Photocouplers Infrared LED & Photo Transistor

TLP294-4

1. Applications

- Programmable Logic Controllers (PLCs)
- I/O Interface Boards

2. General

TLP294-4 is a high isolation and a low AC input type photocoupler that consists of phototransistor optically coupled to two antiparallel infrared LEDs in a SO16 package.

Its feature shorter propagation delay time by incorporating a discharging resistor for base stored charge of the transistor.

TLP294-4 is suitable for FA equipment such as programmable logic controllers and inverters, and insulated communication interface applications.

3. Features

(1) Collector-emitter voltage: 80 V (min)

(2) Current transfer ratio: 100 % (min)

(3) Isolation voltage: 3750 Vrms (min)

(4) Operating temperature: -55 to 125 ℃

(5) Safety standards

UL-recognized: UL 1577, File No.E67349

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

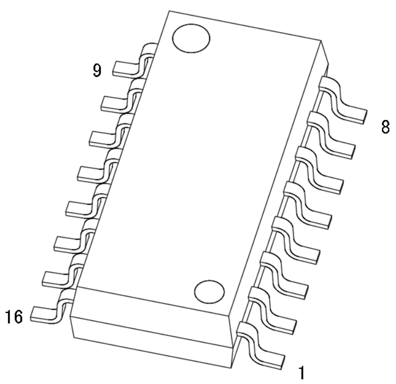
VDE-approved: EN 60747-5-5, EN 62368-1 **(Note 1)**

CQC-approved: GB4943.1, GB8898 Thailand Factory

仅适用于海拔 2000m 以下地区安全使用

Note 1: When a VDE approved type is needed, please designate the **Option (V4)**.

4. Packaging and Pin Assignment



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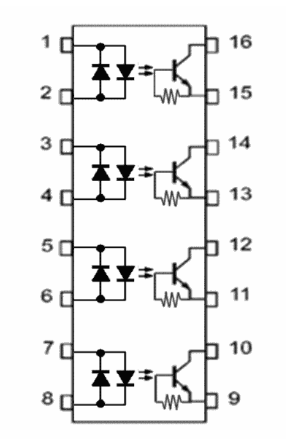


1, 3, 5, 7: Anode, Cathode
2, 4, 6 ,8: Cathode, Anode
9, 11, 13, 15: Emitter
10, 12, 14, 16: Collector

Start of commercial production
2022-01

5. Mechanical Parameters

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

6. Absolute Maximum Ratings (Note) (Unless otherwise specified, T_a = 25 °C)

	Characteristics		Symbol	Note	Rating	Unit
LED	R.M.S. forward current		$I_{F(RMS)}$		±50	mA
	Input forward current derating	(T_a ≥ 50 °C)	$\Delta I_F/\Delta T_a$		-0.59	mA/°C
	Input forward current (pulsed)		I_{FP}	(Note 1)	±1	A
	Input power dissipation		P_D		70	mW
	Input power dissipation derating	(T_a ≥ 50 °C)	$\Delta P_D/\Delta T_a$		-0.82	mW/°C
	Junction temperature		T_j		135	°C
Detector	Collector-emitter voltage		V_{CEO}		80	V
	Emitter-collector voltage		V_{ECO}		5	V
	Collector current		I_C		50	mA
	Collector power dissipation		P_C		100	mW
	Collector power dissipation derating	(T_a ≥ 25 °C)	$\Delta P_C/\Delta T_a$		-0.91	mW/°C
	Junction temperature		T_j		135	°C
Common	Operating temperature		T_{opr}		-55 to 125	°C
	Storage temperature		T_{stg}		-55 to 125	°C
	Lead soldering temperature	(10 s)	T_{sol}		260	°C
	Total power dissipation		P_T		170	mW
	Total power dissipation derating	(T_a ≥ 25 °C)	$\Delta P_T/\Delta T_a$		-1.55	mW/°C
	Isolation voltage	AC, 60 s, R.H. ≤ 60 %	BV_S	(Note 2)	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) ≤ 0.1 ms, f = 100 Hz

Note 2: This device is considered as a two-terminal device: All pins on the LED side are shorted together, and all pin on the photodetector side are shorted together.

