Photocouplers GaAℓAs Infrared LED & Photo IC

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 GaAℓAs light-emitting diode coupled with a high-speed photo-diode-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℃

(3) Current transfer ratio: 400% (min) @I_F = 0.5 mA

(4) Maximum output current: 60 mA

(5) Propagation delay time: t_{pHL} = 2 μs (typ.), t_{pLH} = 4 μs (typ.) @ R_L = 4.7 kΩ, I_F = 0.5 mA

(6) Isolation voltage: 3750 Vrms (min)

(7) Safety standards

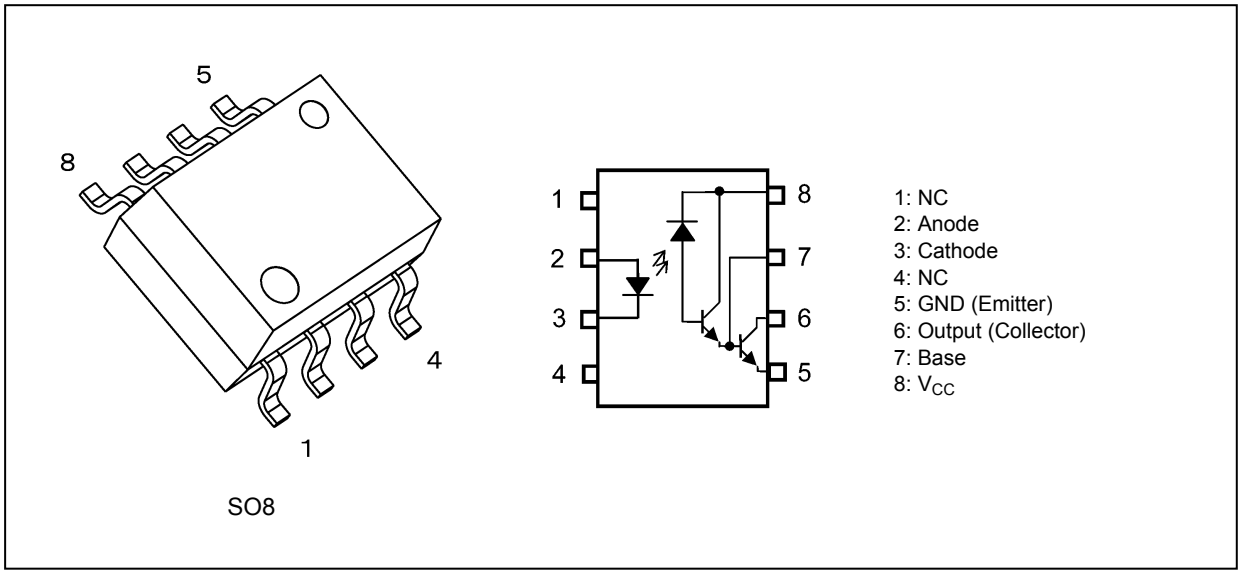
UL-approved: UL1577 File No.E67349

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

VDE-approved: Option (V4) EN60747-5-2 **(Note)**

Note: When an EN60747-5-2 approved type is needed, please designate the **Option (V4)**.

