Photocouplers GaAℓAs Infrared LED & Photo IC

TLP151A

1. Applications

- Transistor Inverters
- MOSFET Gate Drivers
- IGBT Gate Drivers

2. General

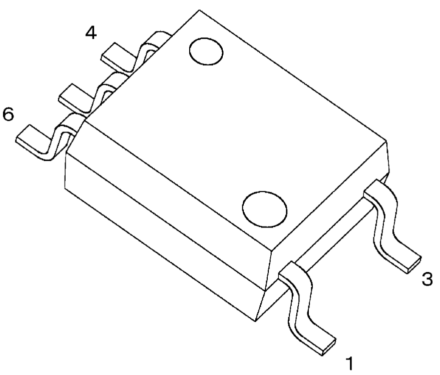
The TLP151A is a photocoupler in a SO6 package that consists of a GaAℓAs infrared light-emitting diode (LED) optically coupled to an integrated high-gain, high-speed photodetector IC chip.
The photodetector has an internal Faraday shield that provides a guaranteed common-mode transient immunity.
TLP151A is suitable for direct gate driving circuit for small capacity IGBTs or power MOSFETs.

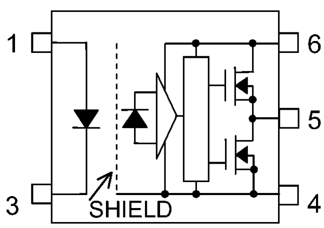
3. Features

(1) Buffer logic type (Totem pole output)
(2) Package type: SO6
(3) Output peak current: ±0.6 A (max)
(4) Operating temperature: -40 to 110 ℃
(5) Supply voltage: 10 to 30 V
(6) Threshold input current: 5.0 mA(max)
(7) Propagation delay time: 500 ns (max)
(8) Common-mode transient immunity: ±20 kV/μs (min)
(9) Isolation voltage: 3750 Vrms (min)
(10) 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





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

Start of commercial production
2011-05

5. Internal Circuit (Note)

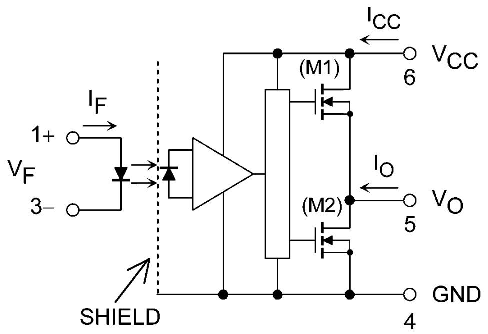


Fig. 5.1 Internal Circuit

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	M1	M2	Output
H	ON	ON	OFF	H
L	OFF	OFF	ON	L

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		25	mA
	Input forward current derating	($T_a \geq$ 95 °C)	$\Delta I_F/\Delta T_a$		-0.67	mA/°C
	Input forward current (pulsed)		I_{FP}	(Note 1)	1	A
	Input forward current derating (pulsed)	($T_a \geq$ 95 °C)	$\Delta I_{FP}/\Delta T_a$		-25	mA/°C
	Input reverse voltage		V_R		5	V
	Input power dissipation		P_D		40	mW
	Input power dissipation derating	($T_a \geq$ 95 °C)	$\Delta P_D/\Delta T_a$		-1.0	mW/°C
Detector	Peak high-level output current		I_{OPH}	(Note 2)	-0.6	A
	Peak low-level output current		I_{OPL}	(Note 2)	+0.6	A
	Output voltage		V_O		35	V
	Supply voltage		V_{CC}		35	V
	Output power dissipation		P_O		80	mW
	Output power dissipation derating	($T_a \geq$ 95 °C)	$\Delta P_O/\Delta T_a$		-2.0	mW/°C
Common	Operating temperature		T_{opr}		-40 to 110	°C
	Storage temperature		T_{stg}		-55 to 125	°C
	Lead soldering temperature	(10 s)	T_{sol}	(Note 3)	260	°C
	Isolation voltage	AC, 60 s, R.H. ≤ 60 %	BV_S	(Note 4)	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 μs, 300 pps

Note 2: Exponential waveform. Pulse width ≤ 2 μs, f ≤ 10 kHz, Duty = 50 %

Note 3: ≥ 2 mm below seating plane.

