Photocouplers GaAℓAs Infrared LED & Photo IC

TLP2398

1. Applications

- Programmable Logic Controllers (PLCs)
- High-Speed Digital Interfacing for Instrumentation and Control Devices
- Simplex/Multiplex Data Transmission

2. General

The Toshiba TLP2398 consists of two GaAℓAs light-emitting diode coupled with a high-gain, high-speed photo detector. It is housed in the SO6 package.

Since it is making two LED reverse parallel, it can be dealt with both sinking and sourcing input signals.

The detector has a totem-pole output stage with current sourcing and sinking capabilities.

The TLP2398 has an internal Faraday shield that provides a guaranteed common-mode transient immunity of ±20 kV/μs.

The TLP2398 has a logic inverter output. A buffer output version, the TLP2395, is also available.

3. Features

(1) Inverter logic type (totem pole output)

(2) Package: SO6

(3) Supply voltage: 3 to 20 V

(4) Threshold input current, high to low: I_{FHL} = ±2.3 mA (max)

(5) Propagation delay time: t_{pHL}/t_{pLH} = 250 ns (max)

(6) Pulse width distortion: $|t_{pHL} - t_{pLH}|$ = 80 ns (max)

(7) Common-mode transient immunity: ±20 kV/μs (min)

(8) Operating temperature: -40 to 125 ℃

(9) Isolation voltage: 3750 Vrms (min)

(10) Safety standards

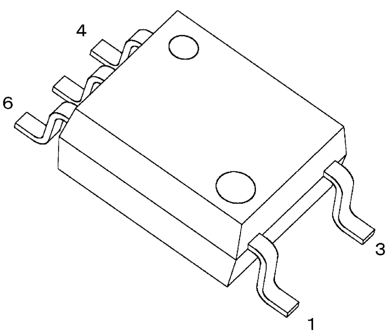
UL-approved: UL1577 File No.E67349

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

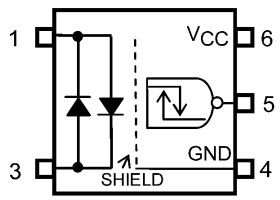
VDE-approved: Option (V4) EN60747-5-5 **(Note)**

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

4. Packaging and Pin Assignment



11-4L1S



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

5. Internal Circuit (Note)

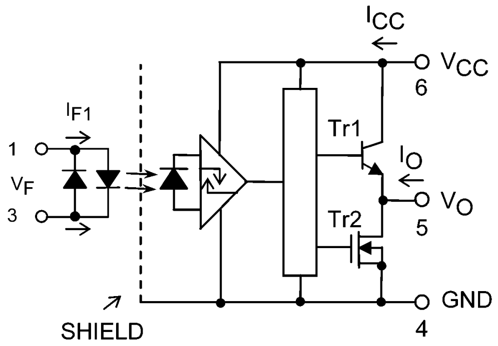


Fig. 5.1 Internal Circuit

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	Output
H	ON	L
L	OFF	H

6.2. Mechanical Parameters

Characteristics	Min	Unit
Creepage distances	5.0	mm
Clearance	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	($T_a \geq$ 110 °C)	$\Delta I_F/\Delta T_a$		-0.33	mA/°C
	Peak transient input forward current		I_{FPT}	(Note 1)	±1	A
	Peak transient input forward current derating	($T_a \geq$ 110 °C)	$\Delta I_{FPT}/\Delta T_a$		-25	mA/°C
	Input power dissipation		P_D		40	mW
	Input power dissipation derating	($T_a \geq$ 110 °C)	$\Delta P_D/\Delta T_a$		-1.0	mW/°C
Detector	Output current	($T_a \leq$ 25 °C)	I_O		25/-15	mA
	Output current	(T_a = 125 °C)	I_O		5/-5	
	Output voltage		V_O		-0.5 to 20	V
	Supply voltage		V_{CC}		-0.5 to 20	
	Output power dissipation		P_O		100	mW
	Output power dissipation derating	($T_a \geq$ 110 °C)	$\Delta P_O/\Delta T_a$		-2.5	mW/°C
Common	Operating temperature		T_{opr}		-40 to 125	°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 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) ≤ 1 μs, 300 pps

Note 2: 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	$I_{F(ON)}$ pin1→3	(Note 1)	3	—	10	mA
	$I_{F(ON)}$ pin3→1	(Note 1)	-10	—	-3	
Input off-state voltage	$V_{F(OFF)}$ pin1→3		0	—	0.8	V
	$V_{F(OFF)}$ pin3→1		-0.8	—	0	
Supply voltage	V_{CC}	(Note 2)	3	—	20	
Operating temperature	T_{opr}	(Note 2)	-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 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: The rise and fall times of the input on-current should be less than 0.5 μs.

Note 2: Denotes the operating range, not the recommended operating condition.

