Photocouplers GaAℓAs Infrared LED & Photo IC

TLP2303

1. Applications

- Transistor Inverters
- Communications Equipment
- Home Electric Appliances

2. General

The Toshiba TLP2303 consists of a high-output GaAℓAs light-emitting diode coupled with a high-speed photodiode-transistor chip. It is housed in the SO6 package.

The high-speed, high-gain detector element is used, since the current transfer ratio is 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.

TLP2303 corresponds to the transmission rate of 100 kbps, and has become a product which fills between a general-purpose transistor coupler and IC couplers corresponding to 1 Mbps.

3. Features

(1) Package: SO6

(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 μs (max), t_{pLH} = 50 μs (max) @ R_L = 4.7 kΩ, I_F = 0.5 mA, T_a = 25°C

(6) Isolation voltage: 3750 Vrms (min)

(7) Safety standards

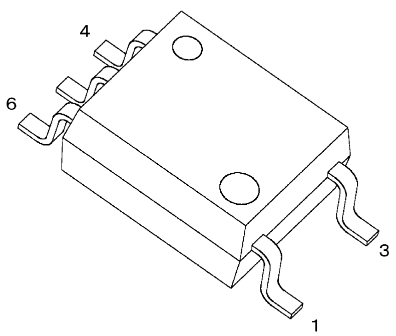
UL-under application: UL1577 File No.E67349

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

VDE-under application: Option (V4) EN60747-5-5 **(Note)**

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

4. Packaging and Pin Assignment



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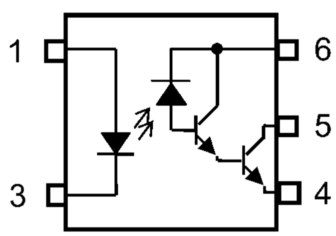


1: Anode
3: Cathode
4: GND (Emitter)
5: Output (Collector)
6: V_{CC}

5. Internal Circuit

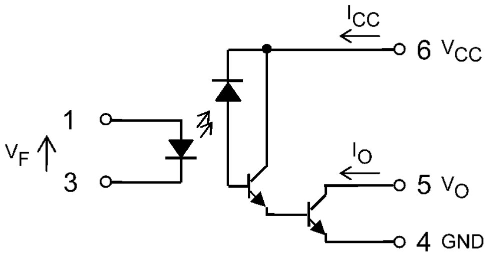


Fig. 5.1 Internal Circuit

6. Principle of Operation

6.1. Truth Table

Input	LED	Output
H	ON	L
L	OFF	H

6.2. Mechanical Parameters

Characteristics	Min	Unit
Creepage distances	5.0	mm
Clearance distances	5.0	
Internal isolation thickness	0.4	

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)	$\Delta I_{FP}/\Delta T_a$		-1.6	mA/°C
	Peak transient input forward current		I_{FPT}	(Note 2)	1	A
	Peak transient input forward current derating	($T_a \geq$ 100 °C)	$\Delta I_{FPT}/\Delta T_a$		-40	mA/°C
	Input power dissipation		P_D		100	mW
	Input power dissipation derating	($T_a \geq$ 100 °C)	$\Delta P_D/\Delta T_a$		-4.0	mW/°C
	Input reverse voltage		V_R		5	V
Detector	Output current		I_O		80	mA
	Output current derating	($T_a \geq$ 100 °C)	$\Delta I_O/\Delta T_a$		-3.2	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)	$\Delta P_O/\Delta T_a$		-4.0	mW/°C
Common	Operating temperature		T_{opr}		-40 to 125	°C
	Storage temperature		T_{stg}		-55 to 125	°C
	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 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	—	15	mA
Input off-state voltage	$V_{F(OFF)}$		0	—	0.8	V
Supply voltage	V_{CC}	(Note 1)	4.5	—	18	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 datasheet 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	0.9	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	4500	8000	%
		I_F = 1.6 mA, V_{CC} = 4.5 V, V_O = 0.4 V	800	2800	5000	
		I_F = 5 mA, V_{CC} = 4.5 V, V_O = 0.4 V	500	1300	—	%
Low-level output voltage	V_{OL}	I_F = 1.6 mA, V_{CC} = 4.5 V, I_{OL} = 6.4 mA	—	0.07	0.3	V
		I_F = 5 mA, V_{CC} = 4.5 V, I_{OL} = 15 mA	—	0.1	0.3	
		I_F = 12 mA, V_{CC} = 4.5 V, I_{OL} = 24 mA	—	0.13	0.3	V