7. Electrical Characteristics (Unless otherwise specified, T_a = 25 °C)

	Characteristics	Symbol	Note	Test Condition	Min	Typ.	Max	Unit
LED	Input forward voltage	V_F		I_F = ±3 mA	1.1	1.2	1.3	V
	Input capacitance	C_t		V = 0 V, f = 1 MHz	—	80	—	pF
Detector	Collector-emitter breakdown voltage	$V_{(BR)CEO}$		I_C = 0.1 mA	80	—	—	V
	Emitter-collector breakdown voltage	$V_{(BR)ECO}$		I_E = 0.5 mA	5	—	—	V
	Dark Current	I_{DARK}		V_{CE} = 48 V	—	0.001	0.1	μA
				V_{CE} = 48 V, T_a = 125 °C	—	0.09	50	μA
	Collector-emitter capacitance	C_{CE}		V = 0 V, f = 1 MHz	—	6	—	pF

8. Coupled Electrical Characteristics (Unless otherwise specified, T_a = 25 °C)

Characteristics	Symbol	Note	Test Condition	Min	Typ.	Max	Unit
Current transfer ratio	I_C/I_F		I_F = ±5 mA, V_{CE} = 5 V	100	—	700	%
Saturated current transfer ratio	$I_C/I_{F(sat)}$		I_F = ±1 mA, V_{CE} = 0.4 V	30	—	—	%
Collector-emitter saturation voltage	$V_{CE(sat)}$		I_C = 2.4 mA, I_F = ±8 mA	—	—	0.3	V
			I_C = 0.2 mA, I_F = ±1 mA	—	—	0.3	V
OFF-state collector current	$I_{C(off)}$		V_F = ±0.7 V, V_{CE} = 48 V	—	1	10	μA
High-level input threshold voltage	V_{ITH}		V_{CC} = 5 V, R_{IN} = 5.6 kΩ, R_L = 27 kΩ, V_{CE} > 4 V	1	—	—	V
Low-level input threshold voltage	V_{ITL}		V_{CC} = 5 V, R_{IN} = 5.6 kΩ, R_L = 27 kΩ, V_{CE} < 1 V	—	—	5	V

9. 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	—	1.2	—	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	3750	—	—	Vrms

Note 1: This device is considered as a two-terminal device: All pins on the LED side are shorted together, and all pin on the photodetector side are shorted together.

10. Switching Characteristics (Unless otherwise specified, T_a = 25 °C)

Characteristics	Symbol	Note	Test Condition	Min	Typ.	Max	Unit
Rise time	t_r		V_{CC} = 10 V, I_C = 2 mA, R_L = 100 Ω	—	2	—	μs
Fall time	t_f			—	3	—	μs
Turn-on time	t_{on}			—	3	—	μs
Turn-off time	t_{off}			—	3	—	μs
Turn-on time	t_{on}		I_F = ±1 mA, V_{CC} = 5 V, R_L = 27 kΩ	—	20	—	μs
Storage time	t_s			—	15	—	μs
Turn-off time	t_{off}			—	55	—	μs
Propagation delay time (H/L)	t_{pHL}		see fig. 10.1 V_{IN} = ±10 V, R_{IN} = 5.6 kΩ, V_{CC} = 5 V, R_L = 27 kΩ	—	—	50	μs
Propagation delay time (L/H)	t_{pLH}			25	—	100	μs