9. Electrical Characteristics (Note) (Unless otherwise specified, T_a = -40 to 125 °C, V_{CC} = 3 to 20 V)

Characteristics	Symbol	Note	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Input forward voltage	V_F		—	I_F = 3 mA, T_a = 25 °C	1.33	1.50	1.63	V
Input forward voltage temperature coefficient	$\Delta V_F/\Delta T_a$		—	I_F = 3 mA	—	-2.0	—	mV/°C
Input capacitance	C_t		—	V = 0 V, f = 1 MHz	—	90	—	pF
Low-level output voltage	V_{OL}		Fig. 12.1.1	I_O = 3.5 mA, I_F = 5 mA	—	0.11	0.6	V
High-level output voltage	V_{OH}	(Note 1)	Fig. 12.1.2	V_{CC} = 3 V, I_O = -2.6 mA, V_F = 0.8 V	1.78	2.1	—	
				V_{CC} = 20 V, I_O = -2.6 mA, V_F = 0.8 V	17.4	19.1	—	
Low-level supply current	I_{CCL}		Fig. 12.1.3	V_{CC} = 3.6 V, I_F = 5 mA	—	1.4	3.0	mA
				V_{CC} = 20 V, I_F = 5 mA	—	1.5	3.0	
High-level supply current	I_{CCH}		Fig. 12.1.4	V_{CC} = 3.6 V, V_F = 0 V	—	1.9	3.0	
				V_{CC} = 20 V, V_F = 0 V	—	2.0	3.0	
Low-level short-circuit output current	I_{OSL}	(Note 2)	Fig. 12.1.5	V_{CC} = V_O = 3.6 V, I_F = 5 mA	15	100	—	
				V_{CC} = V_O = 20 V, I_F = 5 mA	20	130	—	
High-level short-circuit output current	I_{OSH}	(Note 2)	Fig. 12.1.6	V_{CC} = 3.6 V, V_F = 0 V, V_O = GND	—	-14	-5	
				V_{CC} = 20 V, V_F = 0 V, V_O = GND	—	-24	-10	
Threshold input current (H/L)	I_{FHL}		—	I_O = 3.5 mA, V_O < 0.4 V	—	0.7	2.3	
Threshold input voltage (L/H)	V_{FLH}		—	I_O = -2.6 mA, V_O > 2.4 V	0.8	—	—	V
Input current hysteresis	I_{HYS}		—	V_{CC} = 5 V	—	0.05	—	mA

Note: All typical values are at T_a = 25 °C.
Note 1: $V_{OH} = V_{CC} - V_O$ (V)
Note 2: Duration of output short circuit time should not exceed 10 ms.

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 (Note)
(Unless otherwise specified, T_a = -40 to 125 °C, V_{CC} = 3 to 20 V)

Characteristics	Symbol	Note	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Propagation delay time (L/H)	t_{pLH}		Fig. 12.1.7, Fig. 12.1.8	I_F = 3 → 0 mA	—	95	250	ns
Propagation delay time (H/L)	t_{pHL}			I_F = 0 → 3 mA	—	105	250	
Pulse width distortion	$\|t_{pHL}-t_{pLH}\|$			I_F = 3 mA	—	10	80	
Propagation delay skew (device to device)	t_{psk}				-130	—	130	
Rise time	t_r			I_F = 3 → 0 mA, V_{CC} = 5 V	—	15	75	
Fall time	t_f			I_F = 0 → 3 mA, V_{CC} = 5 V	—	12	75	
Common-mode transient immunity at output high	CM_H		Fig. 12.1.9	V_{CM} = 1000 V_{p-p}, I_F = 0 mA, V_{CC} = 20 V, T_a = 25 °C	±20	±25	—	kV/μs
Common-mode transient immunity at output low	CM_L			V_{CM} = 1000 V_{p-p}, I_F = 5 mA, V_{CC} = 20 V, T_a = 25 °C	±20	±25	—	

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

12. Test Circuits and Characteristics Curves

12.1. Test Circuits

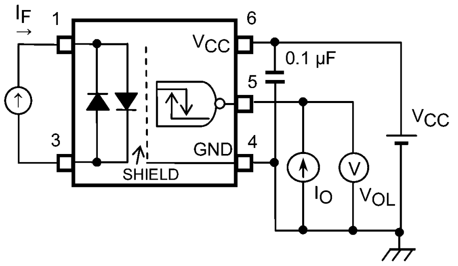


Fig. 12.1.1 V_{OL} Test Circuit

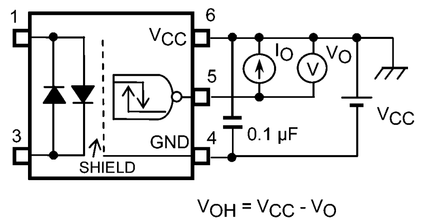


Fig. 12.1.2 V_{OH} Test Circuit

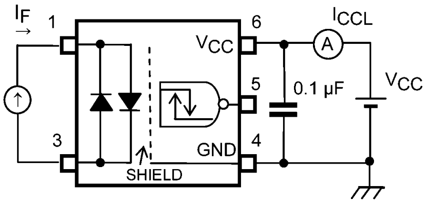


Fig. 12.1.3 I_{CCL} Test Circuit

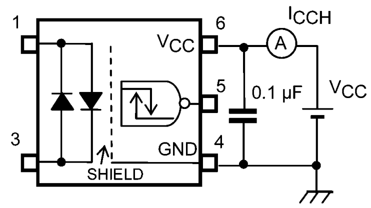


Fig. 12.1.4 I_{CCH} Test Circuit

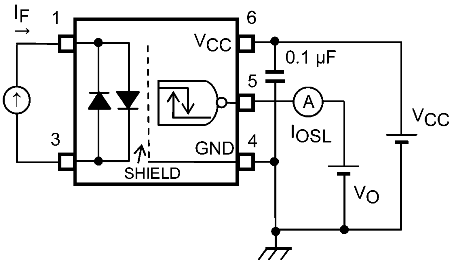


Fig. 12.1.5 I_{OSL} Test Circuit

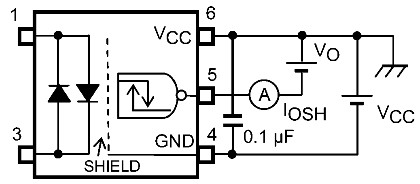
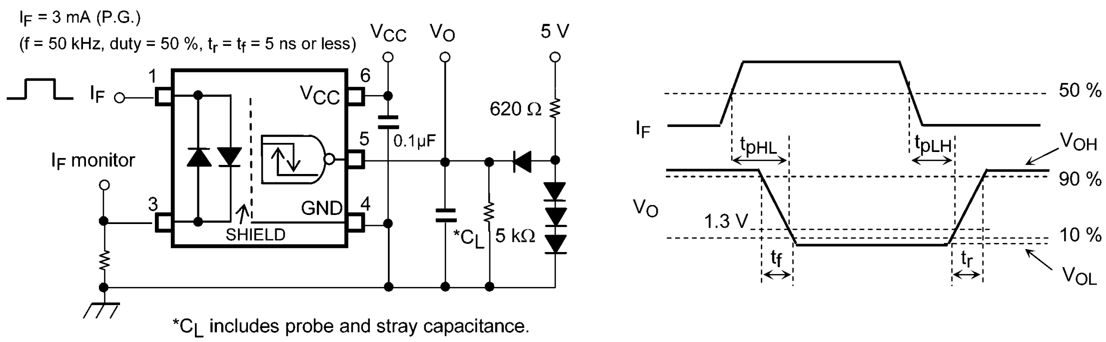