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%	1×10^{12}	10^{14}	—	Ω
Isolation voltage	BV_S	(Note 1)	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 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	—	1.4	15	μs
				I_F = 0.5 mA, R_L = 4.7 kΩ	—	1.4	20	
				I_F = 12 mA, R_L = 270 Ω, T_a = 25 °C	—	0.25	1	
				I_F = 12 mA, R_L = 270 Ω	—	0.25	2	
				I_F = 1.6 mA, R_L = 2.2 kΩ, T_a = 25 °C	—	0.6	5	
				I_F = 1.6 mA, R_L = 2.2 kΩ	—	0.6	10	
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	—	15.5	50	μs
				I_F = 0.5 mA, R_L = 4.7 kΩ	—	15.5	90	
				I_F = 12 mA, R_L = 270 Ω, T_a = 25 °C	—	2.5	7	
				I_F = 12 mA, R_L = 270 Ω	—	2.5	10	
				I_F = 1.6 mA, R_L = 2.2 kΩ, T_a = 25 °C	—	8.5	25	
				I_F = 1.6 mA, R_L = 2.2 kΩ	—	8.5	50	
Common-mode transient immunity at output high	CM_H	(Note 1)	Fig. 12.1.2	I_F = 0 mA, R_L = 4.1 kΩ, V_{CM} = 400 V, $V_{O(min)}$ = 2 V	±15	±30	—	kV/μs
Common-mode transient immunity at output low	CM_L	(Note 2)	Fig. 12.1.2	I_F = 10 mA, R_L = 4.1 kΩ, V_{CM} = 400 V, $V_{O(max)}$ = 0.4 V	±15	±30	—	kV/μs

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 < 0.4 V).