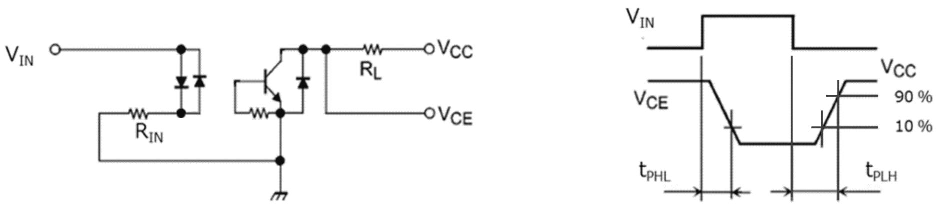


Fig. 10.1 Propagation delay Time Test Circuit and Waveform

11. Characteristics Curves (Note)

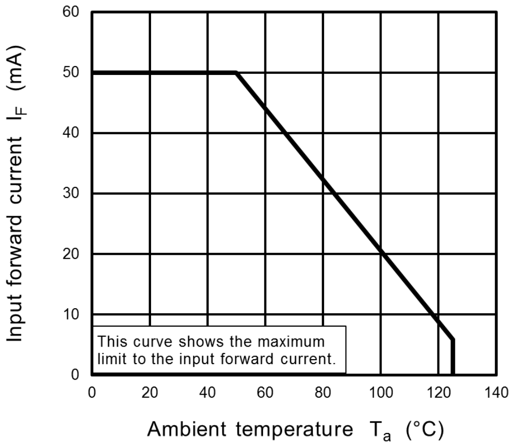


Fig. 11.1 I_F - T_a

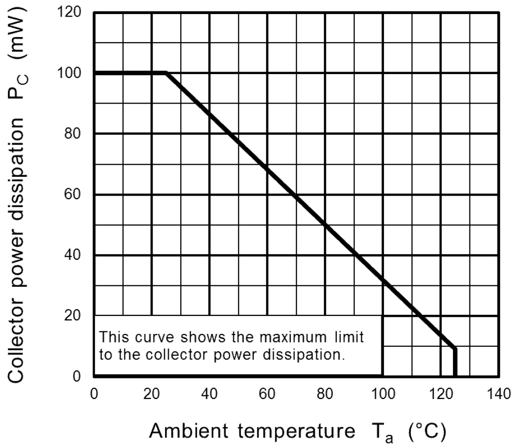


Fig. 11.2 P_C - T_a

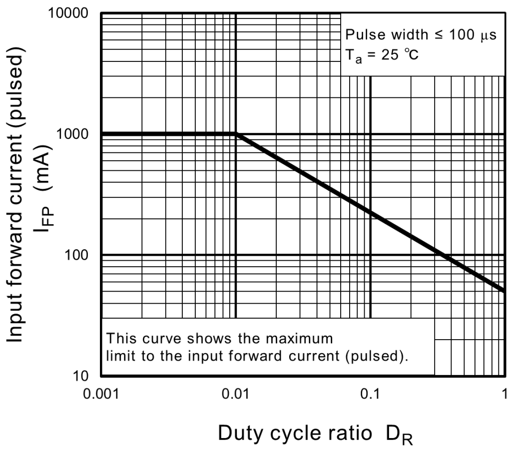


Fig. 11.3 I_{FP} - D_R

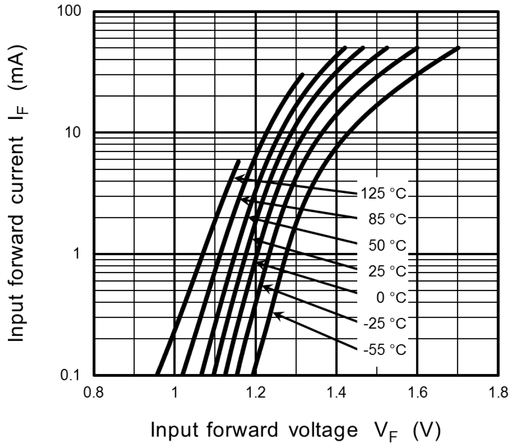