Note 4: 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	$I_{F(ON)}$		7.5	—	15	mA
Input off-state voltage	$V_{F(OFF)}$		0	—	0.8	V
Supply voltage	V_{CC}		10	—	30	V
Peak high-level output current	I_{OPH}		—	—	-0.2	A
Peak low-level output current	I_{OPL}		—	—	+0.2	A
Operating temperature	T_{opr}	(Note 1)	-40	—	110	°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 6 and pin 4 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 100 °C)

Characteristics	Symbol	Note	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Input forward voltage	V_F			I_F = 10 mA, T_a = 25 °C	1.45	1.55	1.7	V
Input forward voltage temperature coefficient	$\Delta V_F/\Delta T_a$			I_F = 10 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	—	60	—	pF
Peak high-level output current	I_{OPH}	(Note 1)	Fig. 12.1.1	I_F = 5 mA, V_{CC} = 15 V, V_{6-5} = 4 V	—	—	-0.2	A
				I_F = 5 mA, V_{CC} = 15 V, V_{6-5} = 10 V	—	—	-0.4	
Peak low-level output current	I_{OPL}	(Note 1)	Fig. 12.1.2	I_F = 0 mA, V_{CC} = 15 V, V_{5-4} = 2 V	0.2	—	—	
				I_F = 0 mA, V_{CC} = 15 V, V_{5-4} = 10 V	0.4	—	—	
High-level output voltage	V_{OH}		Fig. 12.1.3	I_F = 5 mA, V_{CC} = 10 V, I_O = -100 mA	6.0	8.5	—	V
Low-level output voltage	V_{OL}		Fig. 12.1.4	V_F = 0.8 V, V_{CC} = 10 V, I_O = 100 mA	—	0.35	1.0	
High-level supply current	I_{CCH}		Fig. 12.1.5	I_F = 10 mA, V_{CC} = 10 to 30 V, V_O = Open	—	—	2.0	mA
Low-level supply current	I_{CCL}		Fig. 12.1.6	I_F = 0 mA, V_{CC} = 10 to 30 V, V_O = Open	—	—	2.0	
Threshold input current (L/H)	I_{FLH}			V_{CC} = 15 V, V_O > 1 V	—	—	5.0	
Threshold input voltage (H/L)	V_{FHL}			V_{CC} = 15 V, V_O < 1 V	0.8	—	—	V
Supply voltage	V_{CC}			—	10	—	30	

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

Note: This device is designed for low power consumption, making it more sensitive to ESD than its predecessors. Extra care should be taken in the design of circuitry and pc board implementation to avoid ESD problems.

Note 1: I_O application time ≤ 50 μs, single pulse.

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, 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 and 3 are shorted together, and pins 4, 5 and 6 are shorted together.

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11. Switching Characteristics (Note) (Unless otherwise specified, T_a = -40 to 100 °C)

Characteristics	Symbol	Note	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Propagation delay time (L/H)	t_{pLH}		Fig. 12.1.7	I_F = 0 → 5 mA, V_{CC} = 30 V, R_g = 47 Ω, C_g = 3 nF, T_a = 25 °C	—	—	450	ns
Propagation delay time (H/L)	t_{pHL}			I_F = 5 → 0 mA, V_{CC} = 30 V, R_g = 47 Ω, C_g = 3 nF, T_a = 25 °C	—	—	450	
Propagation delay time (L/H)	t_{pLH}			I_F = 0 → 5 mA, V_{CC} = 30 V, R_g = 47 Ω, C_g = 3 nF	30	—	500	
Propagation delay time (H/L)	t_{pHL}			I_F = 5 → 0 mA, V_{CC} = 30 V, R_g = 47 Ω, C_g = 3 nF	30	—	500	
Pulse width distortion	$\|t_{pHL}-t_{pLH}\|$		Fig. 12.1.7	I_F = 0 ←→ 5 mA, V_{CC} = 30 V, R_g = 47 Ω, C_g = 3 nF	—	—	350	ns
Rise time	t_r			I_F = 0 → 5 mA, V_{CC} = 30 V, R_g = 47 Ω, C_g = 3 nF	—	50	—	
Fall time	t_f			I_F = 5 → 0 mA, V_{CC} = 30 V, R_g = 47 Ω, C_g = 3 nF	—	50	—	
Common-mode transient immunity at output high	CM_H	(Note1)	Fig. 12.1.8	V_{CM} = 1000 V_{p-p}, I_F = 5 mA, V_{CC} = 30 V, T_a = 25 °C, $V_{O(min)}$ = 26 V	±20	—	—	kV/μs
Common-mode transient immunity at output low	CM_L			V_{CM} = 1000 V_{p-p}, I_F = 0 mA, V_{CC} = 30 V, T_a = 25 °C, $V_{O(max)}$ = 1 V	±20			

