Photocouplers GaAℓAs Infrared LED & Photo IC

TLP2748

1. Applications

- Intelligent Power Module Signal Isolation
- Programmable Logic Controllers (PLCs)
- High-Speed Digital Interfacing for Instrumentation and Control Devices

2. General

The Toshiba TLP2748 consists of high-output GaAℓAs light-emitting diode coupled with a high-gain, high-speed photo detector. It is housed in a thin SO6L package of 2.3 mm(max). The TLP2748 has guaranteed the isolation voltage 5 kVrms and compliant with international safety standards for reinforced insulation.

This product can operate in power supply voltage 4.5 V to 30 V with the maximum operative temperature of 110 ℃. Since TLP2748 has guaranteed 3 mA low supply current (I_{CCL}/I_{CCH}), and 1.6 mA low threshold input current (I_{FHL}), it contributes to energy saving of devices. It can drive directly from a microcomputer for a low input current. The detector has a totem-pole output stage with current sourcing and sinking capabilities. The TLP2748 has an internal Faraday shield that provides a guaranteed common-mode transient immunity of ±30 kV/μs.

The TLP2748 has an inverter output. A buffer output version, the TLP2745, is also available.

3. Features

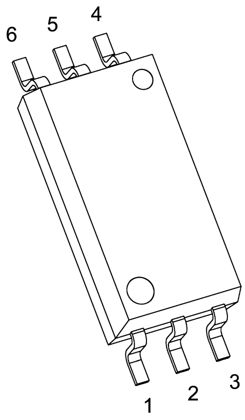
(1) Inverter logic type (Totem pole output)
(2) Package: SO6L
(3) Operating temperature: -40 to 110 ℃
(4) Supply voltage: 4.5 to 30 V
(5) Threshold input current: 1.6 mA (max)
(6) Supply current: 3 mA (max)
(7) Propagation delay time: 120 ns (max)
(8) Pulse width distortion: 40 ns (max)
(9) Common-mode transient immunity: ±30 kV/μs (min)
(10) Isolation voltage: 5000 Vrms (min)
(11) Safety standards
UL-approved: UL1577, File No.E67349
cUL-approved: CSA Component Acceptance Service No.5A File No.E67349
VDE-approved: EN60747-5-5, EN60065, EN60950-1, EN 62368-1 **(Note 1)**

Note 1: When a VDE approved type is needed, please designate the **Option (D4)**.

Start of commercial production
2015-05

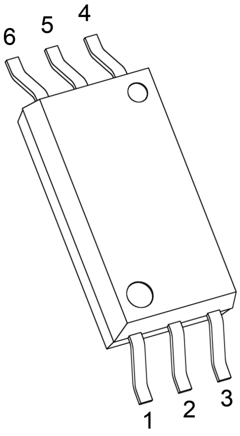
4. Packaging (Note)

TLP2748



11-4N1A

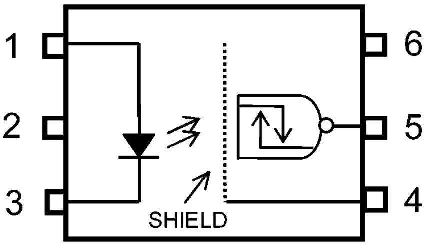
TLP2748(LF4)



11-4N101A

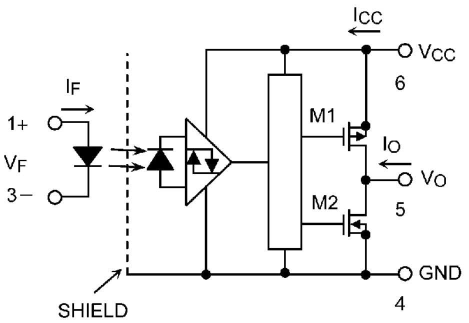
Note: Lead-formed product: (LF4)

5. Pin Assignment



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

6. Internal Circuit (Note)



Note: A 0.1-µF bypass capacitor must be connected between pin 6 and pin 4.

