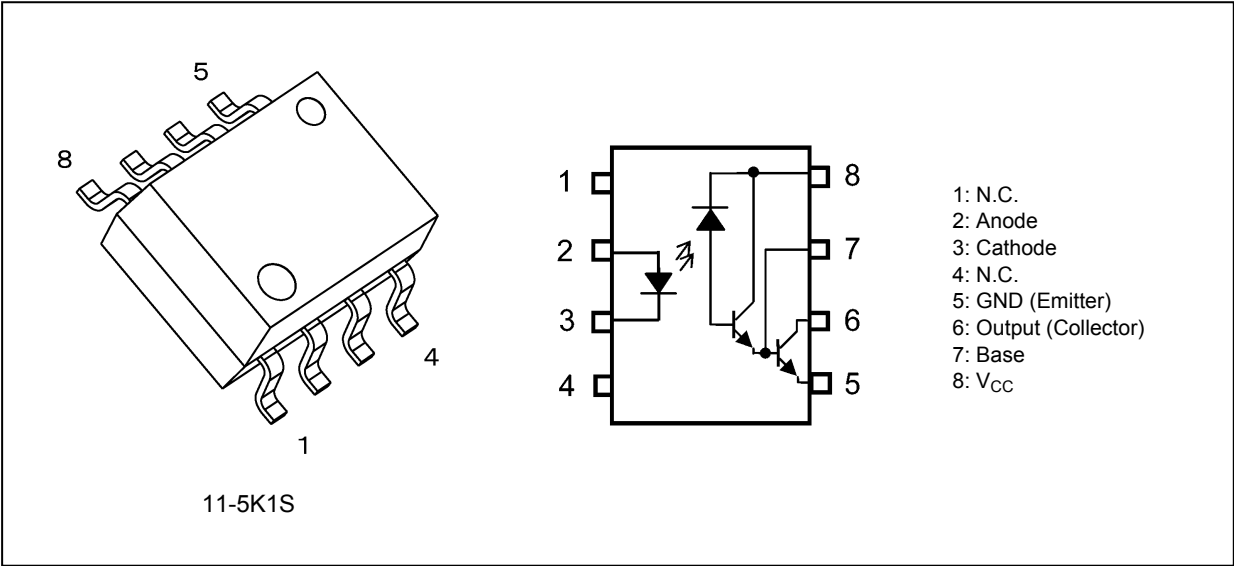
The Toshiba TLP2403 consists of a high-output GaAs light-emitting diode coupled with a high-speed photodiode-transistor chip. It is housed in the SO8 package. The TLP2403 uses a high-speed, high-gain detector element and thus is ideal for applications which require low-input current and high-speed data transmission.

3. Features

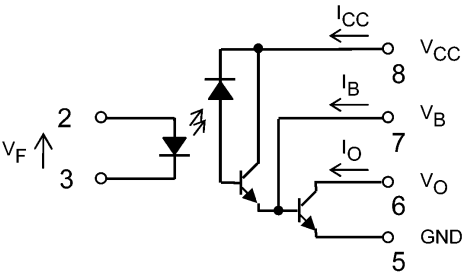
- (1) Package: SO8
- (2) Operating temperature: -40 to 100 °C
- (3) Current transfer ratio: 400 % (min) @ $I_F = 0.5$ mA
- (4) Maximum output current: 60 mA
- (5) Propagation delay time: $t_{pHL} = 2$ μ s (typ.), $t_{pLH} = 4$ μ s (typ.) @ $R_L = 4.7$ k Ω , $I_F = 0.5$ mA
- (6) Isolation voltage: 3750 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 (**Note 1**)

Note 1: When an EN60747-5-5 approved type is needed, please designate the **Option (V4)**.