4. Packaging and Pin Configuration



5. Internal Circuit

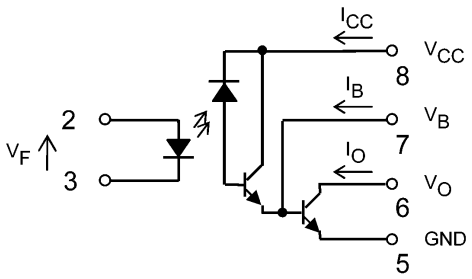


Fig. 5.1 Internal Circuit

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°C

	Characteristics		Symbol	Note	Rating	Unit
LED	Forward current		I_F		20	mA
	Forward current derating	($T_a \geq$ 85°C)	ΔI_F/°C		-0.67	mA/°C
	Pulse forward current		I_{FP}	(Note 1)	40	mA
	Pulse forward current derating	($T_a \geq$ 85°C)	ΔI_{FP}/°C		-1.0	mA/°C
	Transient pulse forward current		I_{FPT}	(Note 2)	1	A
	Transient pulse forward current derating	($T_a \geq$ 85°C)	ΔI_{FPT}/°C		-25	mA/°C
	Reverse voltage		V_R		5	V
	Power dissipation		P_D		40	mW
	Power dissipation derating	($T_a \geq$ 85°C)	ΔP_D/°C		-1.0	mW/°C
Detector	Output current		I_O		60	mA
	Output current derating	($T_a \geq$ 25°C)	ΔI_O/°C		-0.6	mA/°C
	Output voltage		V_O		-0.5 to 18	V
	Supply voltage		V_{CC}		-0.5 to 18	
	Emitter-base reverse voltage		V_{EB}		0.5	
	Output power dissipation		P_O		100	mW
	Output power dissipation derating	($T_a \geq$ 25°C)	ΔP_O/°C		-1.0	mW/°C
Common	Operating temperature		T_{opr}		-40 to 100	°C
	Storage temperature		T_{stg}		-55 to 125	
	Lead soldering temperature	(10 s)	T_{sol}		260	
	Isolation voltage	AC, 1 min, R.H. ≤ 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) ≤ 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, 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
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	°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°C

Characteristics	Symbol	Note	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Input forward voltage	V_F			I_F = 1.6 mA, T_a = 25°C	1.30	1.45	1.70	V
Input temperature coefficient of forward voltage	$\Delta V_F/\Delta T_a$			I_F = 1.6 mA	—	-1.8	—	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	—	60	—	pF
High-level output current	I_{OH}			V_F = 0.8 V, V_{CC} = V_O = 18 V	—	0.1	100	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	1	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	400	1000	—	%
				I_F = 1.6 mA, V_{CC} = 4.5 V, V_O = 0.4 V	500	900	—	
Low-level output voltage	V_{OL}			I_F = 1.6 mA, V_{CC} = 4.5 V, I_{OL} = 6.4 mA	—	0.1	0.4	V
				I_F = 5 mA, V_{CC} = 4.5 V, I_{OL} = 15 mA	—	0.1	0.4	
				I_F = 12 mA, V_{CC} = 4.5 V, V_O = 24 mA	—	0.15	0.4	

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

10. Isolation Characteristics

Unless otherwise specified, T_a = 25°C

Characteristics	Symbol	Note	Test Conditions	Min	Typ.	Max	Unit
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%	1×10^{12}	10^{14}	—	Ω
Isolation voltage	BV_S		AC, 1 min	3750	—	—	Vrms
			AC, 1 s in oil	—	10000	—	
			DC, 1 min 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

Unless otherwise specified, T_a = 0 to 100°C, V_{CC} = 5 V

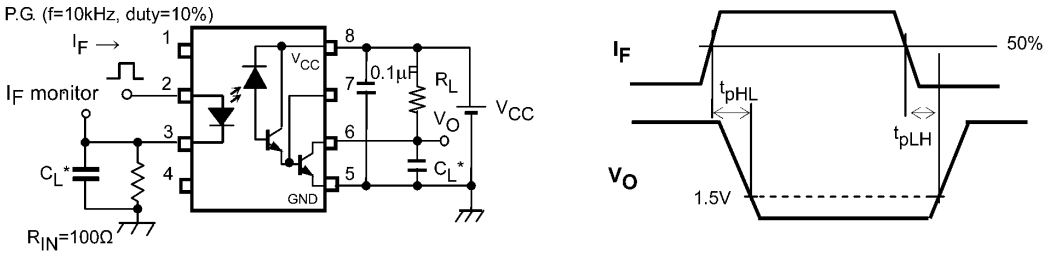
Characteristics	Symbol	Note	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Propagation delay time (H/L)	t_{pHL}		Fig. 12.1.1	I_F = 0.5 mA, R_L = 4.7 kΩ, T_a = 25°C	—	2	25	μs
				I_F = 0.5 mA, R_L = 4.7 kΩ	—	2	30	
				I_F = 12 mA, R_L = 270 Ω, T_a = 25°C	—	0.3	1	
				I_F = 12 mA, R_L = 270 Ω	—	0.3	2	
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