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

Note1: 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 > 26 V).
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 < 1 V).

12. Test Circuits and Characteristics Curves

12.1. Test Circuits

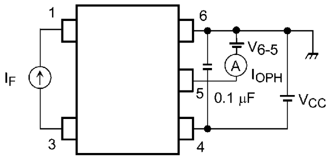


Fig. 12.1.1 I_{OPH} Test Circuit

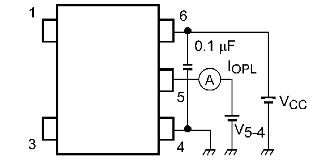


Fig. 12.1.2 I_{OPL} Test Circuit

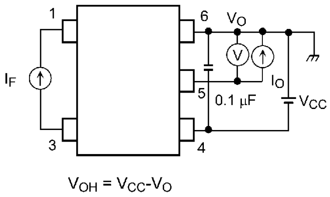


Fig. 12.1.3 V_{OH} Test Circuit

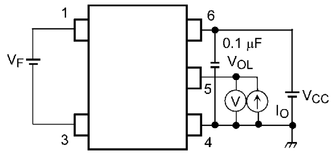


Fig. 12.1.4 V_{OL} Test Circuit

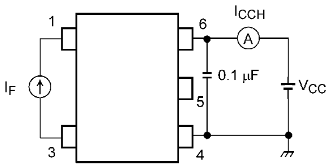


Fig. 12.1.5 I_{CCH} Test Circuit

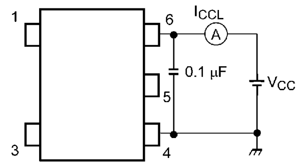


Fig. 12.1.6 I_{CCL} Test Circuit

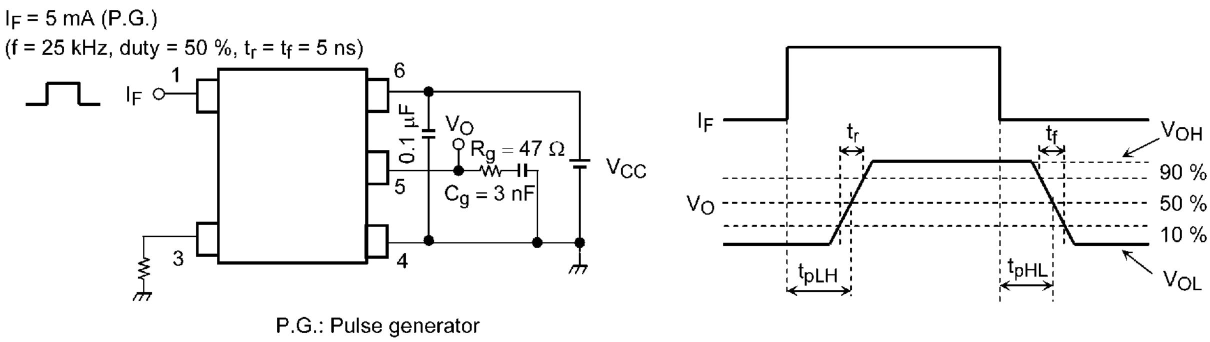
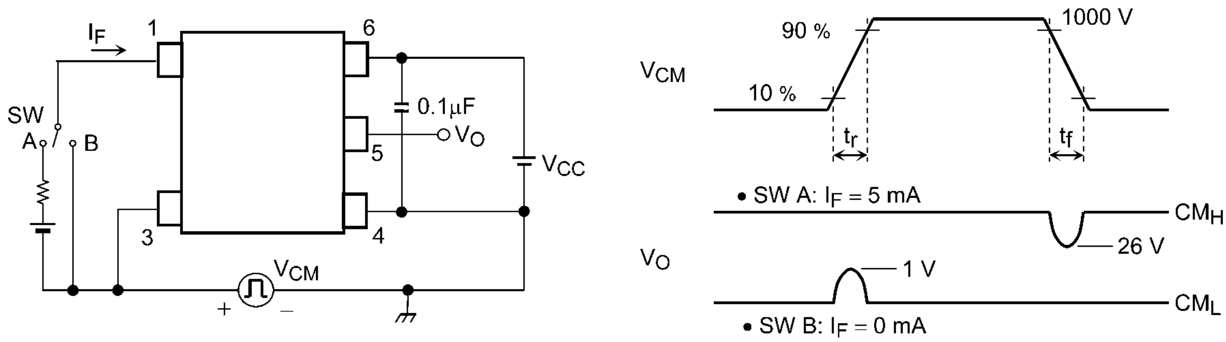