4. Packaging and Pin Assignment



5. Internal Circuit



6. Principle of Operation

6.1. Mechanical Parameters

Characteristics	Min	Unit
Creepage distances	4.0	mm
Clearance	4.0	
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		20	mA
	Input forward current derating ($T_a \geq 85\text{ }^{\circ}\text{C}$)	$\Delta I_F / \Delta T_a$		-0.67	mA/ $^{\circ}\text{C}$
	Input forward current (pulsed)	I_{FP}	(Note 1)	40	mA
	Input forward current derating (pulsed) ($T_a \geq 85\text{ }^{\circ}\text{C}$)	$\Delta I_{FP} / \Delta T_a$		-1.0	mA/ $^{\circ}\text{C}$
	Peak transient input forward current	I_{FPT}	(Note 2)	1	A
	Peak transient input forward current derating ($T_a \geq 85\text{ }^{\circ}\text{C}$)	$\Delta I_{FPT} / \Delta T_a$		-25	mA/ $^{\circ}\text{C}$
	Input reverse voltage	V_R		5	V
	Input power dissipation	P_D		40	mW
	Input power dissipation derating ($T_a \geq 85\text{ }^{\circ}\text{C}$)	$\Delta P_D / \Delta T_a$		-1.0	mW/ $^{\circ}\text{C}$
Detector	Output current	I_O		60	mA
	Output current derating ($T_a > 25\text{ }^{\circ}\text{C}$)	$\Delta I_O / \Delta T_a$		-0.6	mA/ $^{\circ}\text{C}$
	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 ($T_a > 25\text{ }^{\circ}\text{C}$)	$\Delta P_O / \Delta T_a$		-1.0	mW/ $^{\circ}\text{C}$
Common	Operating temperature	T_{opr}		-40 to 100	$^{\circ}\text{C}$
	Storage temperature	T_{stg}		-55 to 125	$^{\circ}\text{C}$
	Lead soldering temperature (10 s)	T_{sol}		260	$^{\circ}\text{C}$
	Isolation voltage AC, 60 s, R.H. $\leq 60\%$	BV_S	(Note 3)	3750	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) $\leq 1\text{ ms}$, duty = 50 %

Note 2: Pulse width (PW) $\leq 1\text{ }\mu\text{s}$, 300 pps

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 forward current	I_F		0.5	—	15	mA
Output current	I_O		—	—	30	
Supply voltage	V_{CC}		—	—	16	V
Operating temperature	T_{opr}	(Note 1)	-40	—	100	$^{\circ}\text{C}$

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 1: Denotes the operating range, not the recommended operating condition.

9. Electrical Characteristics (Note)

(Unless otherwise specified, $T_a = 0$ to $100\text{ }^{\circ}\text{C}$)

Characteristics	Symbol	Note	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Input forward voltage	V_F			$I_F = 1.6\text{ mA}$, $T_a = 25\text{ }^{\circ}\text{C}$	1.30	1.45	1.70	V
Input forward voltage temperature coefficient	$\Delta V_F / \Delta T_a$			$I_F = 1.6\text{ mA}$	—	-1.8	—	mV/ $^{\circ}\text{C}$
Input reverse current	I_R			$V_R = 5\text{ V}$, $T_a = 25\text{ }^{\circ}\text{C}$	—	—	10	μA
Input capacitance	C_i			$V = 0\text{ V}$, $f = 1\text{ MHz}$, $T_a = 25\text{ }^{\circ}\text{C}$	—	60	—	pF
High-level output current	I_{OH}			$V_F = 0.8\text{ V}$, $V_{CC} = V_O = 18\text{ V}$	—	0.1	100	μA
High-level supply current	I_{CCH}			$I_F = 0\text{ mA}$, $V_{CC} = 5\text{ V}$, $V_O = \text{Open}$	—	0.01	10	μA
Low-level supply current	I_{CCL}			$I_F = 1.6\text{ mA}$, $V_{CC} = 5\text{ V}$, $V_O = \text{Open}$	0.1	1	1.5	mA
Current transfer ratio	I_O / I_F			$I_F = 0.5\text{ mA}$, $V_{CC} = 4.5\text{ V}$, $V_O = 0.4\text{ V}$	400	1000	—	%
				$I_F = 1.6\text{ mA}$, $V_{CC} = 4.5\text{ V}$, $V_O = 0.4\text{ V}$	500	900	—	
Low-level output voltage	V_{OL}			$I_F = 1.6\text{ mA}$, $V_{CC} = 4.5\text{ V}$, $I_O = 6.4\text{ mA}$	—	0.1	0.4	V
				$I_F = 5\text{ mA}$, $V_{CC} = 4.5\text{ V}$, $I_O = 15\text{ mA}$	—	0.1	0.4	
				$I_F = 12\text{ mA}$, $V_{CC} = 4.5\text{ V}$, $I_O = 24\text{ mA}$	—	0.15	0.4	

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

10. Isolation Characteristics (Unless otherwise specified, $T_a = 25\text{ }^{\circ}\text{C}$)

Characteristics	Symbol	Note	Test Condition	Min	Typ.	Max	Unit
Total capacitance (input to output)	C_S	(Note 1)	$V_S = 0\text{ V}$, $f = 1\text{ MHz}$	—	0.8	—	pF
Isolation resistance	R_S	(Note 1)	$V_S = 500\text{ V}$, R.H. $\leq 60\%$	1×10^{12}	10^{14}	—	Ω
Isolation voltage	BV_S	(Note 1)	AC, 60 s	3750	—	—	Vrms
			AC, 1 s in oil	—	10000	—	
			DC, 60 s in oil	—	10000	—	Vdc