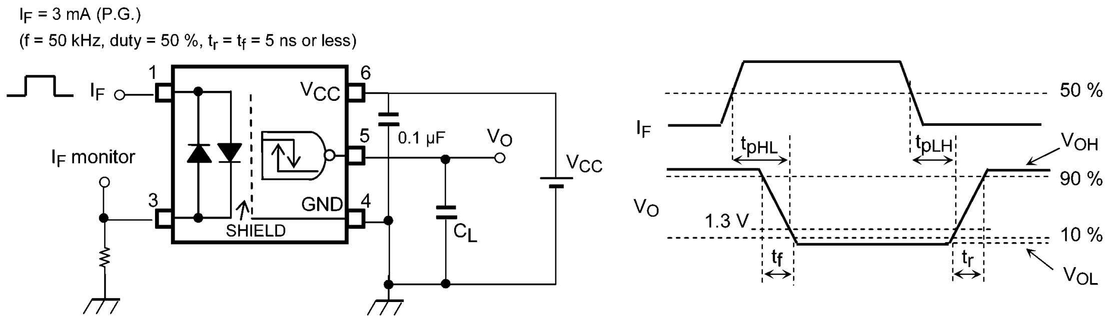
Fig. 12.1.6 I_{OSH} Test Circuit



*C_L includes probe and stray capacitance.

P.G.: Pulse generator

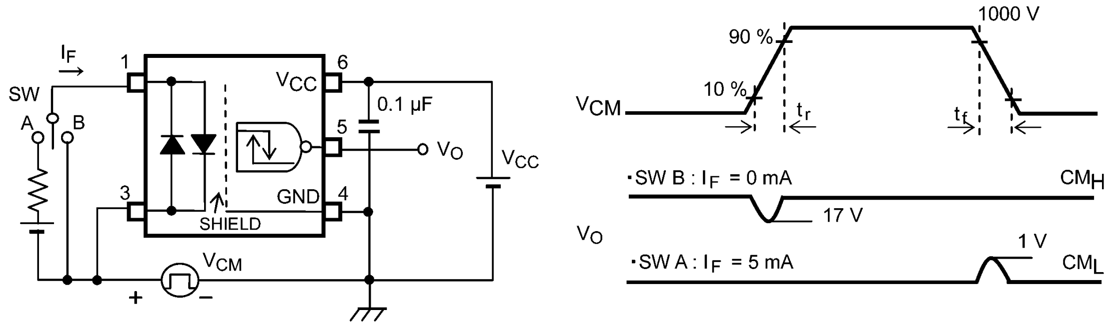
Fig. 12.1.7 Switching Time Test Circuit and Waveform



*C_L includes probe and stray capacitance.

P.G.: Pulse generator

Fig. 12.1.8 Switching Time Test Circuit and Waveform



$$CM_L = \frac{800(V)}{t_r\,(\mu s)} \qquad CM_H = -\frac{800(V)}{t_f\,(\mu s)}$$