12. Test Circuits and Characteristics Curves

12.1. Test Circuits

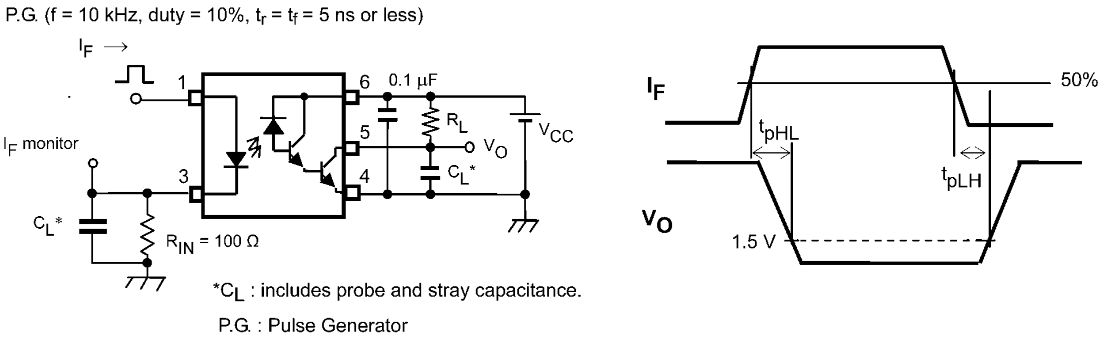


Fig. 12.1.1 Switching Time Test Circuit and Waveform

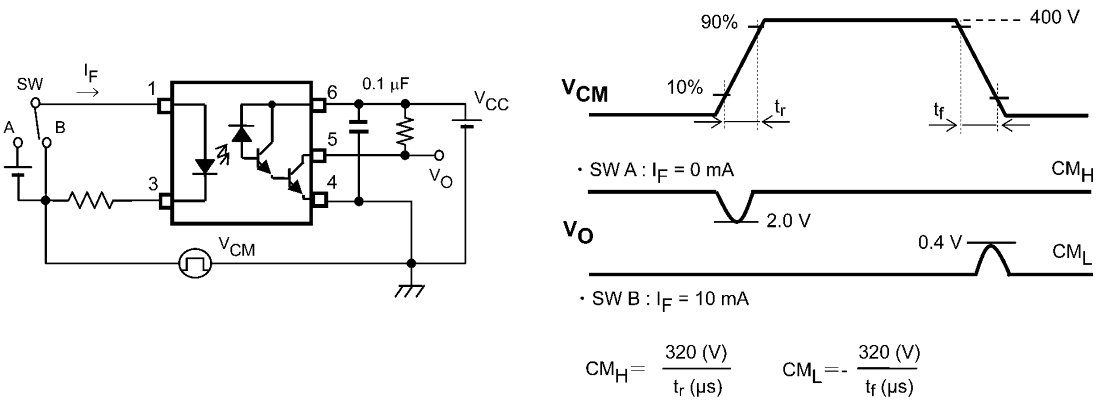


Fig. 12.1.2 Common-Mode Transient Immunity and Waveform

12.2. Characteristics Curves (Note)

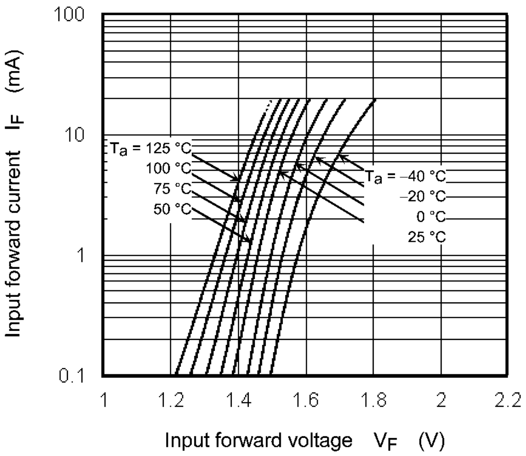


Fig. 12.2.1 I_F - V_F

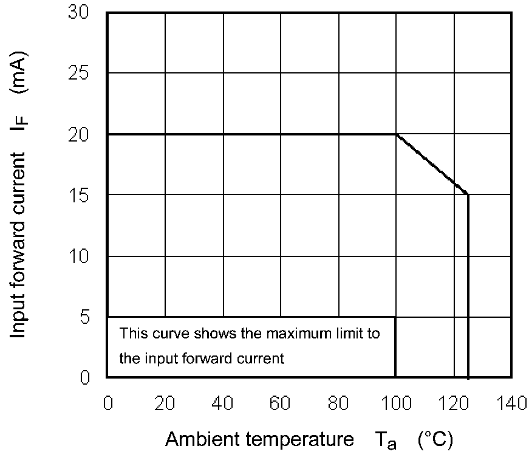


Fig. 12.2.2 I_F - T_a