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

11. Switching Characteristics (Note)

(Unless otherwise specified, $T_a = 0$ to $100\text{ }^{\circ}\text{C}$, $V_{CC} = 5\text{ V}$)

Characteristics	Symbol	Note	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Propagation delay time (H/L)	t_{pHL}	(Note 1)	Fig. 12.1.1	$I_F = 0.5\text{ mA}$, $R_L = 4.7\text{ k}\Omega$, $T_a = 25\text{ }^{\circ}\text{C}$	—	2	25	μs
				$I_F = 0.5\text{ mA}$, $R_L = 4.7\text{ k}\Omega$	—	2	30	
				$I_F = 12\text{ mA}$, $R_L = 270\text{ }\Omega$, $T_a = 25\text{ }^{\circ}\text{C}$	—	0.3	1	
				$I_F = 12\text{ mA}$, $R_L = 270\text{ }\Omega$	—	0.3	2	
				$I_F = 1.6\text{ mA}$, $R_L = 2.2\text{ k}\Omega$, $T_a = 25\text{ }^{\circ}\text{C}$	—	0.5	10	
				$I_F = 1.6\text{ mA}$, $R_L = 2.2\text{ k}\Omega$	—	0.5	15	
Propagation delay time (L/H)	t_{pLH}	(Note 1)	Fig. 12.1.1	$I_F = 0.5\text{ mA}$, $R_L = 4.7\text{ k}\Omega$, $T_a = 25\text{ }^{\circ}\text{C}$	—	4	60	μs
				$I_F = 0.5\text{ mA}$, $R_L = 4.7\text{ k}\Omega$	—	4	90	
				$I_F = 12\text{ mA}$, $R_L = 270\text{ }\Omega$, $T_a = 25\text{ }^{\circ}\text{C}$	—	1	7	
				$I_F = 12\text{ mA}$, $R_L = 270\text{ }\Omega$	—	1	10	
				$I_F = 1.6\text{ mA}$, $R_L = 2.2\text{ k}\Omega$, $T_a = 25\text{ }^{\circ}\text{C}$	—	4.5	35	
				$I_F = 1.6\text{ mA}$, $R_L = 2.2\text{ k}\Omega$	—	4.5	50	
Common-mode transient immunity at output high	CM_H	(Note 2)	Fig. 12.1.2	$I_F = 0\text{ mA}$, $R_L = 2.2\text{ k}\Omega$, $V_{CM} = 10\text{ V}$, $V_{O(min)} = 2\text{ V}$	—	500	—	$\text{V}/\mu\text{s}$
Common-mode transient immunity at output low	CM_L	(Note 3)	Fig. 12.1.2	$I_F = 1.6\text{ mA}$, $R_L = 2.2\text{ k}\Omega$, $V_{CM} = 10\text{ V}$, $V_{O(max)} = 0.8\text{ V}$	—	-500	—	$\text{V}/\mu\text{s}$

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

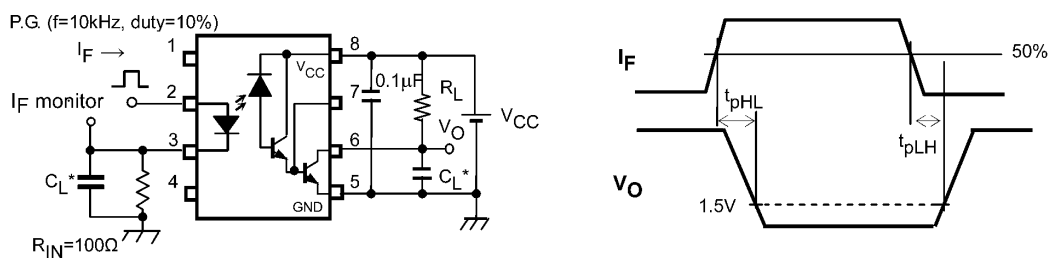
Note 1: $f = 10\text{ kHz}$, duty = 10 %, input current $t_r = t_f = 5\text{ ns}$, C_L is approximately 15 pF which includes probe and stray wiring capacitance.

Note 2: 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 ($V_O > 2.0\text{ V}$).

Note 3: 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 ($V_O < 0.8\text{ V}$).