Fig. 12.1.9 Common-Mode Transient Immunity Test Circuit and Waveform

12.2. Characteristics Curves (Note)

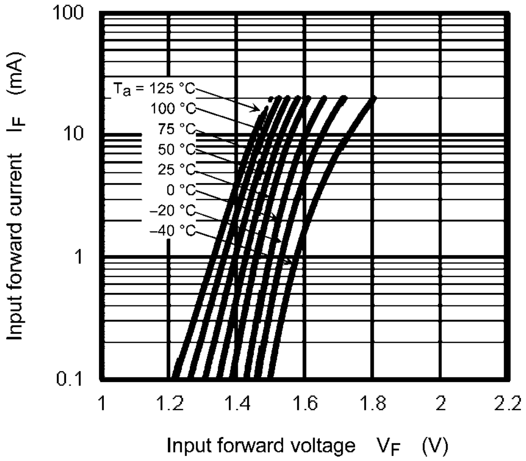


Fig. 12.2.1 I_F - V_F

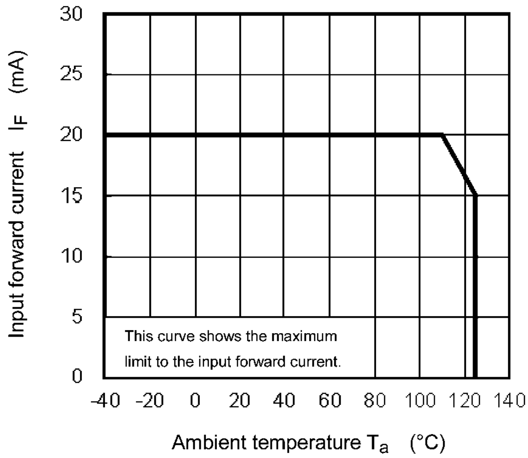


Fig. 12.2.2 I_F - T_a

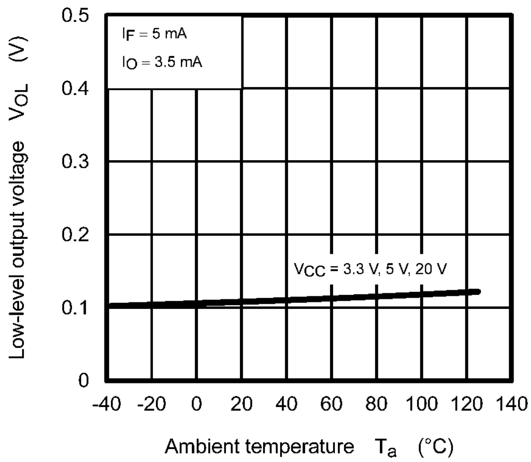


Fig. 12.2.3 V_{OL} - T_a

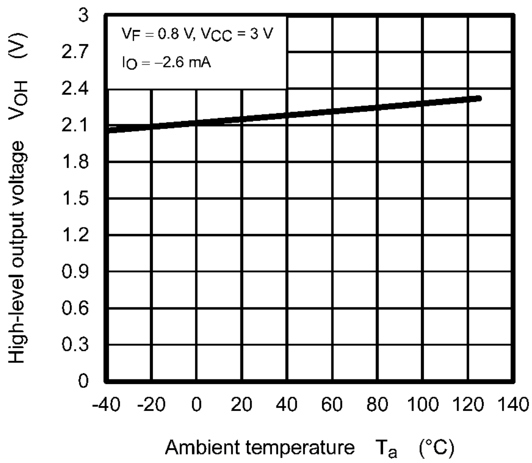


Fig. 12.2.4 V_{OH} - T_a

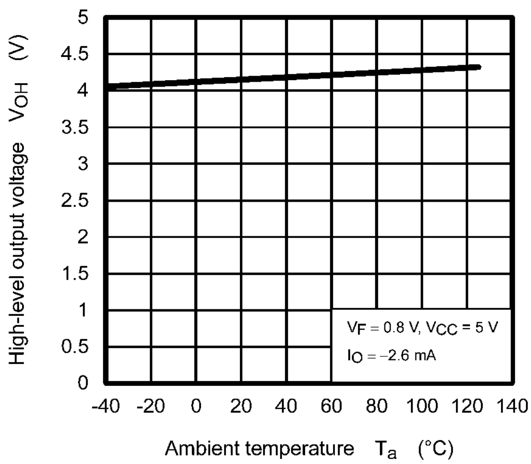


Fig. 12.2.5 V_{OH} - T_a

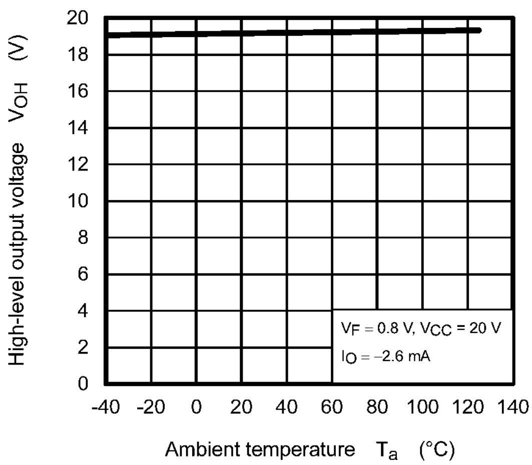


Fig. 12.2.6 V_{OH} - T_a

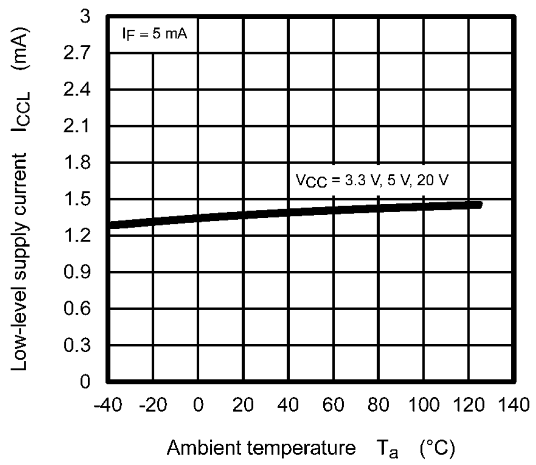


Fig. 12.2.7 I_{CCL} - T_a

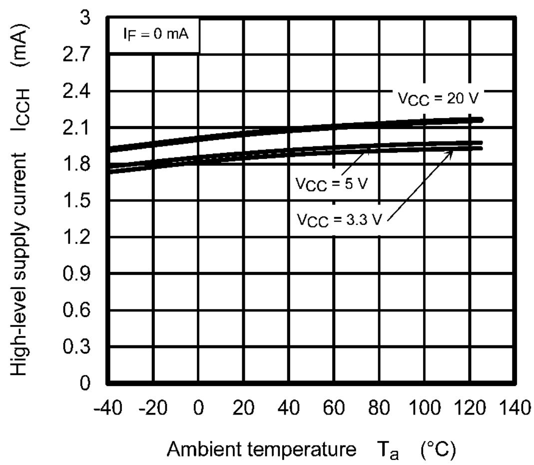


Fig. 12.2.8 I_{CCH} - T_a

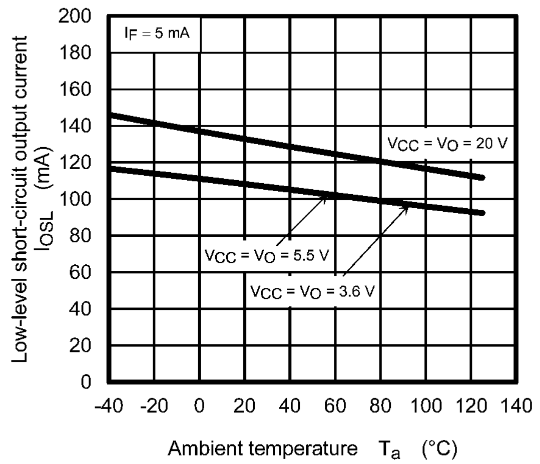