Fig. 11.4 I_F - V_F

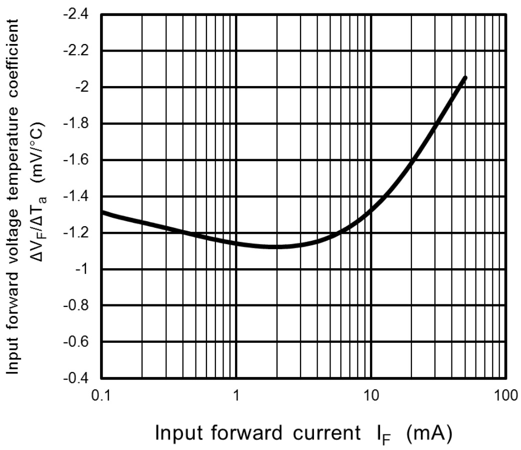


Fig. 11.5 $\Delta V_F/\Delta T_a$ - I_F

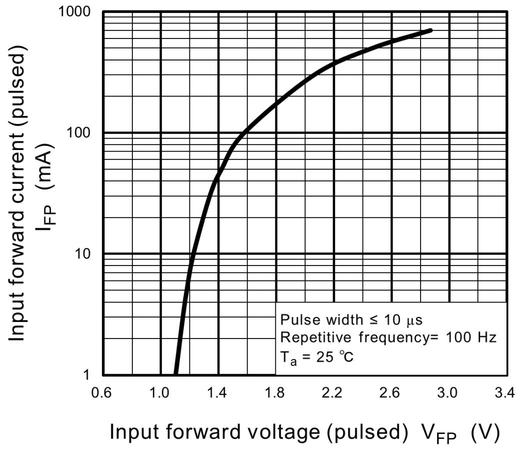


Fig. 11.6 I_{FP} - V_{FP}

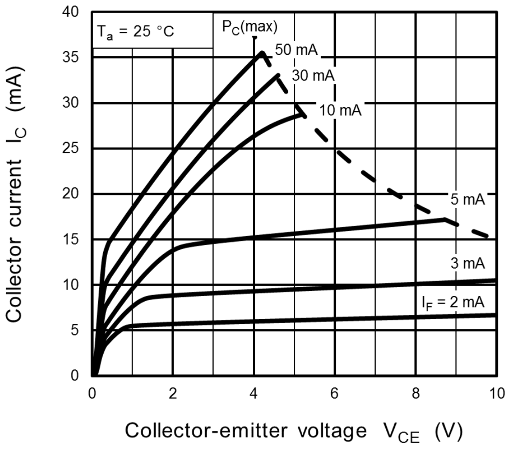


Fig. 11.7 I_C - V_{CE}

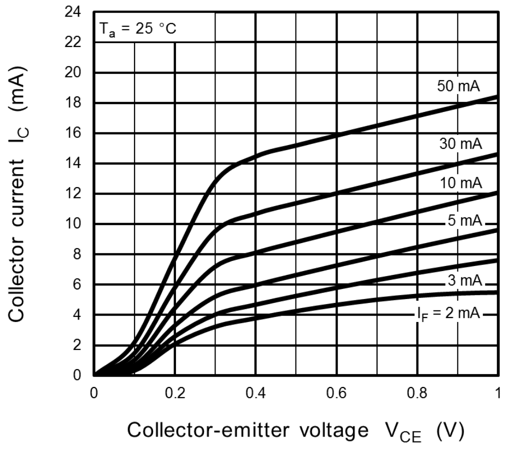


Fig. 11.8 I_C - V_{CE}

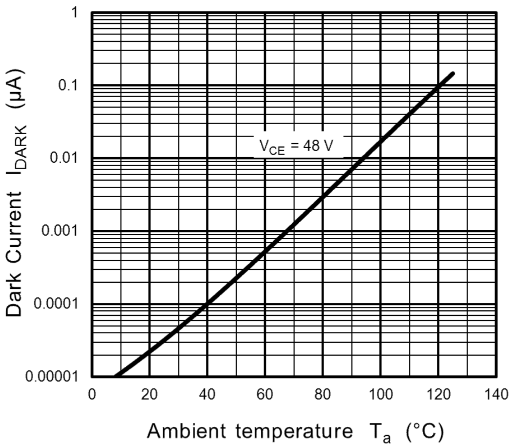