12. Test Circuits and Characteristics Curves

12.1. Test Circuits



*C_L is approximately 15 pF which includes probe and stray wiring capacitance.

P.G.: Pulse Generator

Fig. 12.1.1 Switching Time Test Circuit and Waveform

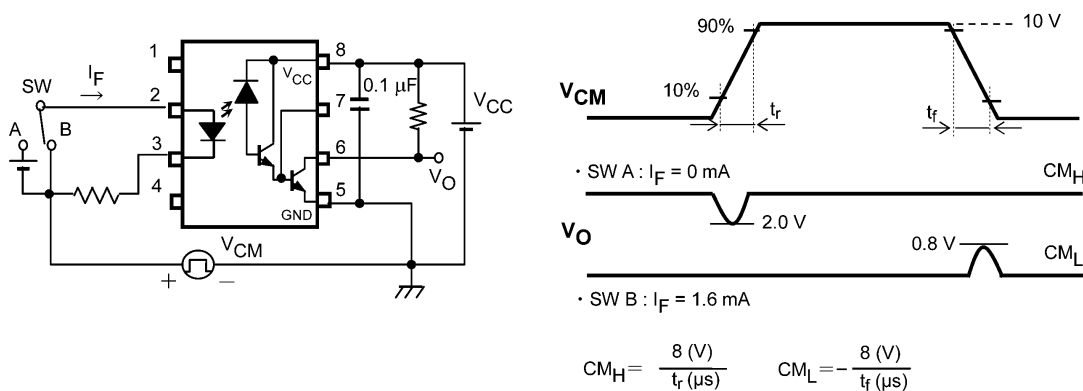


Fig. 12.1.2 Common-Mode Transient Immunity Test Circuit and Waveform

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.

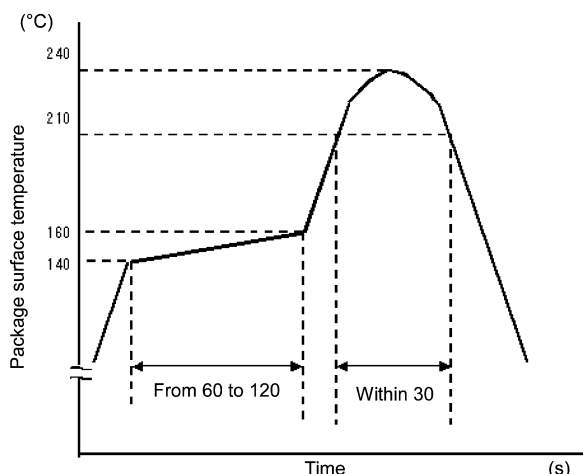


Fig. 13.1.1 An Example of a Temperature Profile When Sn-Pb Eutectic Solder Is Used

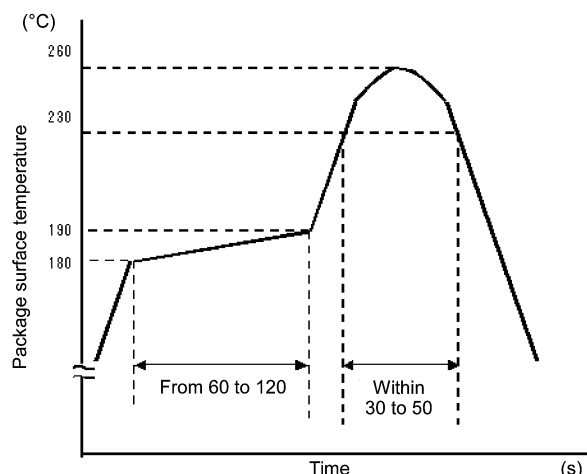


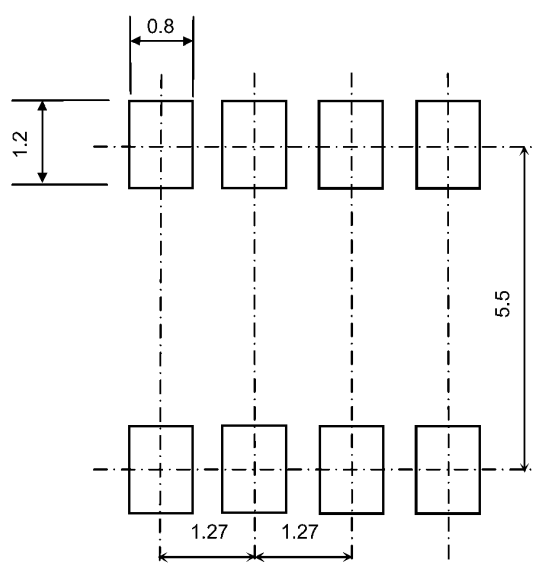
Fig. 13.1.2 An Example of a Temperature Profile When Lead(Pb)-Free Solder Is Used