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 > 2.0 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 < 0.8 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

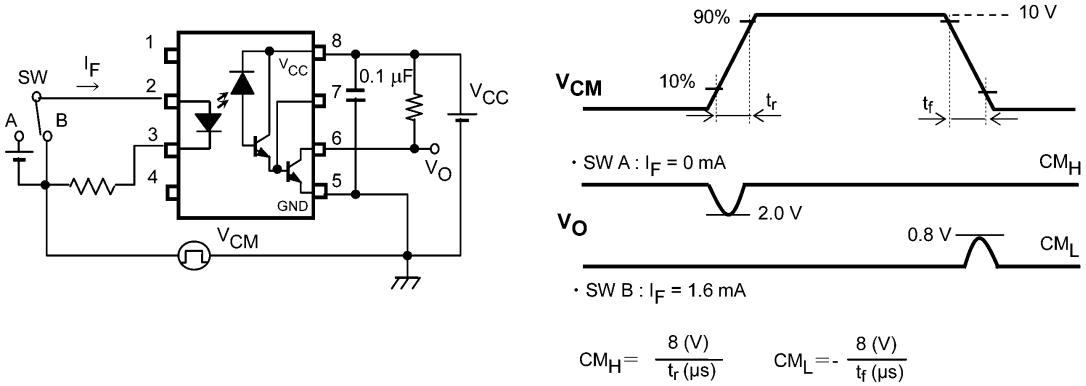


Fig. 12.1.2 Common-Mode Transient Immunity

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 (See Fig. 13.1.1 and 13.1.2)
  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.

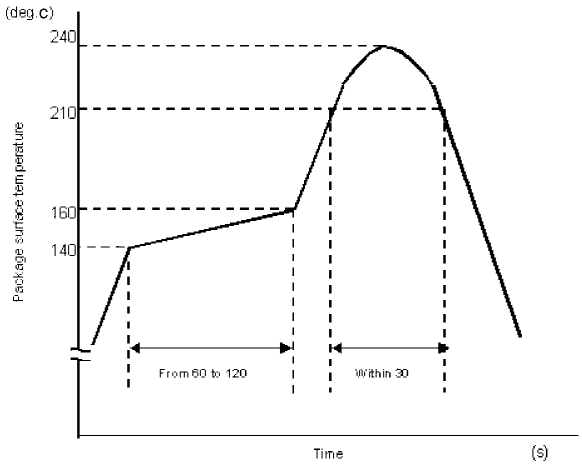


Fig. 13.1.1 An example of a temperature profile when Sn-Pb eutectic solder is used

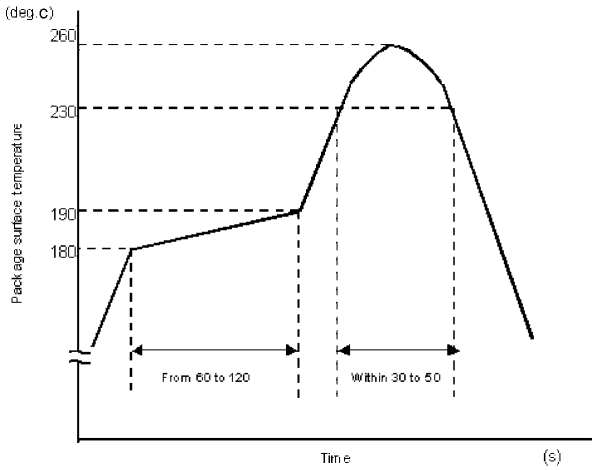


Fig. 13.1.2 An example of a temperature profile when lead(Pb)-free solder is used