7. Principle of Operation

7.1. Truth Table

Input	LED	Output
H	ON	L
L	OFF	H

7.2. Mechanical Parameters

Characteristics	Min	Unit
Creepage distances	8.0	mm
Clearance distances	8.0	
Internal isolation thickness	0.4	

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

	Characteristics		Symbol	Note	Rating	Unit
LED	Input forward current		I_F		15	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
	Input power dissipation		P_D		40	mW
	Input power dissipation derating	($T_a \geq$ 110 °C)	$\Delta P_D/\Delta T_a$		-0.89	mW/°C
	Input reverse voltage		V_R		5	V
Detector	Output current		I_O		50 / -50	mA
	Output voltage		V_O		-0.5 to 30	V
	Supply voltage		V_{CC}		-0.5 to 30	V
	Output power dissipation		P_O		100	mW
	Output power dissipation derating	($T_a \geq$ 75 °C)	$\Delta P_O/\Delta T_a$		-2	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}		260	°C
	Isolation voltage	(AC, 60 s, R.H. $\leq$ 60 %)	BV_S	(Note 2)	5000	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) $\leq$ 1 μs, 300 pps

Note 2: This device is considered as a two-terminal device: Pins 1, 2 and 3 are shorted together, and pins 4, 5 and 6 are shorted together.

9. Recommended Operating Conditions (Note)

Characteristics	Symbol	Note	Min	Typ.	Max	Unit
Input on-state current	$I_{F(ON)}$	(Note 1)	2	—	10	mA
Input off-state voltage	$V_{F(OFF)}$		0	—	0.8	V
Supply voltage	V_{CC}	(Note 2)	4.5	—	30	
Operating temperature	T_{opr}	(Note 2)	-40	—	110	℃

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: 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.

10. Electrical Characteristics (Note) (Unless otherwise specified, T_a = -40 to 110 ℃, V_{CC} = 4.5 to 30 V)

Characteristics	Symbol	Note	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Input forward voltage	V_F		—	I_F = 3 mA, T_a = 25 ℃	1.35	1.55	1.65	V
Input forward voltage temperature coefficient	$\Delta V_F/\Delta T_a$		—	I_F = 3 mA	—	-2.0	—	mV/℃
Input reverse current	I_R		—	V_R = 5 V, T_a = 25 ℃	—	—	10	μA
Input capacitance	C_t		—	V = 0 V, f = 1 MHz, T_a = 25 ℃	—	20	—	pF
Low-level output voltage	V_{OL}		Fig. 13.1.1	I_F = 3 mA, I_O = 3.5 mA	—	0.026	0.2	V
				I_F = 3 mA, I_O = 6.5 mA	—	0.047	0.4	
High-level output voltage	V_{OH}		Fig. 13.1.2	V_F = 0.8 V, I_O = -3.5 mA	V_{CC}-0.2	V_{CC}-0.03	—	
				V_F = 0.8 V, I_O = -6.5 mA	V_{CC}-0.4	V_{CC}-0.05	—	
Low-level supply current	I_{CCL}		Fig. 13.1.3	I_F = 3 mA, V_{CC} = 5.5 V	—	2.1	3	mA
				I_F = 3 mA, V_{CC} = 30 V	—	2.35	3	
High-level supply current	I_{CCH}		Fig. 13.1.4	V_{CC} = 5.5 V	—	2.1	3	
				V_{CC} = 30 V	—	2.35	3	
Low-level short-circuit output current	I_{OSL}		Fig. 13.1.5	I_F = 3 mA, V_{CC} = V_O = 5.5 V	150	280	—	
				I_F = 3 mA, V_{CC} = V_O = 20 V	160	300	—	
High-level short-circuit output current	I_{OSH}		Fig. 13.1.6	V_{CC} = 5.5 V, V_O = GND	—	-350	-150	
				V_{CC} = 20 V, V_O = GND	—	-350	-160	
Threshold input current (H/L)	I_{FHL}		—	I_O = 3.5 mA, V_O < 0.2 V, V_{CC} = 5 V	—	—	1.6	
Input current hysteresis	I_{HYS}		—	I_O = 3.5 mA	—	0.1	—	
Threshold input voltage (L/H)	V_{FLH}		—	I_O = -6.5 mA, V_O > (V_{CC}-0.4 V)	0.8	—	—	V

Note: All typical values are at V_{CC} = 5 V, T_a = 25 ℃, unless otherwise noted.

11. Isolation Characteristics (Unless otherwise specified, T_a = 25 ℃)

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}	1×10^{14}	—	Ω
Isolation voltage	BV_S	(Note 1)	AC, 60 s	5000	—	—	Vrms

Note 1: This device is considered as a two-terminal device: Pins 1, 2 and 3 are shorted together, and pins 4, 5 and 6 are shorted together.