- When using soldering flow (Applicable to both eutectic solder and Lead(Pb)-Free solder)
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

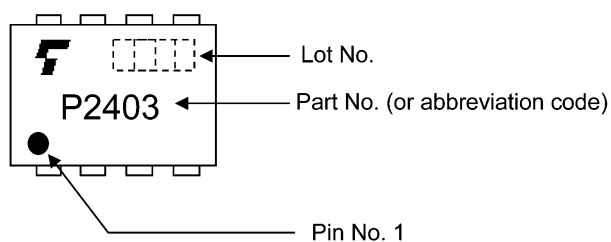
- Avoid storage locations where devices may be exposed to moisture or direct sunlight.
- Follow the precautions printed on the packing label of the device for transportation and storage.
- Keep the storage location temperature and humidity within a range of 5 °C to 35 °C and 45 % to 75 %, respectively.
- 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. EN60747-5-5 Option (V4) Specification

- Part number: TLP2403 (**Note 1**)
- The following part naming conventions are used for the devices that have been qualified according to option (V4) of EN60747.
Example: TLP2403(V4-TP,F)
V4: EN60747 option
TP: Tape type
F: [[G]]/RoHS COMPATIBLE (**Note 2**)

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

e.g., TLP2403(V4-TP,F) → TLP2403

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 electronics equipment.

Description	Symbol	Rating	Unit
Application classification			
for rated mains voltage ≤ 150 Vrms		I-IV	—
for rated mains voltage ≤ 300 Vrms		I-III	—
Climatic classification		40 / 100 / 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}	6000	Vpeak
Safety limiting values (max. permissible ratings in case of fault, also refer to thermal derating curve)			
current (input current I_F , $P_{SO} = 0$)	I_{Si}	250	mA
power (output or total power dissipation)	P_{SO}	400	mW
temperature	T_S	150	°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}	$\geq 10^{12}$ $\geq 10^{11}$ $\geq 10^9$	Ω

Fig. 16.1 EN60747 Insulation Characteristics

Table Insulation Related Specifications (Note)

Insulation Related Parameters	Symbol	TLP2403
Minimum creepage distance	Cr	4.0 mm
Minimum clearance	Cl	4.0 mm
Minimum insulation thickness	ti	—
Comparative tracking index	CTI	175

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. 16.2 Marking on Packing for EN60747

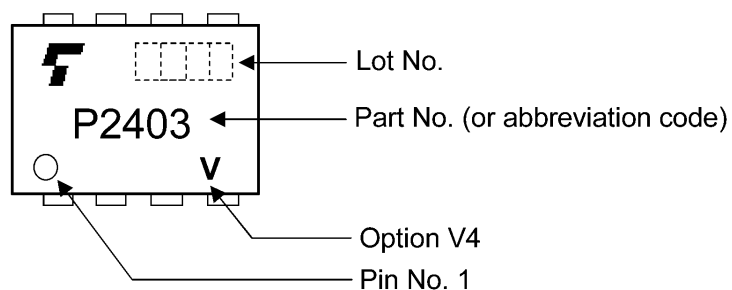


Fig. 16.3 Marking Example (Note)

Note: The above marking is applied to the photocouplers that have been qualified according to option (V4) of EN60747.

Figure 1 Partial discharge measurement procedure according to EN60747
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

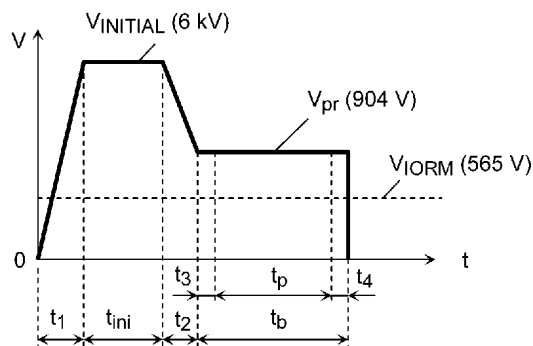


Figure 2 Partial discharge measurement procedure according to EN60747
Non-destructive test for 100 % inspection.