Fig. 11.9 I_{DARK} - T_a

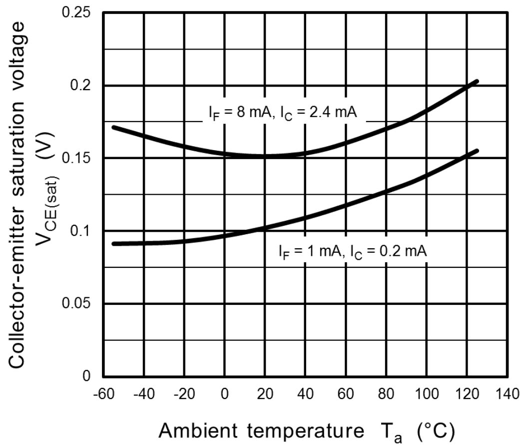


Fig. 11.10 $V_{CE(sat)}$ - T_a

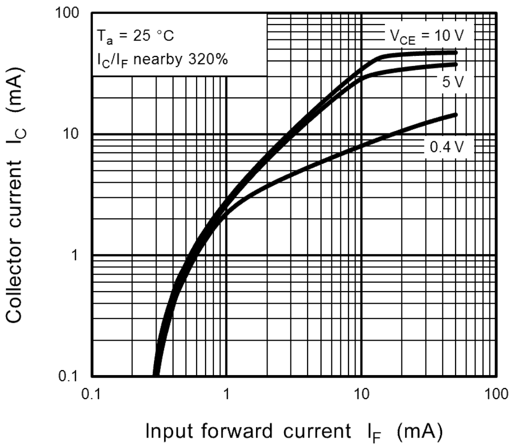


Fig. 11.11 I_C - I_F

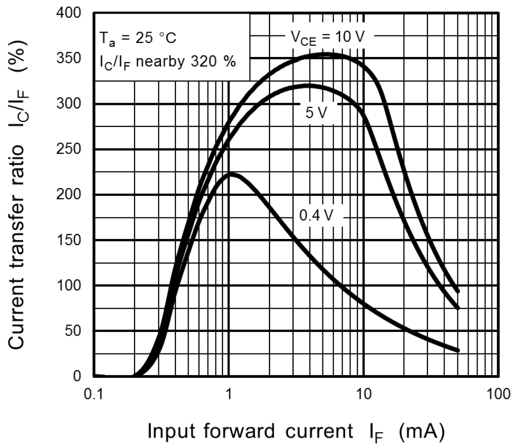


Fig. 11.12 I_C/I_F - I_F

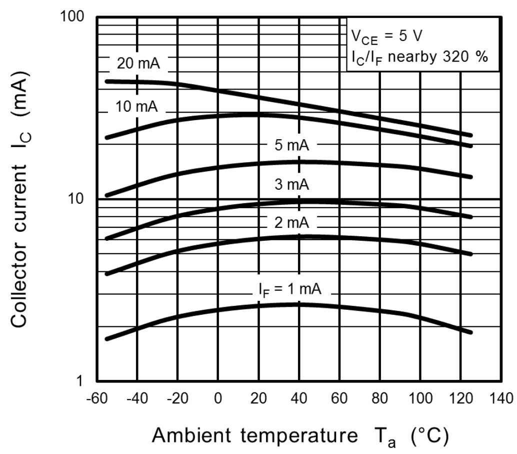


Fig. 11.13 I_C - T_a

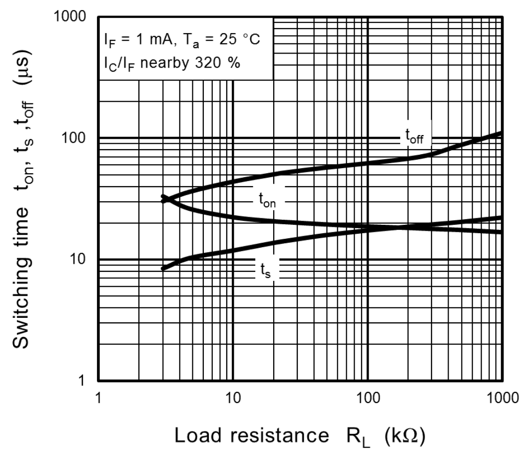


Fig. 11.14 Switching Time - R_L