12. Switching Characteristics (Note) (Unless otherwise specified, T_a = -40 to 110 ℃, V_{CC} = 4.5 to 30 V)

Characteristics	Symbol	Note	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Propagation delay time (H/L)	t_{pHL}	(Note 1)	Fig. 13.1.7	I_F = 0 → 3 mA	35	—	120	ns
Propagation delay time (L/H)	t_{pLH}			I_F = 3 → 0 mA	35	—	120	
Pulse width distortion	$\lvert t_{pHL}-t_{pLH} \rvert$			I_F = 3 mA	—	—	40	
Propagation delay skew (device to device)	t_{psk}	(Note 1), (Note 2)		I_F = 3 mA	-70	—	70	
Fall time	t_f	(Note 1)		I_F = 0 → 3 mA	—	3	30	
Rise time	t_r			I_F = 3 → 0 mA	—	3	30	
Common-mode transient immunity at output high	CM_H		Fig. 13.1.8	I_F = 0 mA, V_{CC} = 30 V, V_{CM} = 1500 V_{p-p}, T_a = 25 ℃	±30	±50	—	kV/μs
Common-mode transient immunity at output low	CM_L			I_F = 3 mA, V_{CC} = 30 V, V_{CM} = 1500 V_{p-p}, T_a = 25 ℃	±30	±50	—	

Note: All typical values are at V_{CC} = 5 V, T_a = 25 ℃, unless otherwise noted.

Note 1: f = 50 kHz, duty = 50 %, input current t_r = t_f = 5 ns, C_L is approximately 15 pF which includes probe and stray wiring capacitance.

Note 2: The propagation delay skew, t_{psk}, is equal to the magnitude of the worst-case difference in t_{pHL} and/or t_{pLH} that will be seen between units at the same given conditions (supply voltage, input current, temperature, etc).