Fig. 12.2.9 I_{OSL} - T_a

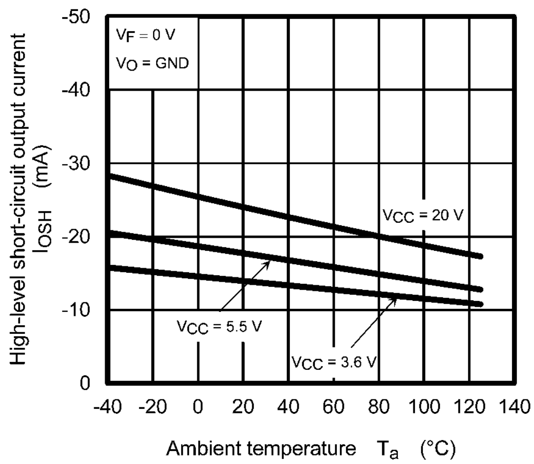


Fig. 12.2.10 I_{OSH} - T_a

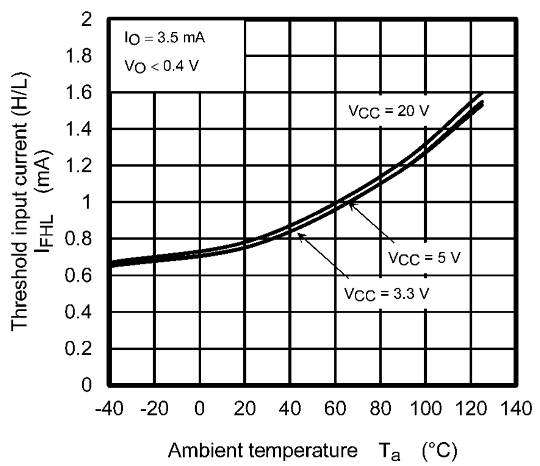


Fig. 12.2.11 I_{FHL} - T_a

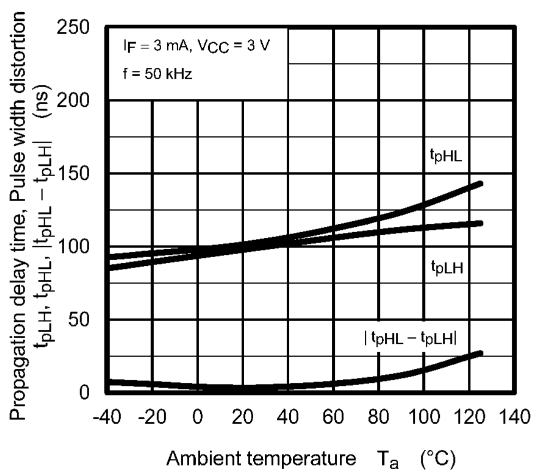


Fig. 12.2.12 t_{pHL}, t_{pLH}, $|t_{pHL}-t_{pLH}|$ - T_a
(Test Circuit Fig. 12.1.7)

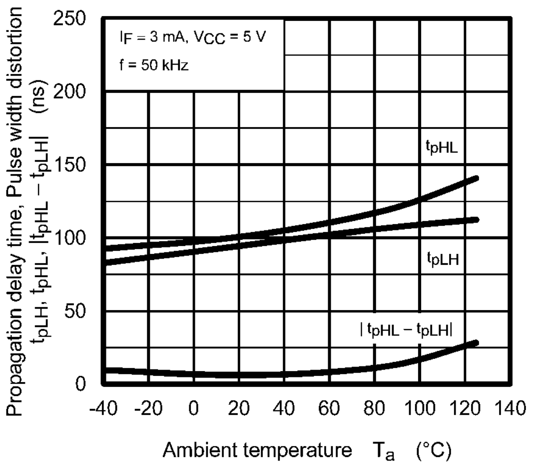


Fig. 12.2.13 t_{pHL}, t_{pLH}, $|t_{pHL}-t_{pLH}|$ - T_a
(Test Circuit Fig. 12.1.7)

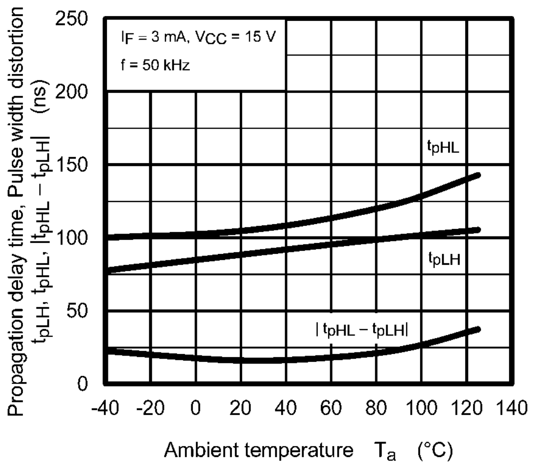


Fig. 12.2.14 t_{pHL}, t_{pLH}, $|t_{pHL}-t_{pLH}|$ - T_a
(Test Circuit Fig. 12.1.7)

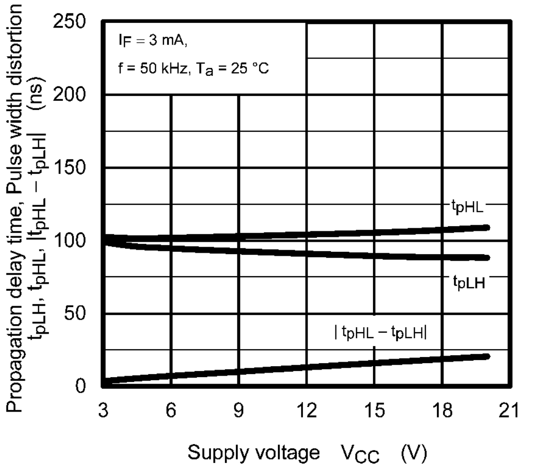


Fig. 12.2.15 t_{pHL}, t_{pLH}, $|t_{pHL}-t_{pLH}|$ - V_{CC}
(Test Circuit Fig. 12.1.7)