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

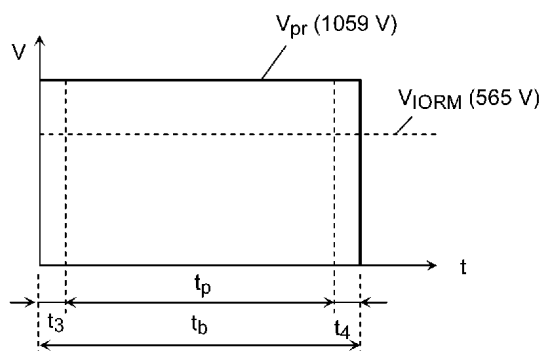


Figure 3 Dependency of maximum safety ratings on ambient temperature

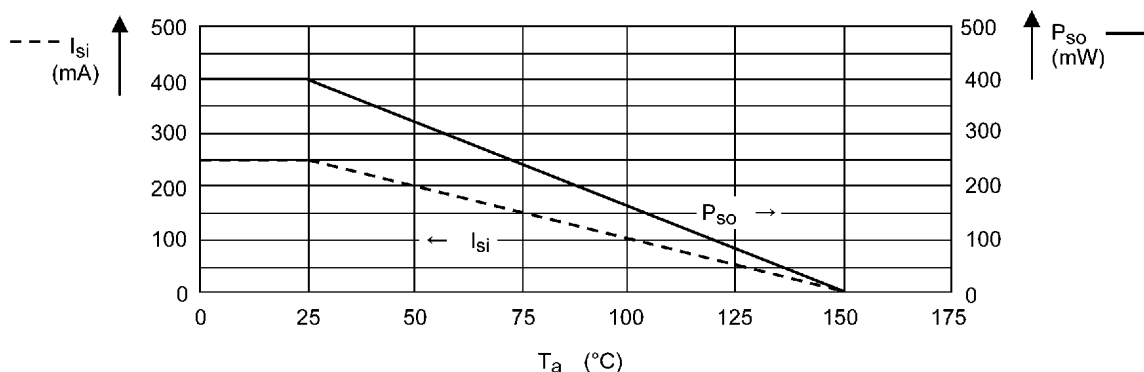


Fig. 16.4 Measurement Procedure

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

17.1. Applicable Package

Package Name	Product Type
SO8	Photocoupler

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) TLP2403(TP,F)

Part number: TLP2403

Tape type: TP

[[G]]/RoHS COMPATIBLE: F (Note 1)

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 electronics equipment.

17.3. Tape Dimensions Specification

Reel: 2500 pcs per reel

17.3.1. Orientation of Device in Relation to Direction of Feed

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

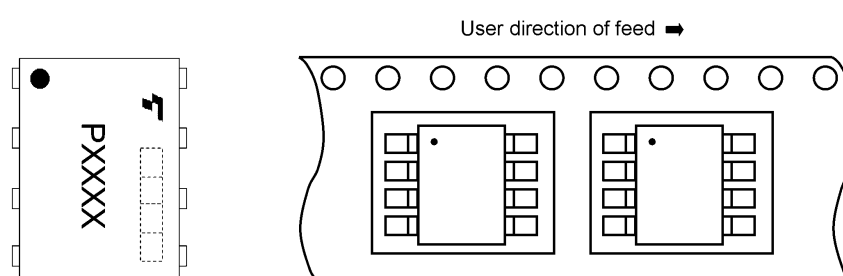


Fig. 17.3.1.1 Device Orientation

17.3.2. Empty Cavities

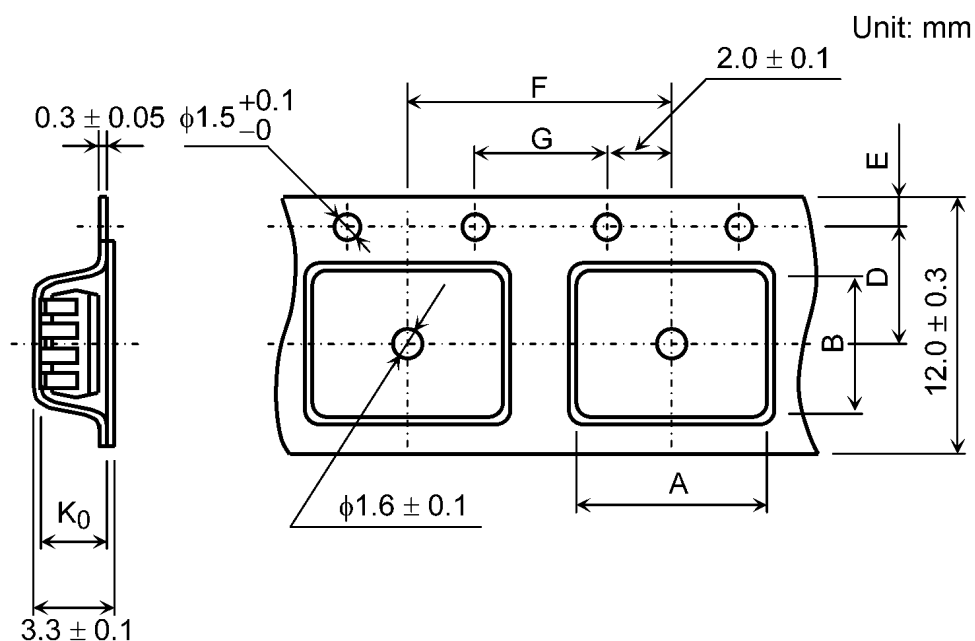
Characteristics	Criterion	Remarks
Occurrences of 2 or more successive empty cavities	0 device	Within any given 40-mm section of tape, not including leader and trailer
Single empty cavity	6 devices (max) per reel	Not including leader and trailer