13. Test Circuits and Characteristics Curves

13.1. Test Circuits

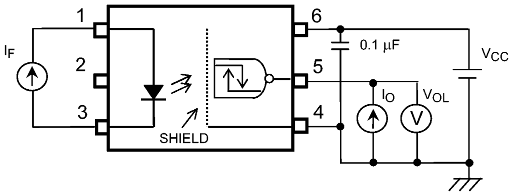


Fig. 13.1.1 V_{OL} Test Circuit

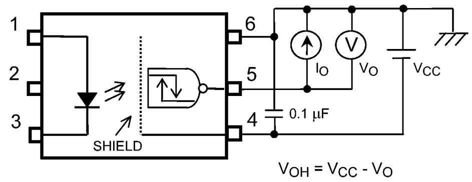


Fig. 13.1.2 V_{OH} Test Circuit

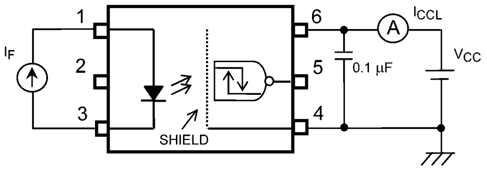


Fig. 13.1.3 I_{CCL} Test Circuit

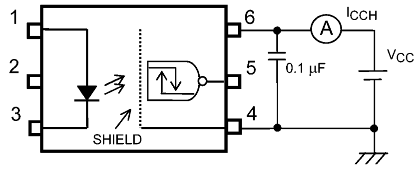


Fig. 13.1.4 I_{CCH} Test Circuit

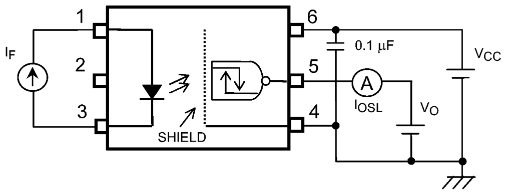


Fig. 13.1.5 I_{OSL} Test Circuit

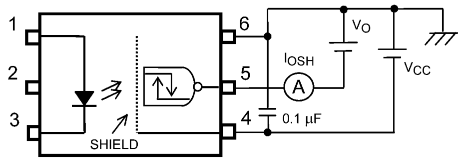
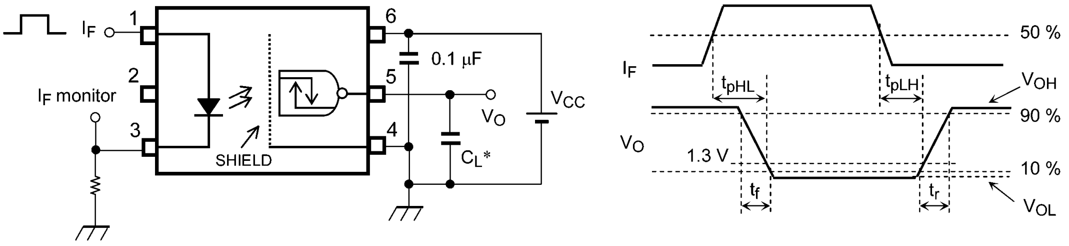


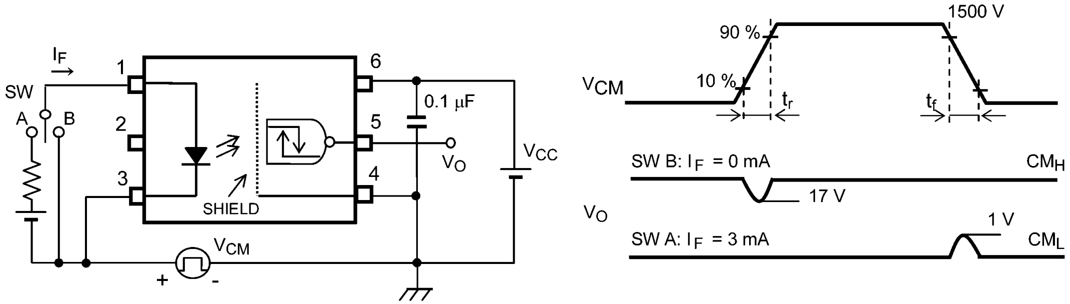
Fig. 13.1.6 I_{OSH} Test Circuit

I_F = 3 mA (P.G.)
(f = 50 kHz, duty = 50 %, $t_r = t_f$ = 5 ns or less)



*C_L includes probe and stray capacitance.
P.G.: Pulse generator

Fig. 13.1.7 Switching Time Test Circuit and Waveform



$$CM_L = -\frac{1200\ (V)}{t_r\ (\mu s)} \quad CM_H = \frac{1200\ (V)}{t_f\ (\mu s)}$$