Fig. 12.1.7 Switching Time Test Circuit and Waveform



$$CM_L = \frac{800\ \text{V}}{t_r\ (\mu s)}$$

$$CM_H = -\frac{800\ \text{V}}{t_f\ (\mu s)}$$

Fig. 12.1.8 Common-Mode Transient Immunity Test Circuit and Waveform

12.2. Characteristics Curves (Note)

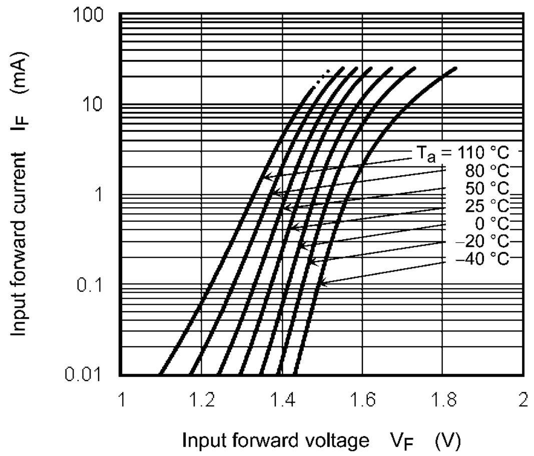


Fig. 12.2.1 I_F - V_F

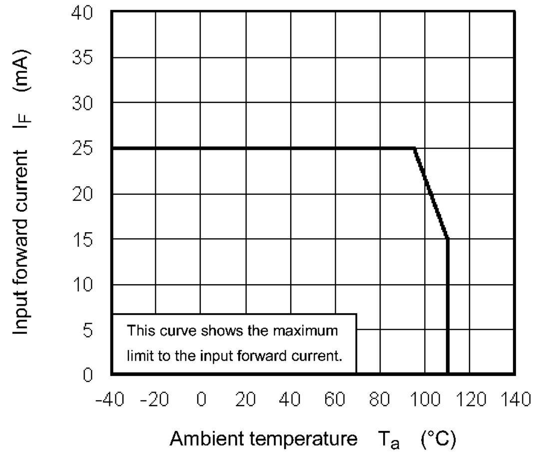


Fig. 12.2.2 I_F - T_a