- When using soldering flow (Applicable to both eutectic solder and Lead(Pb)-Free solder)
  Apply preheating of 150℃ for 60 to 120 seconds.
  Mounting condition of 260℃ within 10 seconds is recommended.
  Flow soldering must be performed once.
- When using soldering Iron (Applicable to both eutectic solder and Lead(Pb)-Free solder)
  Complete soldering within 10 seconds for lead temperature not exceeding 260℃ or within 3 seconds not exceeding 350℃
  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℃ to 35℃ 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

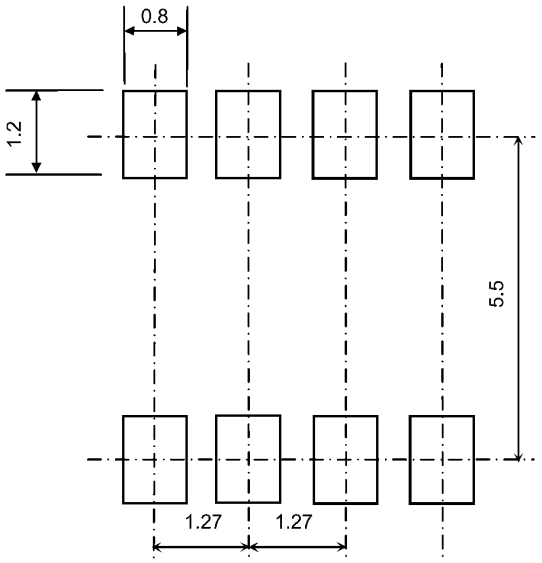


Fig. 14.1 Land Pattern Dimensions for Reference Only (unit: mm)

15. Marking

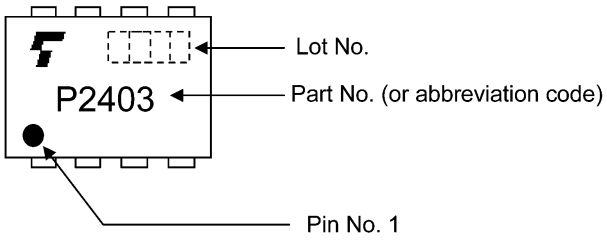


Fig. 15.1 Marking

16. EN60747-5-2 Option (V4) Specification

- Part number: TLP2403 **(Note)**
- 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 specification
  TP: Standard taping name

Note: Use TOSHIBA standard type number for safety standard application.
e.g., TLP2403(V4-TP, F) → TLP2403

Description	Symbol	Rating	Unit
Application classification for rated mains voltage≤150V_{rms} for rated mains voltage≤300V_{rms}		 I-IV I-III	—
Climatic classification		40/ 100 / 21	—
Pollution degree		2	—
Maximum operating insulation voltage	V_{IORM}	565	Vpk
Input to output test voltage, method A Vpr=1.5×V_{IORM}, type and sample test t_p=10s, partial discharge<5pC	Vpr	850	Vpk
Input to output test voltage, method B Vpr=1.875×V_{IORM}, 100% production test t_p=1s, partial discharge<5pC	Vpr	1060	Vpk
Highest permissible overvoltage (transient overvoltage, t_{pr} = 60s)	V_{TR}	6000	Vpk
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	 Isi Pso Ts	 250 400 150	 mA mW ℃
Insulation resistance, V_{IO} =500V, T_a=T_s	Rsi	≥ 10^9	Ω

Fig. 16.1 EN60747 Insulation Characteristics

Minimum creepage distance	Cr	4.0mm
Minimum clearance	Cl	4.0mm
Minimum insulation thickness	ti	-
Comperative tracking index	CTI	175

Fig. 16.2 Insulation Related Specifications (Note)

Note: If a printed circuit is incorporated, the creepage distance and clearance may be reduced below this value. (e. g., at a standard distance between soldering eye centers of 3.5 mm). If this is not permissible, the user shall take suitable measures.

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.