Fig. 13.1.8 Common-Mode Transient Immunity Test Circuit and Waveform

13.2. Characteristics Curves (Note)

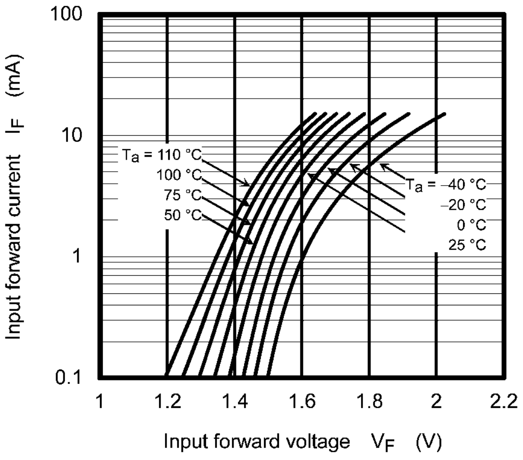


Fig. 13.2.1 I_F - V_F

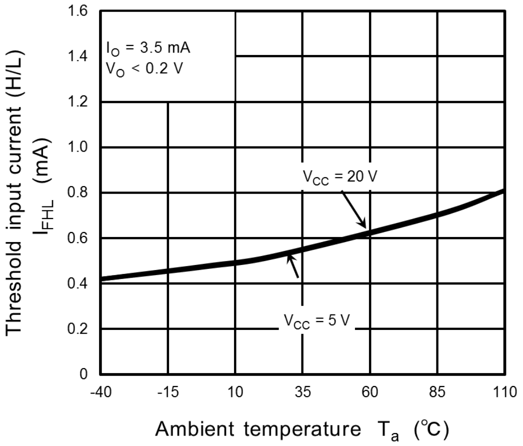


Fig. 13.2.2 I_{FHL} - T_a

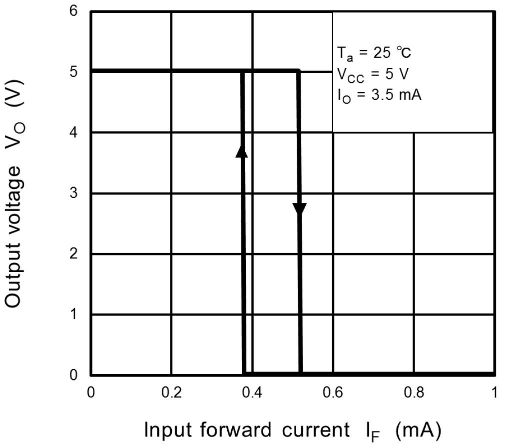


Fig. 13.2.3 V_O - I_F (I_{HYS})

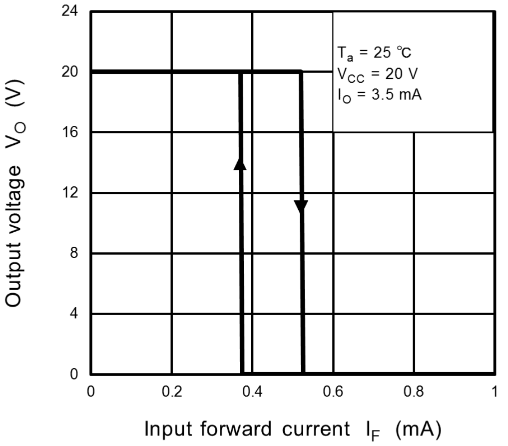


Fig. 13.2.4 V_O - I_F (I_{HYS})