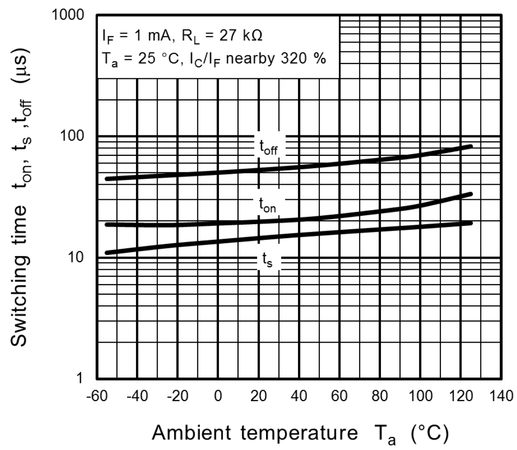


Fig. 11.15 Switching Time - T_a

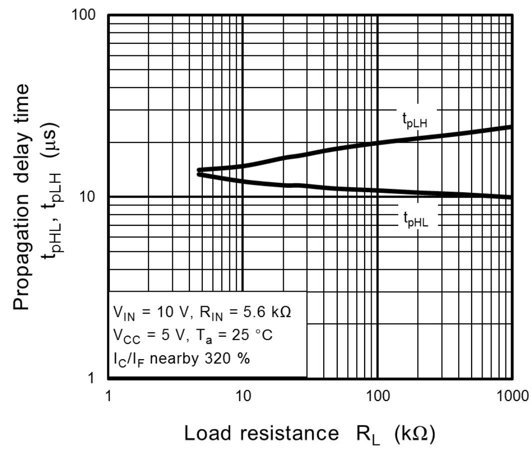


Fig. 11.16 Propagation delay Time - R_L

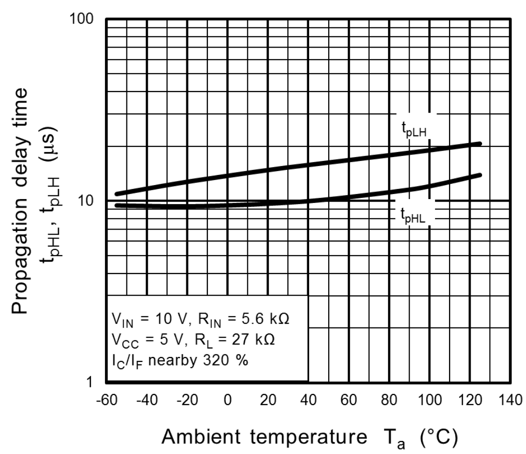


Fig. 11.17 Propagation delay Time - T_a

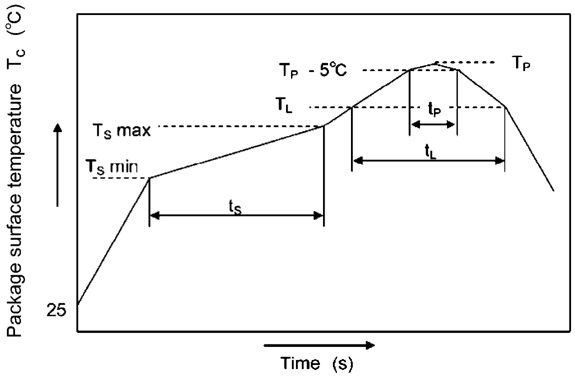
Note: The above characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.