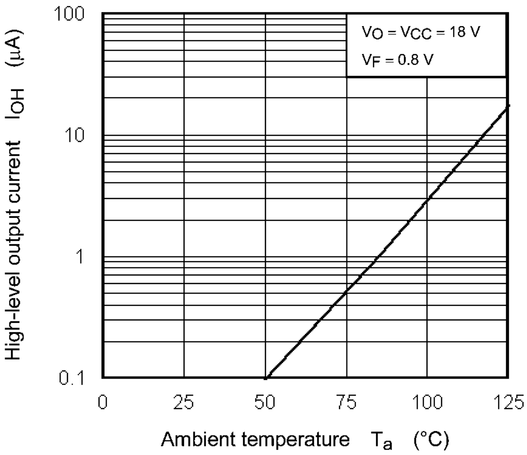


Fig. 12.2.3 I_{OH} - T_a

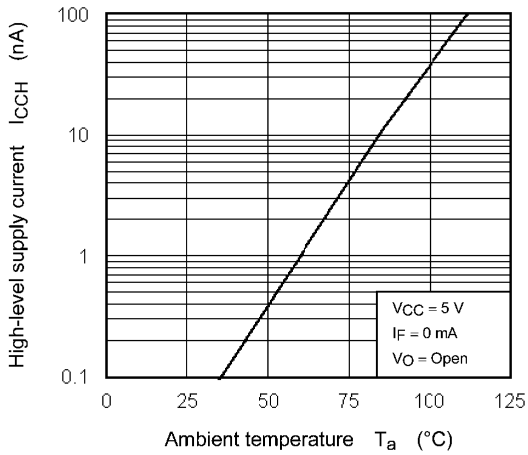


Fig. 12.2.4 I_{CCH} - T_a

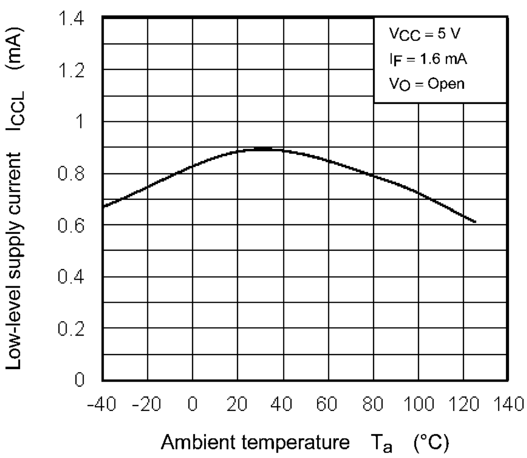


Fig. 12.2.5 I_{CCL} - T_a

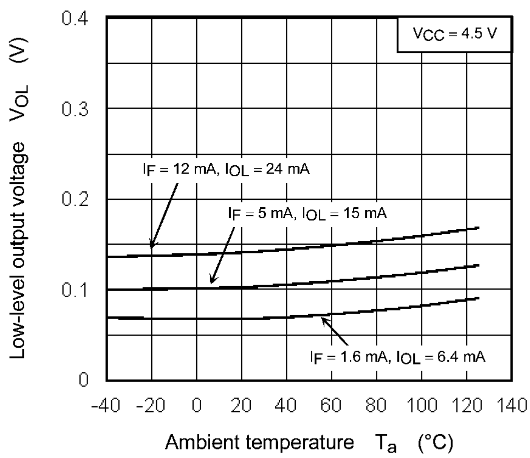


Fig. 12.2.6 V_{OL} - T_a

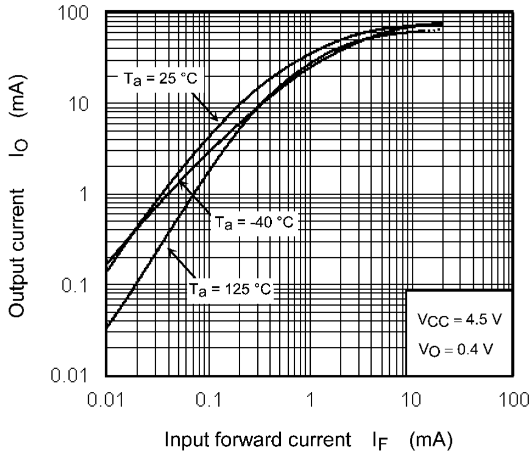


Fig. 12.2.7 I_O - I_F

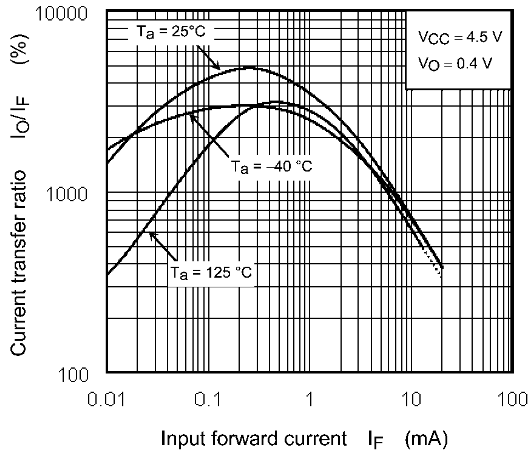


Fig. 12.2.8 I_O/I_F - I_F