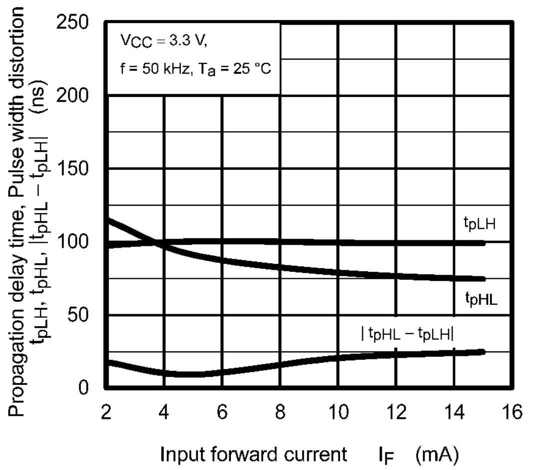


Fig. 12.2.16 t_{pHL}, t_{pLH}, $|t_{pHL}-t_{pLH}|$ - I_F
(Test Circuit Fig. 12.1.7)

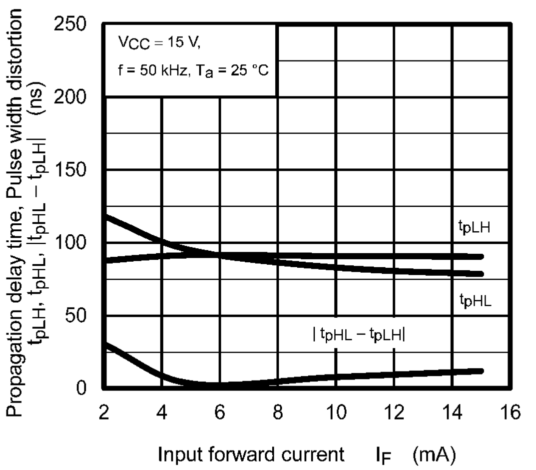


Fig. 12.2.17 t_{pHL}, t_{pLH}, $|t_{pHL}-t_{pLH}|$ - I_F
(Test Circuit Fig. 12.1.7)

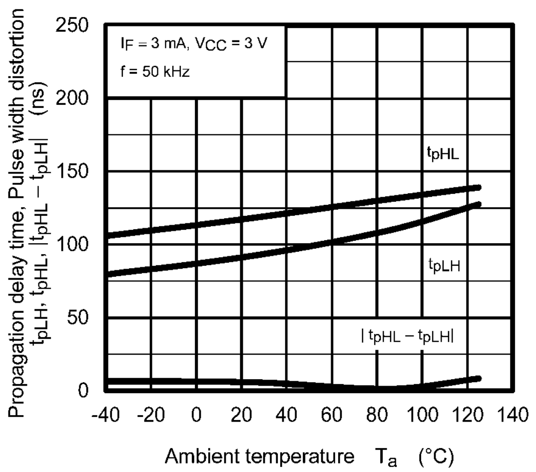


Fig. 12.2.18 t_{pHL}, t_{pLH}, $|t_{pHL}-t_{pLH}|$ - T_a
(Test Circuit Fig. 12.1.8)

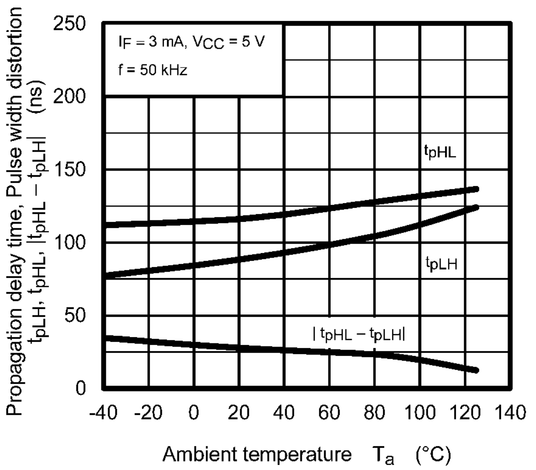


Fig. 12.2.19 t_{pHL}, t_{pLH}, $|t_{pHL}-t_{pLH}|$ - T_a
(Test Circuit Fig. 12.1.8)

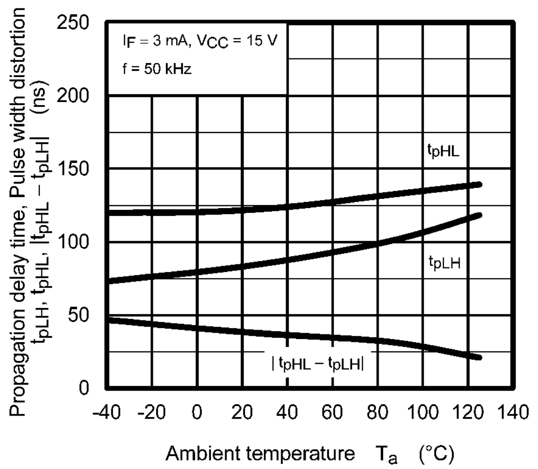


Fig. 12.2.20 t_{pHL}, t_{pLH}, $|t_{pHL}-t_{pLH}|$ - T_a
(Test Circuit Fig. 12.1.8)

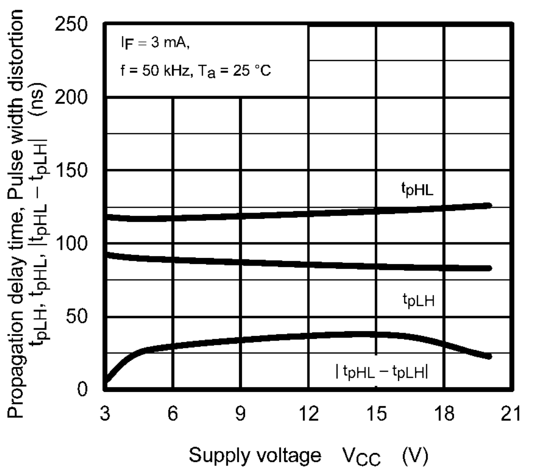


Fig. 12.2.21 t_{pHL}, t_{pLH}, $|t_{pHL}-t_{pLH}|$ - V_{CC}
(Test Circuit Fig. 12.1.8)