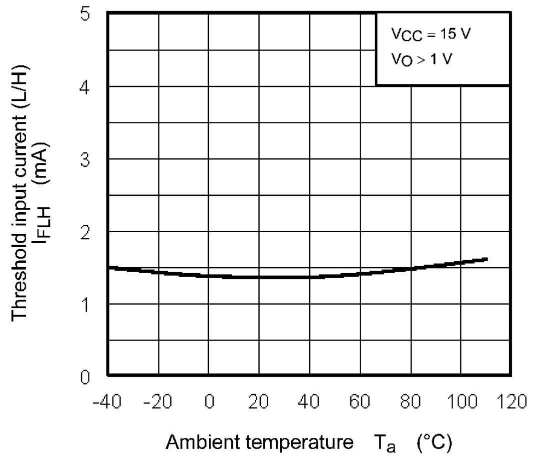


Fig. 12.2.3 I_{FLH} - T_a

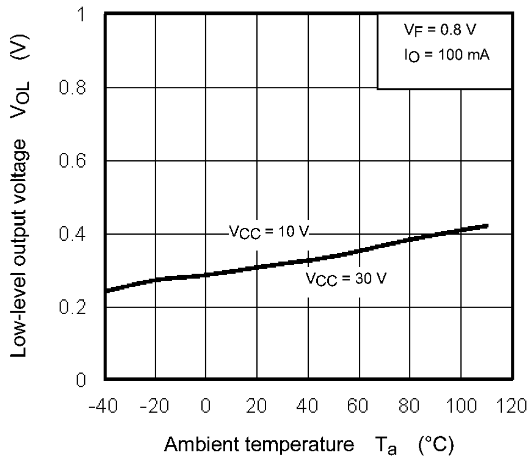


Fig. 12.2.4 V_{OL} - T_a

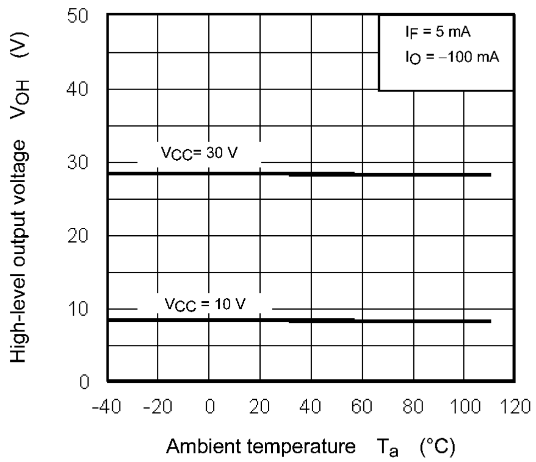


Fig. 12.2.5 V_{OH} - T_a

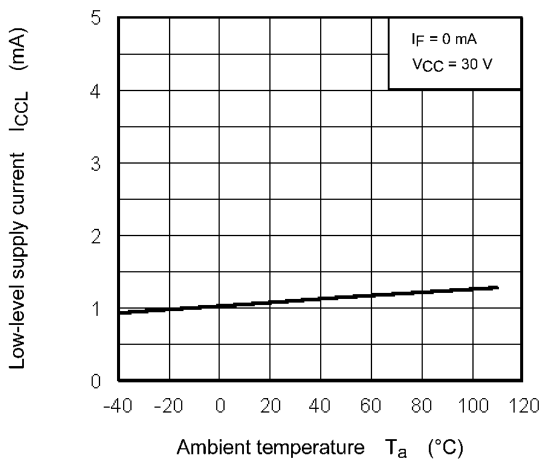


Fig. 12.2.6 I_{CCL} - T_a

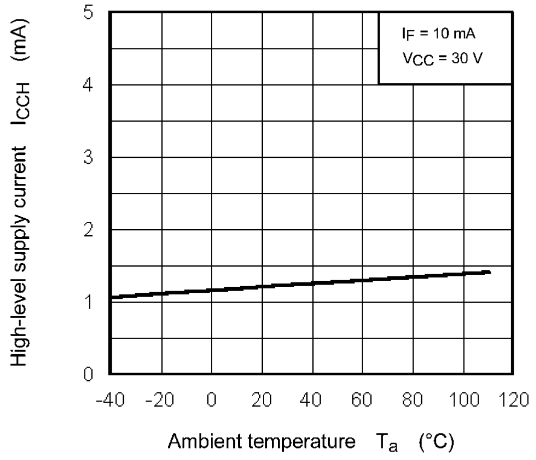


Fig. 12.2.7 I_{CCH} - T_a

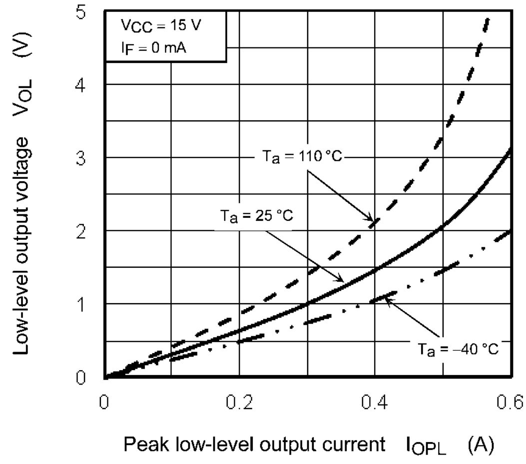