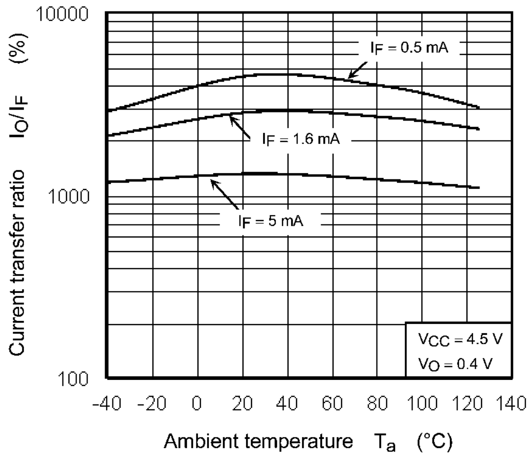


Fig. 12.2.9 I_O/I_F - T_a

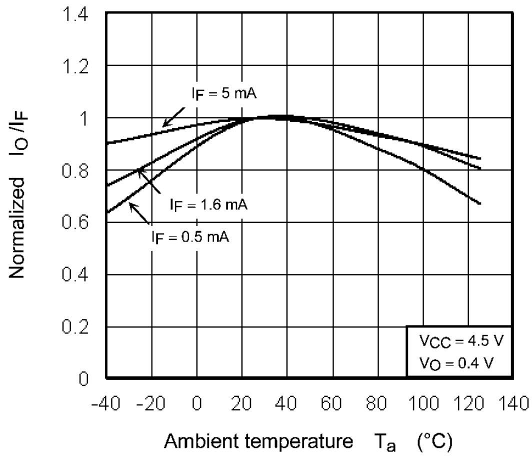


Fig. 12.2.10 I_O/I_F - T_a

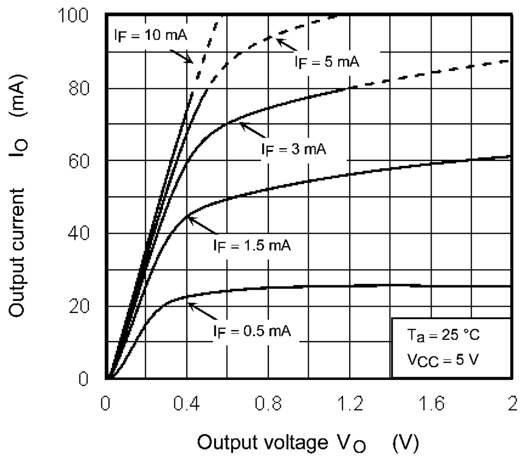


Fig. 12.2.11 I_O - V_O

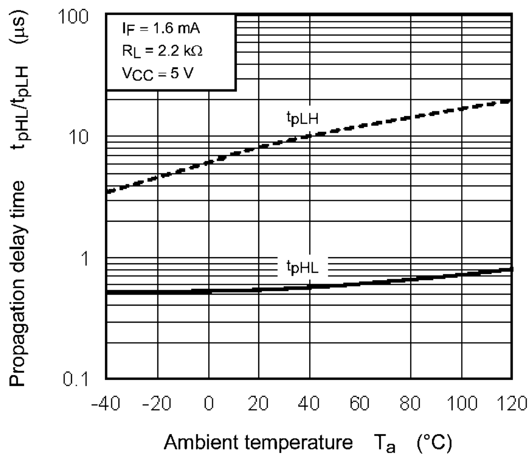


Fig. 12.2.12 t_{pHL}, t_{pLH} - T_a

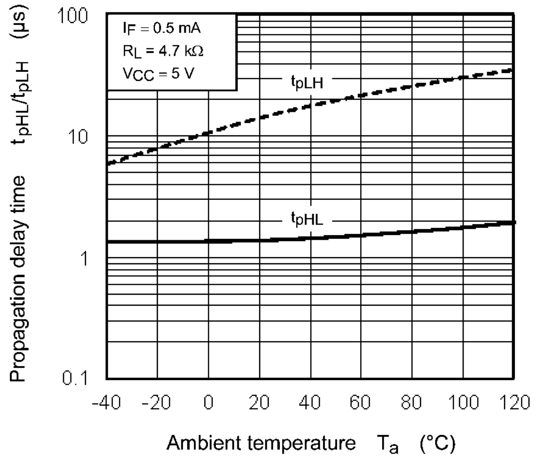


Fig. 12.2.13 t_{pHL},t_{pLH} - T_a

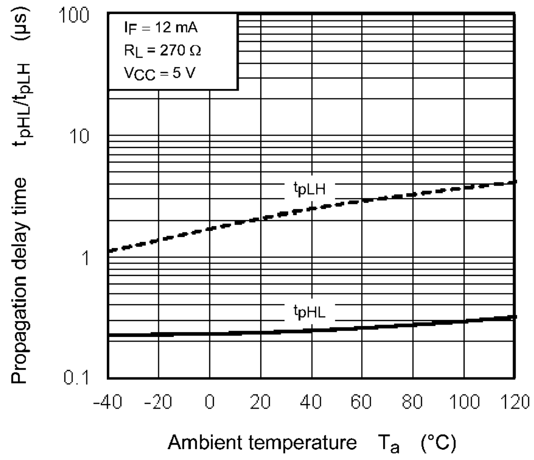


Fig. 12.2.14 t_{pHL},t_{pLH} - T_a