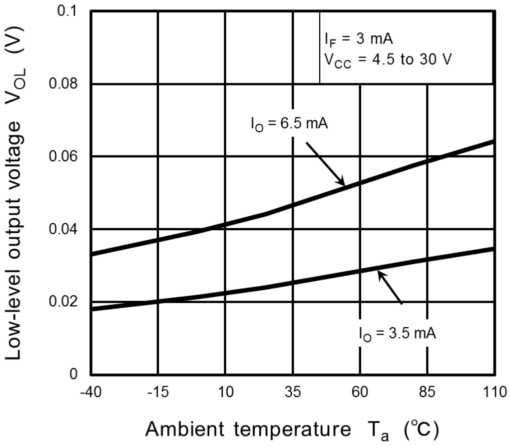


Fig. 13.2.5 V_{OL} - T_a

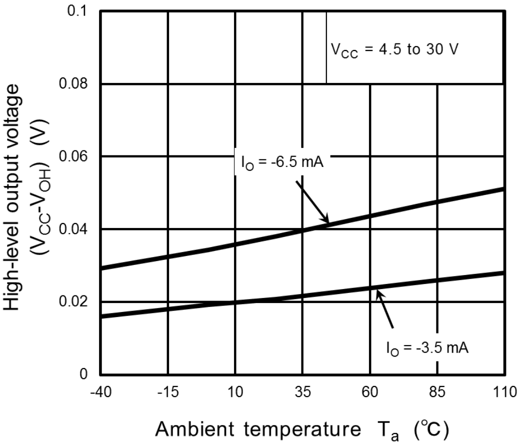


Fig. 13.2.6 (V_{CC}-V_{OH}) - T_a

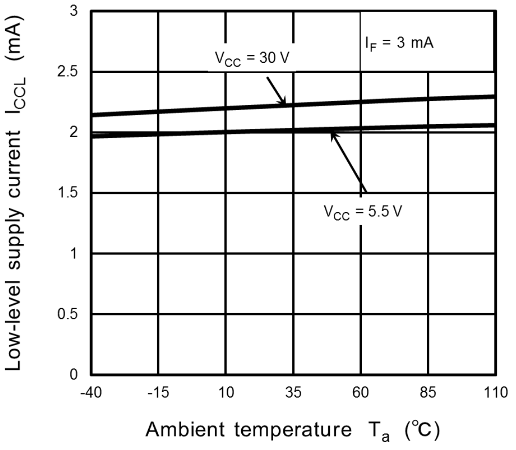


Fig. 13.2.7 I_{CCL} - T_a

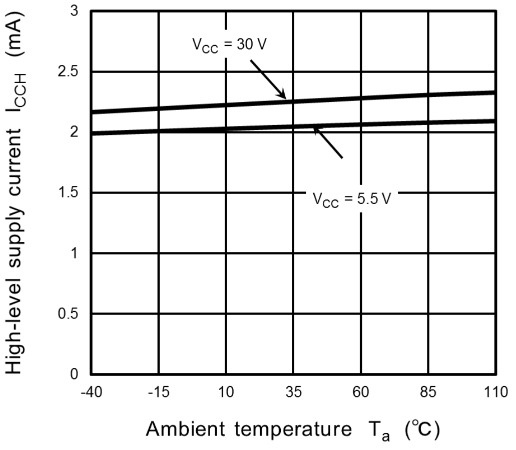


Fig. 13.2.8 I_{CCH} - T_a

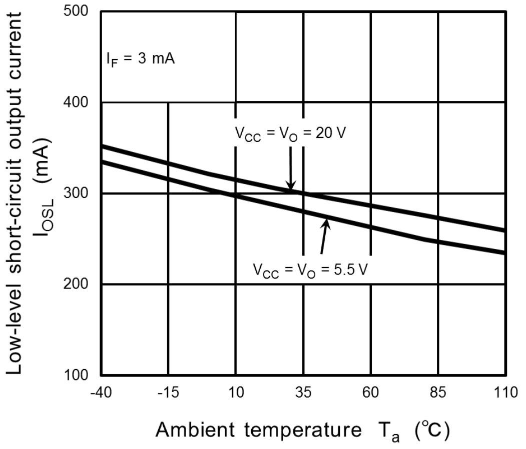


Fig. 13.2.9 I_{OSL} - T_a

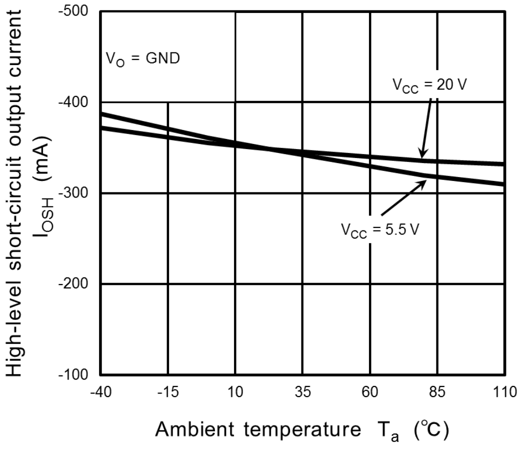


Fig. 13.2.10 I_{OSH} - T_a

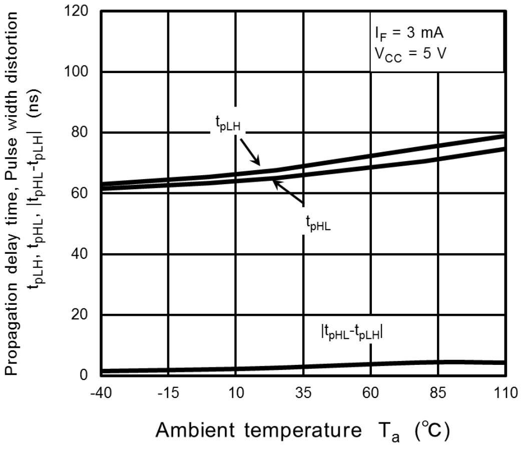


Fig. 13.2.11 t_{pLH}, t_{pHL}, $|t_{pHL} - t_{pLH}|$ - T_a

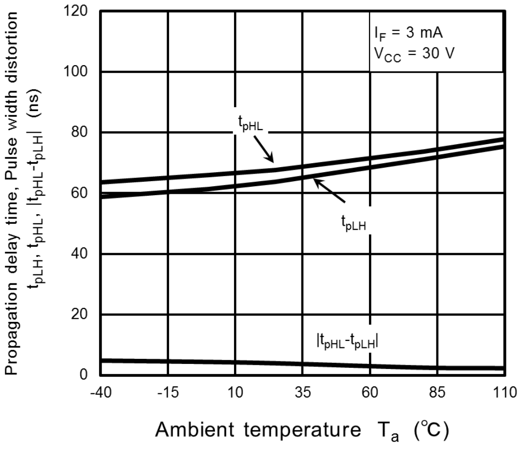


Fig. 13.2.12 t_{pLH}, t_{pHL}, $|t_{pHL} - t_{pLH}|$ - T_a

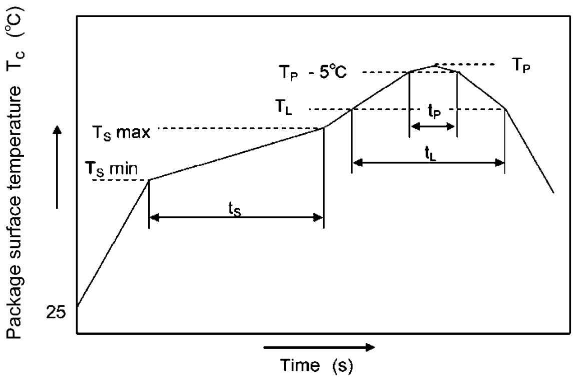
Note: The above characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.

14. Soldering and Storage

14.1. 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

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.

14.2. 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.

15. Land Pattern Dimensions (for reference only)

Unit: mm

TLP2748

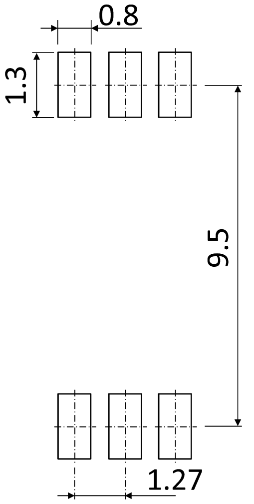


Fig. 15.1 Lead Forming Option (standard)

TLP2748(LF4)

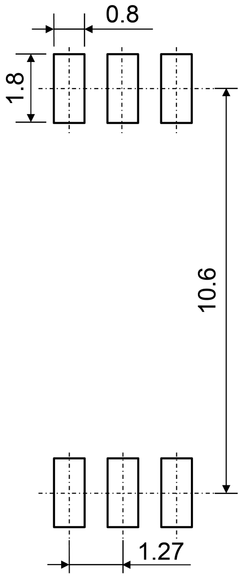
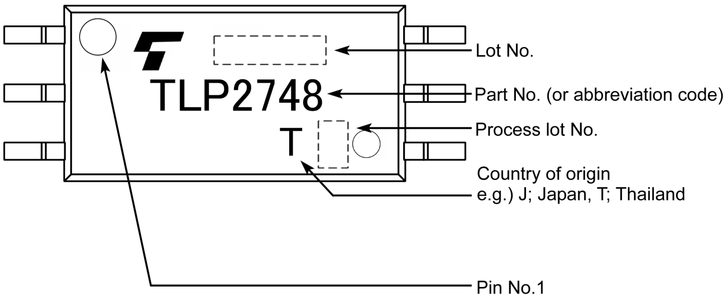


Fig. 15.2 Lead Forming Option (LF4)

16. Marking



17. EN60747-5-5 Option (D4) Specification