Fig. 12.2.8 V_{OL} - I_{OPL}

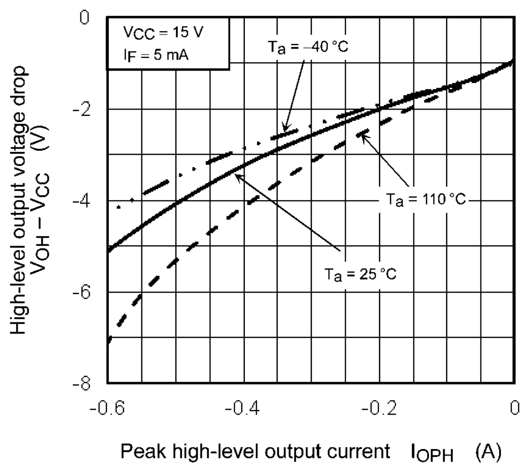


Fig. 12.2.9 (V_{OH} - V_{CC}) - I_{OPH}

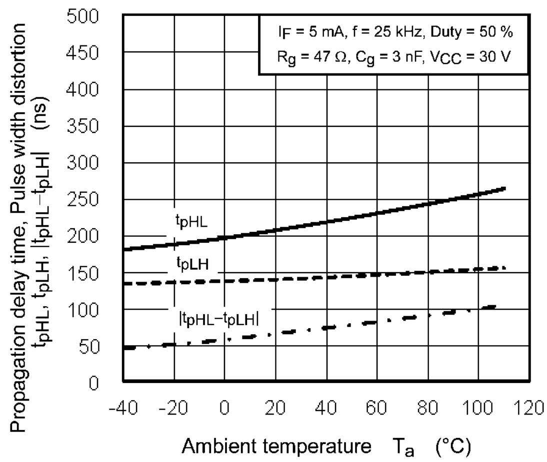


Fig. 12.2.10 t_{pHL},t_{pLH},|t_{pHL}-t_{pLH}| - T_a

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.

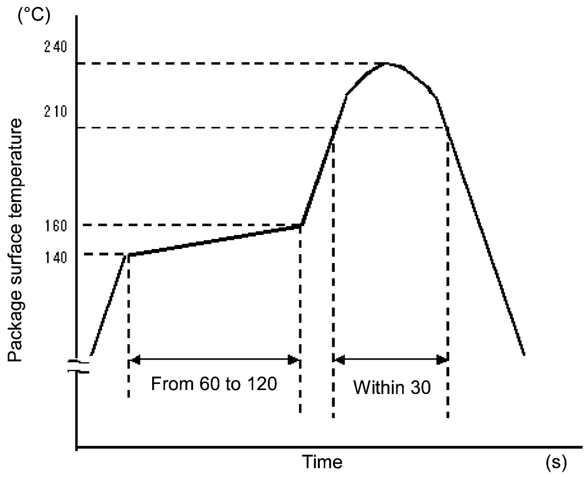


Fig. 13.1.1 An Example of a Temperature Profile When Sn-Pb Eutectic Solder Is Used