12. Soldering and Storage

12.1. 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

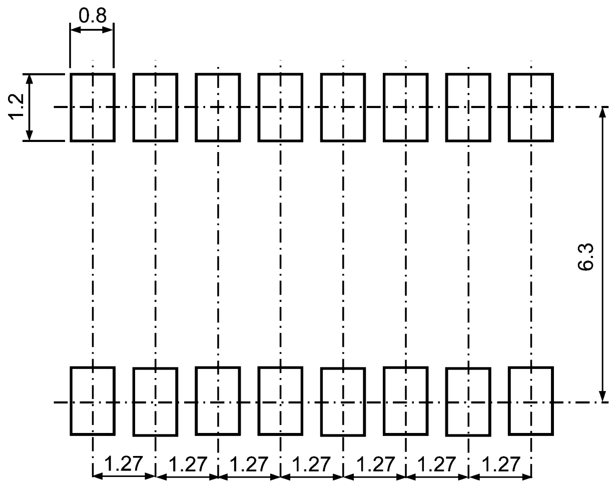
Fig. 12.1.1 An Example of a Temperature Profile When Lead(Pb)-Free Solder Is Used

- 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.

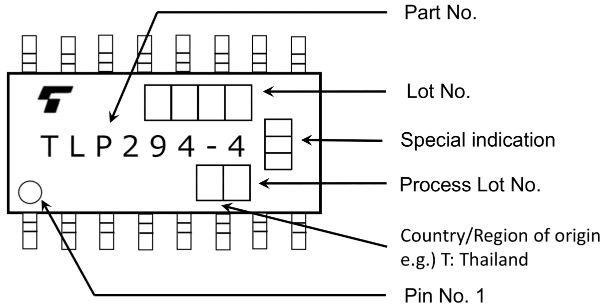
12.2. Precautions for General Storage

- 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.

13. Land Pattern Dimensions (for reference only)



14. Marking



15. EN 60747-5-5 Option (V4) Specification

- Part number: TLP294-4 **(Note 1)**
- The following part naming conventions are used for the devices that have been qualified according to option (V4) of EN 60747.

  Example: TLP294-4(V4-TP,E

  V4: 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., TLP294-4(V4-TP,E → TLP294-4

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 ≤ 150 Vrms for rated mains voltage ≤ 300 Vrms		I-IV I-III	—
Climatic classification		55 / 125 / 21	—
Pollution degree		2	—
Maximum operating insulation voltage	V_{IORM}	707	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}	1131	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}	1330	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) 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}	$\geq 10^{12}$ $\geq 10^{11}$ $\geq 10^{9}$	Ω

Fig. 15.1 EN 60747 Insulation Characteristics

Table 15.1 Insulation Related Specifications (Note)

Insulation Related Parameters	Symbol	TLP292
Minimum creepage distance	Cr	5.0 mm
Minimum clearance	Cl	5.0 mm
Minimum insulation thickness	ti	0.4 mm
Comparative tracking index	CTI	500

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.

VDE

Fig. 15.2 Marking on packing for EN 60747

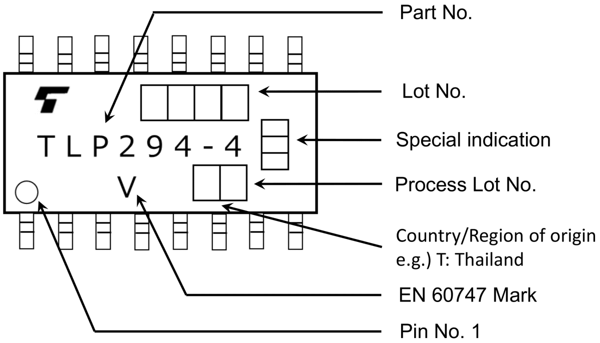


Fig. 15.3 Marking Example (Note)

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

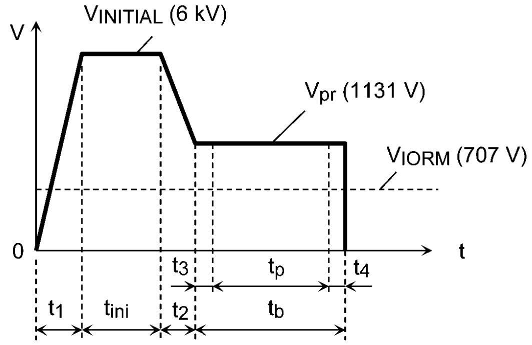


Figure 2 Partial discharge measurement procedure according to EN 60747
Non-destructive test for 100 % inspection.