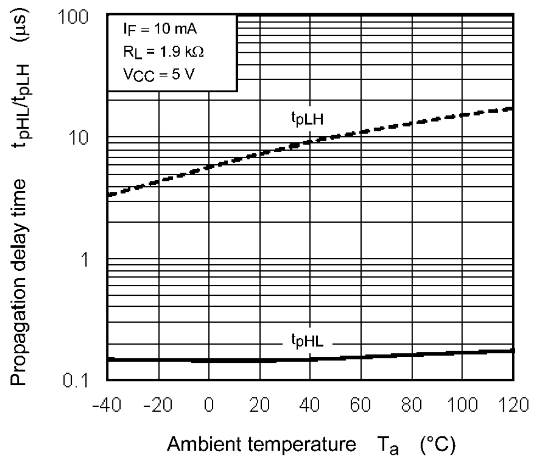


Fig. 12.2.15 t_{pHL},t_{pLH} - T_a

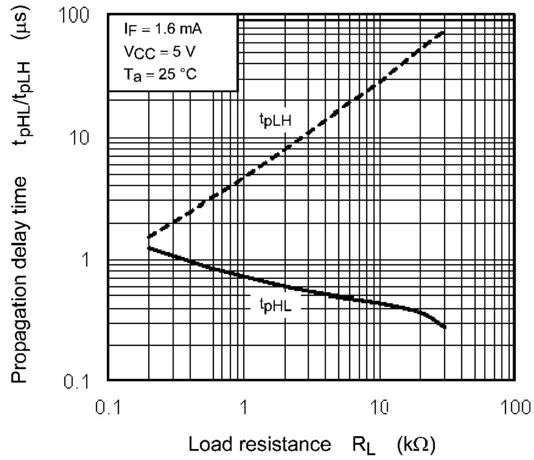


Fig. 12.2.16 t_{pHL},t_{pLH} - R_L

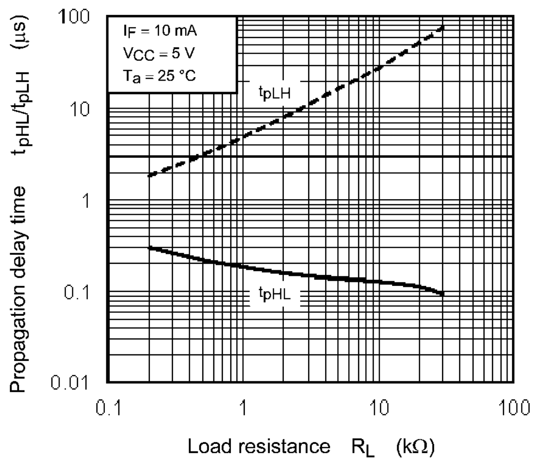


Fig. 12.2.17 t_{pHL},t_{pLH} - R_L

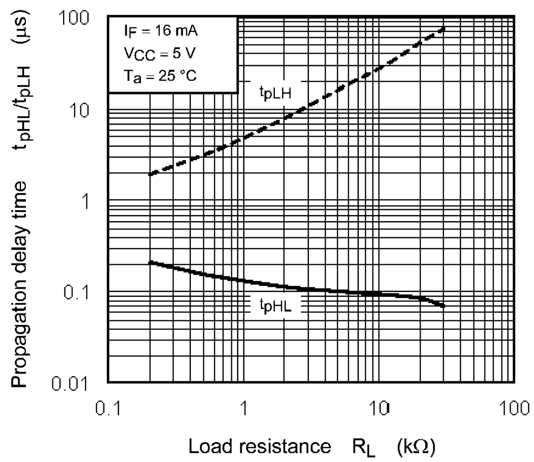


Fig. 12.2.18 t_{pHL},t_{pLH} - R_L

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 (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.