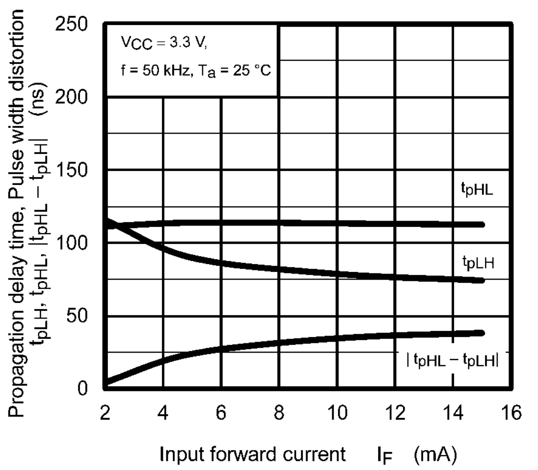


Fig. 12.2.22 t_{pHL}, t_{pLH}, $|t_{pHL}-t_{pLH}|$ - I_F
(Test Circuit Fig. 12.1.8)

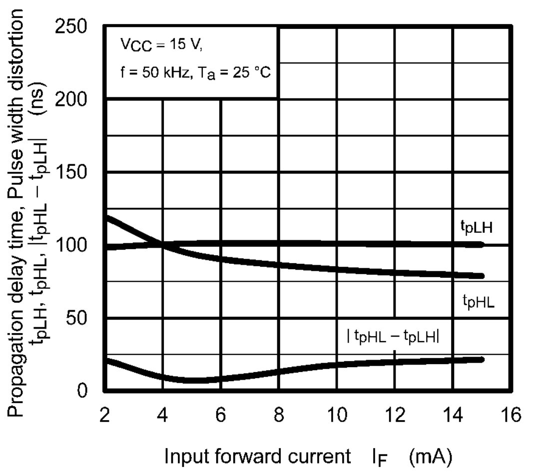


Fig. 12.2.23 t_{pHL}, t_{pLH}, $|t_{pHL}-t_{pLH}|$ - I_F
(Test Circuit Fig. 12.1.8)

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.

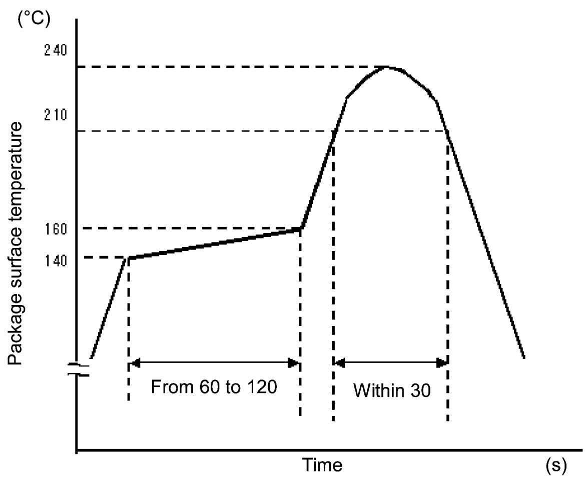


Fig. 13.1.1 An Example of a Temperature Profile When Sn-Pb Eutectic Solder Is Used

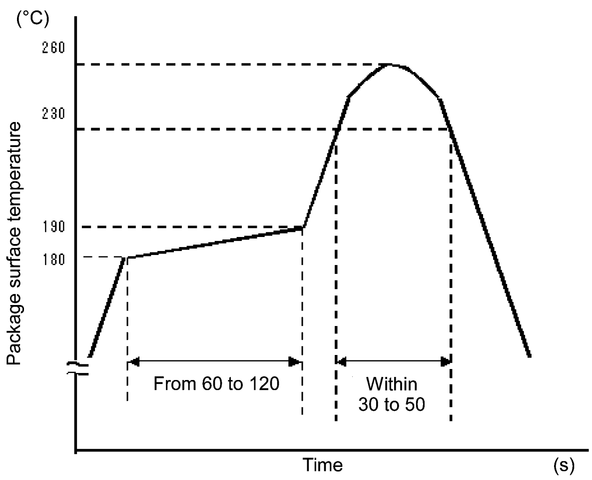


Fig. 13.1.2 An Example of a Temperature Profile When Lead(Pb)-Free Solder Is Used

- 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)

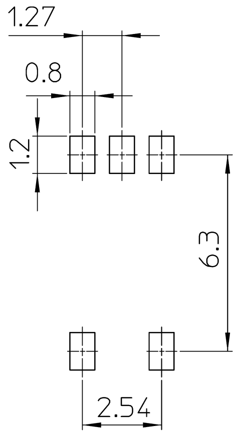


Fig. 14.1 Land Pattern Dimensions for Reference Only (Unit: mm)

15. Marking

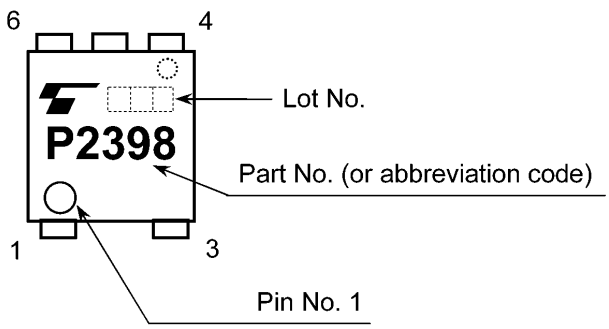


Fig. 15.1 Marking

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

- Part number: TLP2398 (Note)
- The following part naming conventions are used for the devices that have been qualified according to option (V4) of EN60747.
  Example: TLP2398(V4-TPL,E(O
  V4: EN60747 option
  TPL: Tape type
  E: [[G]]/RoHS COMPATIBLE (Note 1)

Note: Use TOSHIBA standard type number for safety standard application.
e.g., TLP2398(V4-TPL,E(O → TLP2398

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.