Marking on product for EN60747 : V

Marking on packing for EN60747 : VDE

Marking Example : TLP2403

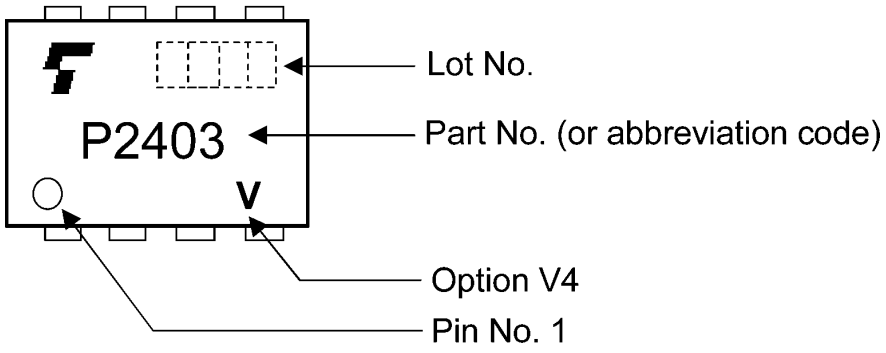
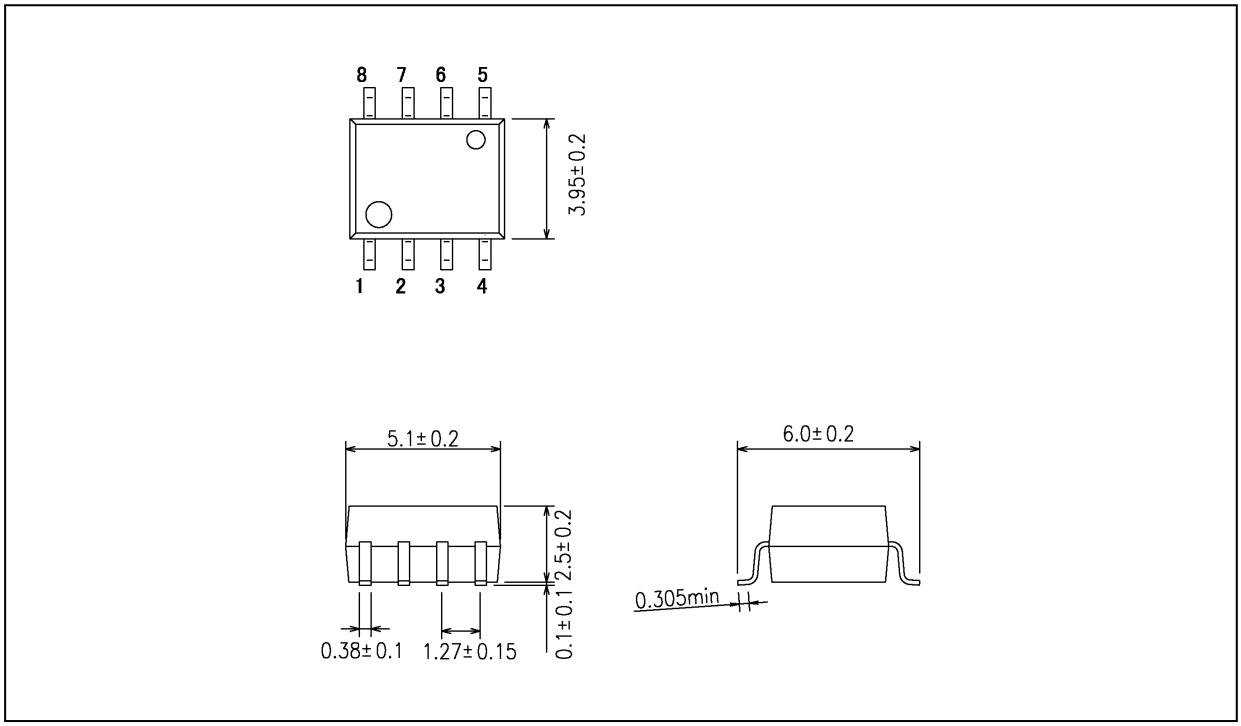


Fig. 16.3 Marking Example (Note)

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

Package Dimensions

Unit: mm



Weight: 0.11 g (typ.)

Package Name(s)
TOSHIBA: 11-5K1S
Nickname: SO8

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