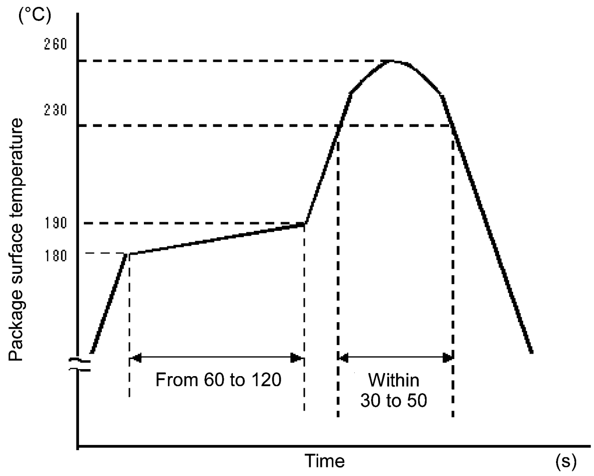


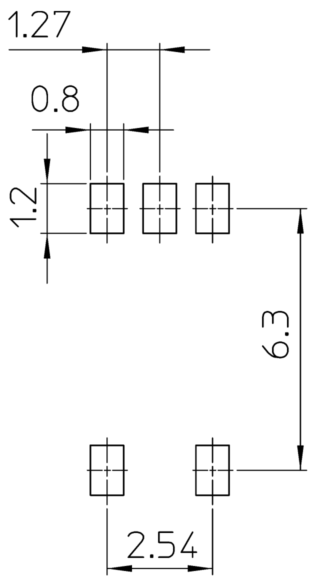
Fig. 13.1.2 An Example of a Temperature Profile When Lead(Pb)-Free Solder Is Used

- 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

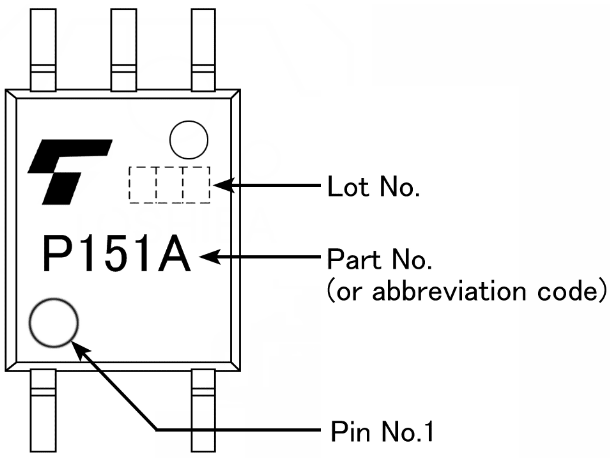
- Avoid storage locations where devices may be exposed to moisture or direct sunlight.
- Follow the precautions printed on the packing label of the device for transportation and storage.
- Keep the storage location temperature and humidity within a range of 5°C to 35°C and 45% to 75%, respectively.
-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



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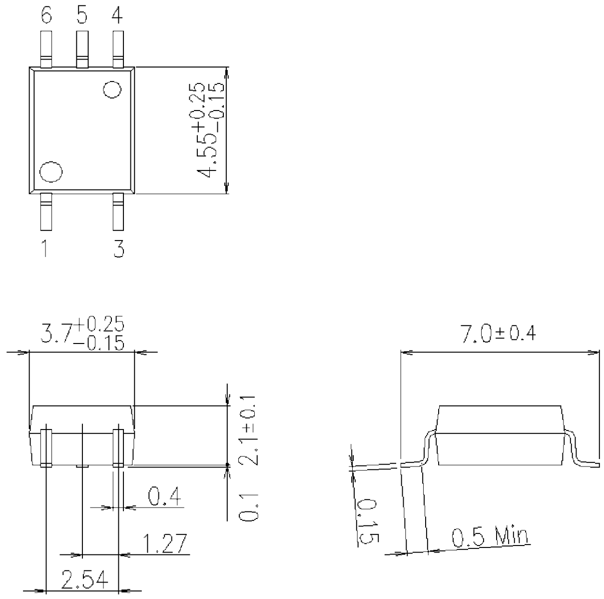
Package Dimensions

Unit: mm



Weight: 0.08 g (typ.)

Package Name(s)
TOSHIBA: 11-4L1S

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