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

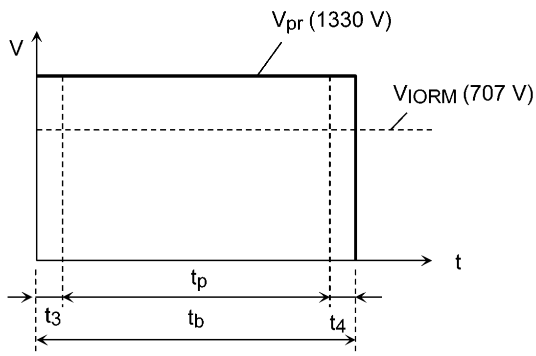


Figure 3 Dependency of maximum safety ratings on ambient temperature

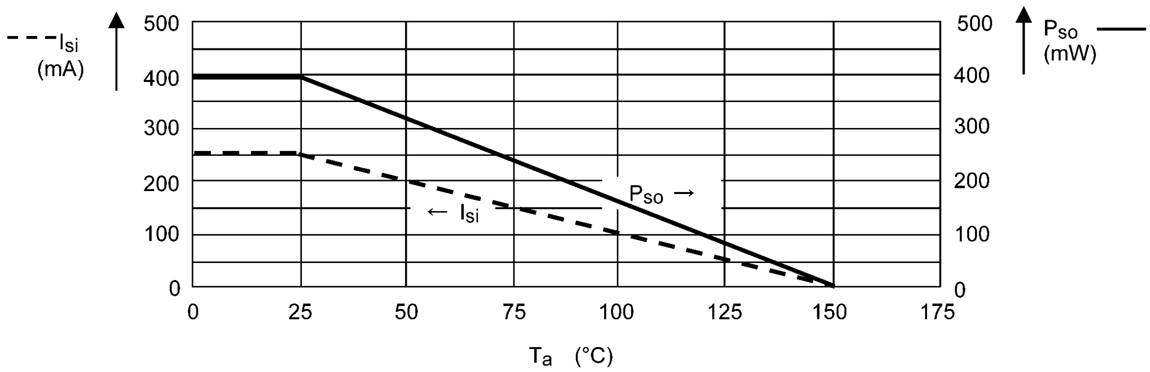
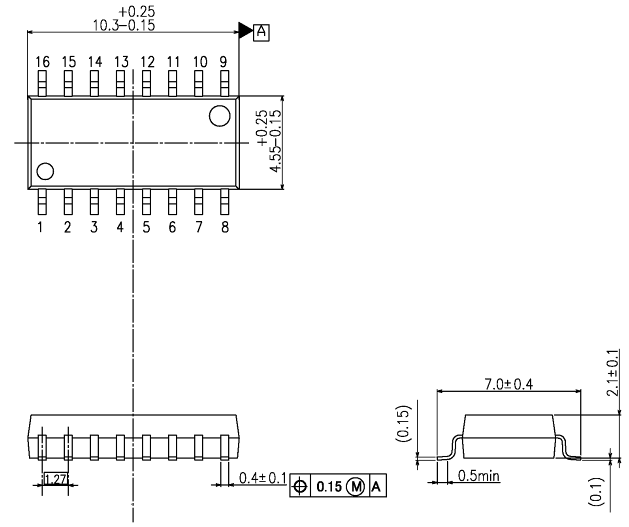


Fig. 15.4 Measurement Procedure

Package Dimensions

Unit: mm



Weight: 0.19 g (typ.)

Package Name(s)
TOSHIBA: 11-11F1

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