- Part number: TLP2748 **(Note 1)**
- The following part naming conventions are used for the devices that have been qualified according to option (D4) of EN60747.

Example: TLP2748(D4-TP,E

D4: EN60747 option
TP: Tape type
E: [[G]]/RoHS COMPATIBLE **(Note 2)**

Note 1: Use TOSHIBA standard type number for safety standard application.
e.g., TLP2748(D4-TP,E → TLP2748

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 ≤ 600 Vrms for rated mains voltage ≤ 1000 Vrms		 I-IV I-III	—
Climatic classification		55 / 125 / 21	—
Pollution degree		2	—
Maximum operating insulation voltage	V_{IORM}	1230	Vpeak
Input to output test voltage, Method A $V_{pr} = 1.6 \times V_{IORM}$, type and sample test t_p = 10 s, partial discharge < 5 pC	V_{pr}	1970	Vpeak
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}	2310	Vpeak
Highest permissible overvoltage (transient overvoltage, t_{pr} = 60 s)	V_{TR}	8000	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. 17.1 EN60747 Insulation Characteristics

Minimum creepage distance	Cr	8.0 mm
Minimum clearance	Cl	8.0 mm
Minimum insulation thickness	ti	0.4 mm
Comparative tracking index	CTI	175

Fig. 17.2 Insulation Related Specifications (Note)

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. 17.3 Marking on Packing for EN60747