17.3.3. Tape Leader and Trailer

The start end of the tape has 50 or more empty cavities. The hub end of the tape has 50 or more empty cavities and 2 empty turns only for a cover tape.

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	6.5	—
B	5.6	—
D	5.5	Center line of embossed cavity and sprocket hole
E	1.75	Distance between tape edge and sprocket hole center
F	8.0	Cumulative error $+0.1/-0.3$ (max) per 10 empty cavities holes
G	4.0	Cumulative error $+0.1/-0.3$ (max) per 10 sprocket holes
K ₀	3.1	Internal space

17.3.5. Reel Specification

Material: Plastic

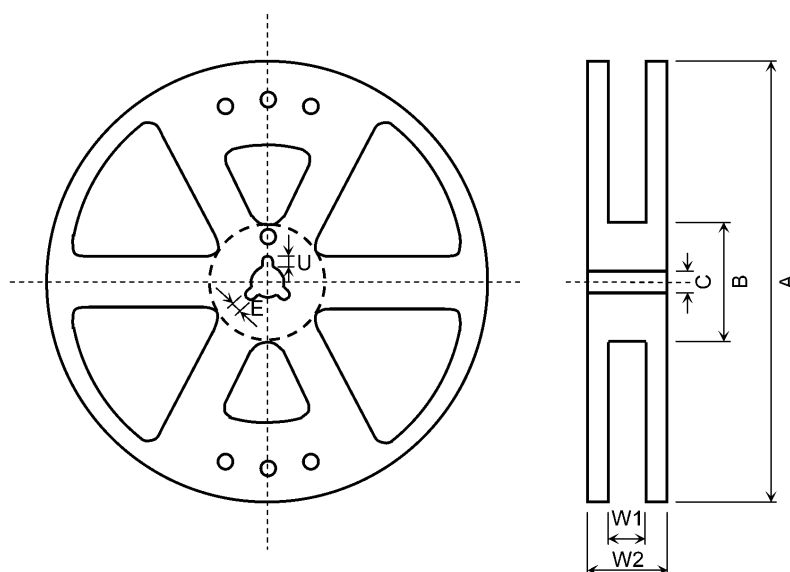
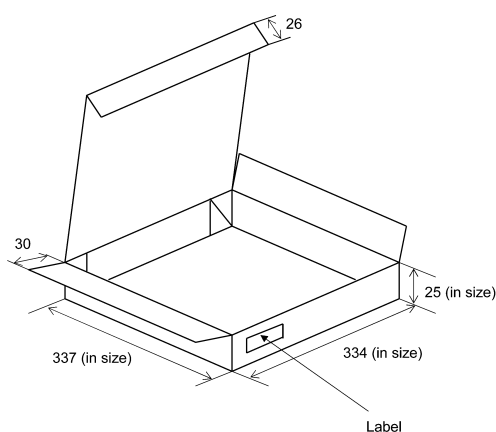


Table Reel Dimensions (unit: mm)

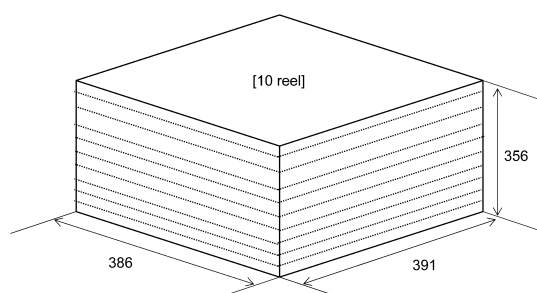
Symbol	Dimension
A	$\phi 330 \pm 2$
B	$\phi 80 \pm 1$
C	$\phi 13 \pm 0.5$
E	2.0 ± 0.5
U	4.0 ± 0.5
W1	13.5 ± 0.5
W2	17.5 ± 1.0