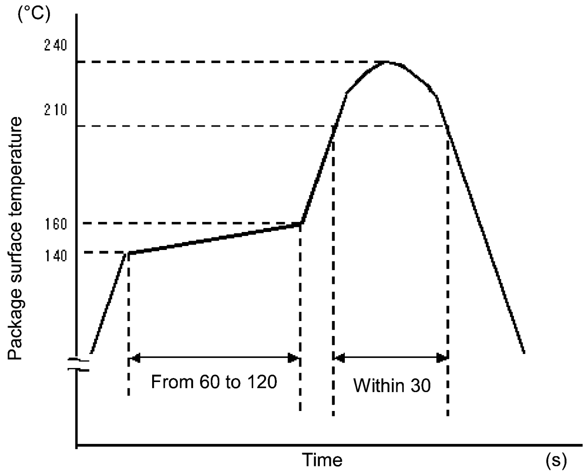


Fig. 13.1.1 An Example of a Temperature Profile When Sn-Pb Eutectic Solder Is Used

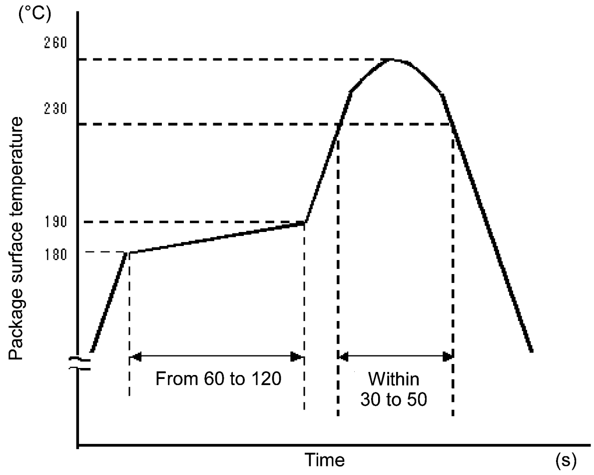


Fig. 13.1.2 An Example of a Temperature Profile When Lead(Pb)-Free Solder Is Used

- When using soldering flow (Applicable to both eutectic solder and Lead(Pb)-Free solder)
  Apply preheating of 150 °C 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 (Applicable to both eutectic solder and Lead(Pb)-Free solder)
  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)

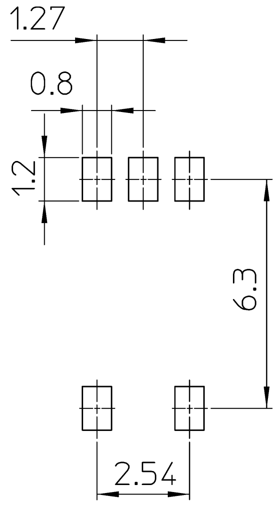


Fig. 14.1 Land Pattern Dimensions (for Reference Only) (Unit: mm)

15. Marking

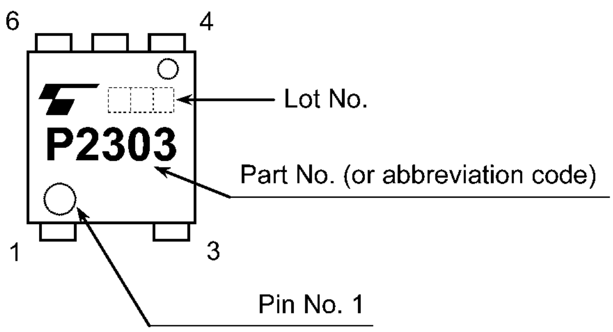
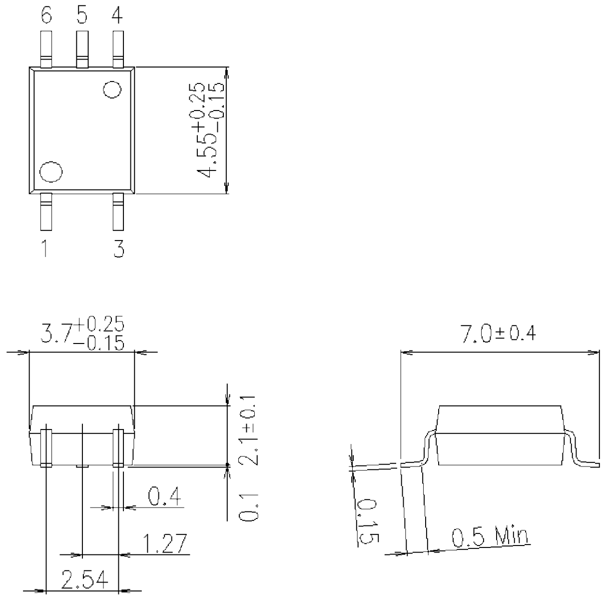


Fig. 15.1 Marking

Package Dimensions

Unit: mm



Weight: 0.08 g (typ.)

Package Name(s)
TOSHIBA: 11-4L1S

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