Description	Symbol	Rating	Unit
Application classification for rated mains voltage ≤ 150 Vrms for rated mains voltage ≤ 300 Vrms		 I-IV I-III	—
Climatic classification		40 / 125 / 21	—
Pollution degree		2	—
Maximum operating insulation voltage	V_{IORM}	707	Vpk
Input to output test voltage, Method A $V_{pr} = 1.5 \times V_{IORM}$, type and sample test t_p = 10 s, partial discharge < 5 pC	V_{pr}	1060	Vpk
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}	1325	Vpk
Highest permissible overvoltage (transient overvoltage, t_{pr} = 60 s)	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	 I_s P_{so} T_s	 250 400 150	 mA mW °C
Insulation resistance, input-output V_{IO} = 500 V, T_a = 25°C V_{IO} = 500 V, T_a = 125°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 Isolation Characteristics

Minimum creepage distance	Cr	5.0 mm
Minimum clearance	Cl	5.0 mm
Minimum insulation thickness	ti	0.4 mm
Comparative 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.

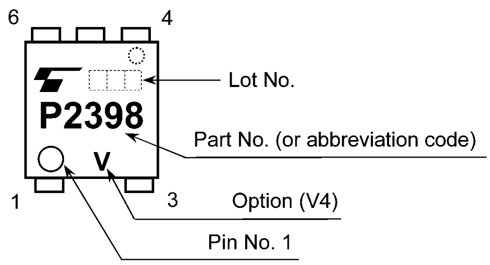


Fig. 16.3 Marking Example (Note)

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

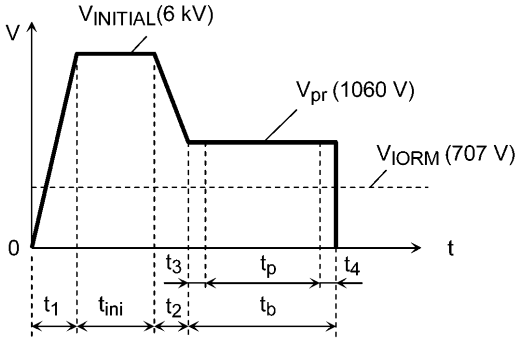


Figure 2 Partial discharge measurement procedure according to EN60747
Non-destructive test for 100% inspection.

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

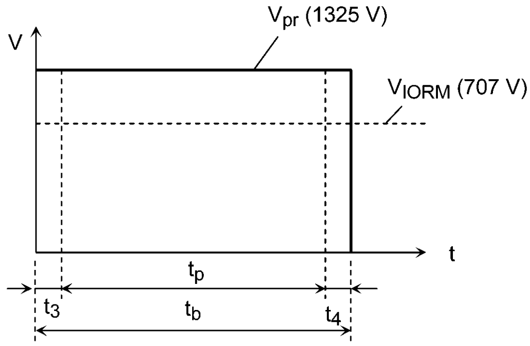


Figure 3 Dependency of maximum safety ratings on ambient temperature

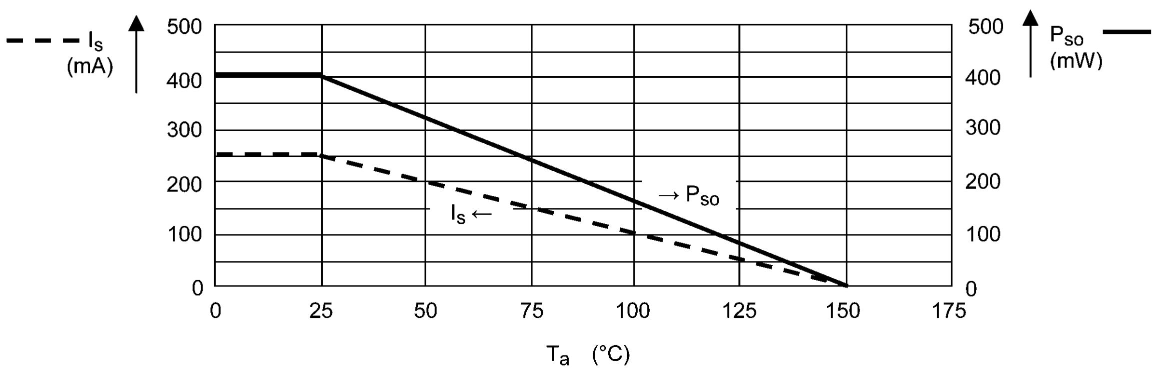
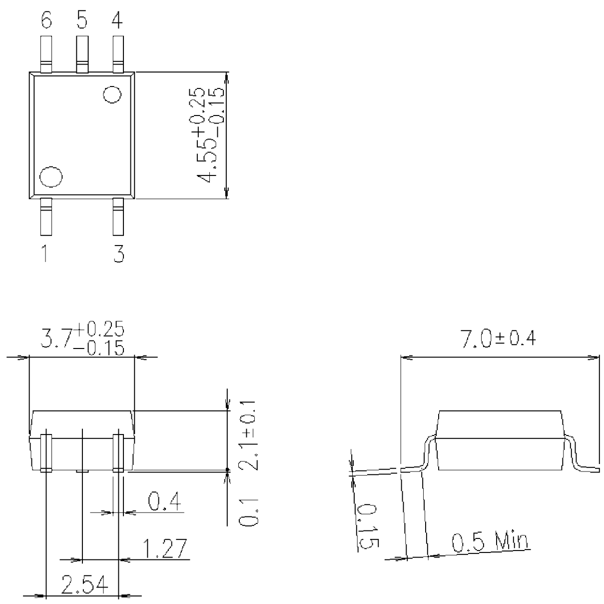


Fig. 16.4 Measurement Procedure

Package Dimensions

Unit: mm



Weight: 0.08 g (typ.)

Package Name(s)
TOSHIBA: 11-4L1S

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