17.4. Packing (Note)

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



1 reel/carton (unit: mm)



10 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) TLP2403(TP,F) 2500 pcs

Part number: TLP2403

Tape type: TP

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

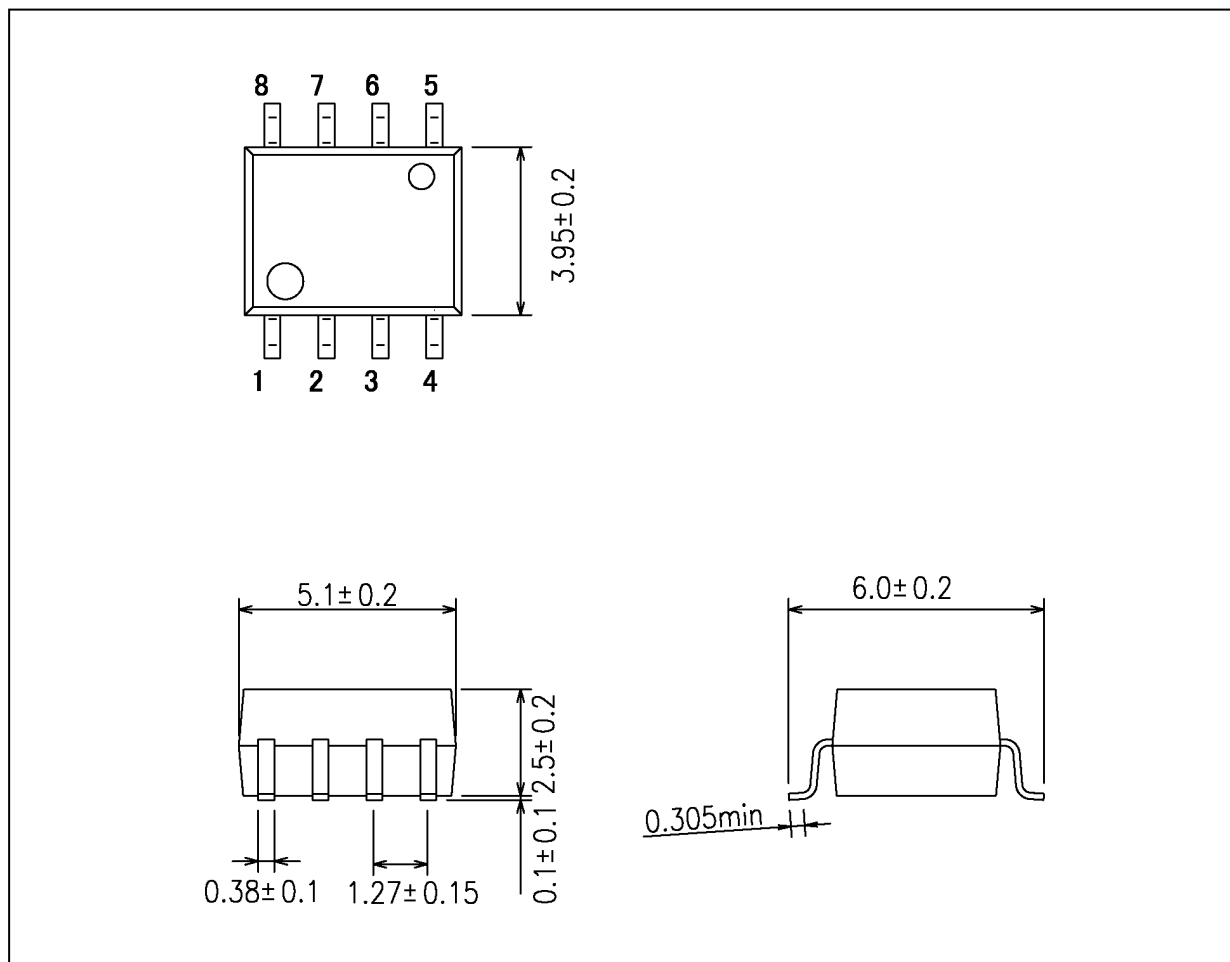
Quantity (must be a multiple of 2500): 2500 pcs

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 electronics equipment.

Package Dimensions

Unit: mm



Weight: 0.11 g (typ.)

Package Name(s)
TOSHIBA: 11-5K1S

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