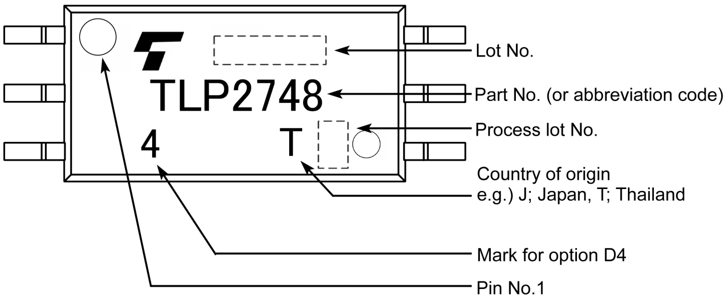


Fig. 17.4 Marking Example (Note)

Note: The above marking is applied to the photocouplers that have been qualified according to option (D4) 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

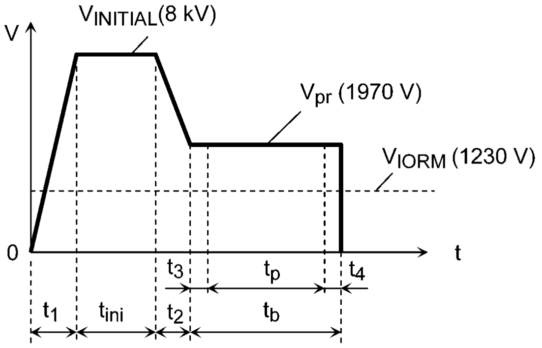


Figure 2 Partial discharge measurement procedure according to EN60747
Non-destructive test for 100 % inspection.

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

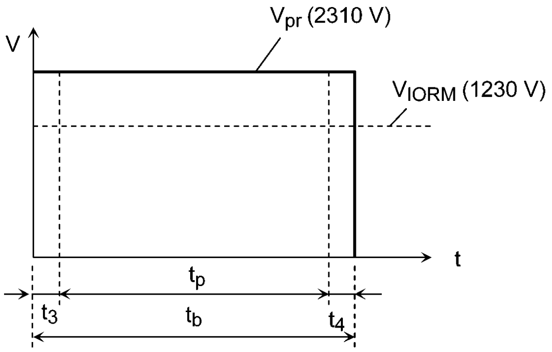


Figure 3 Dependency of maximum safety ratings on ambient temperature

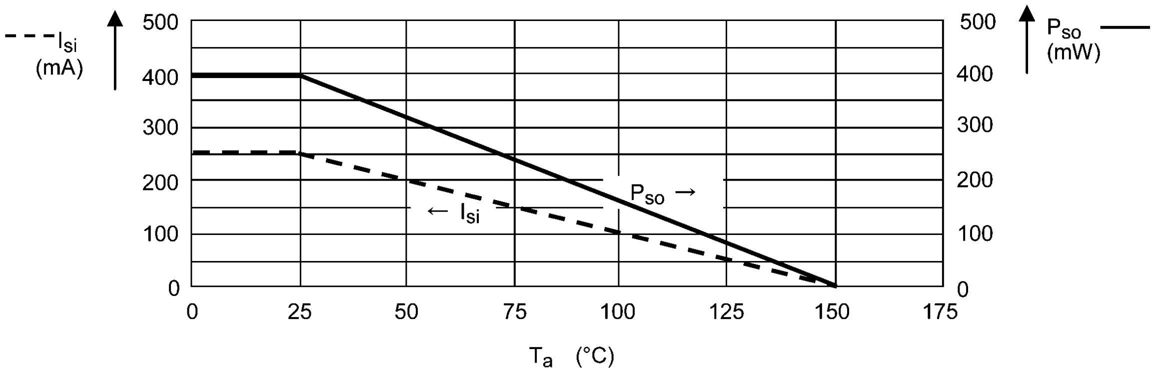


Fig. 17.5 Measurement Procedure

18. Specifications for Embossed-Tape Packing

18.1. Applicable Package

Package Name	Product Type
SO6L / SO6L(LF4)	Long creepage mini flat coupler

18.2. Product Naming Conventions

Type of package used for shipment is denoted by a symbol suffix after a part number. The method of classification is as below.

Example) TLP2748(TP,E

Part number: TLP2748
Tape type: TP
[[G]]/RoHS COMPATIBLE: E **(Note 1)**

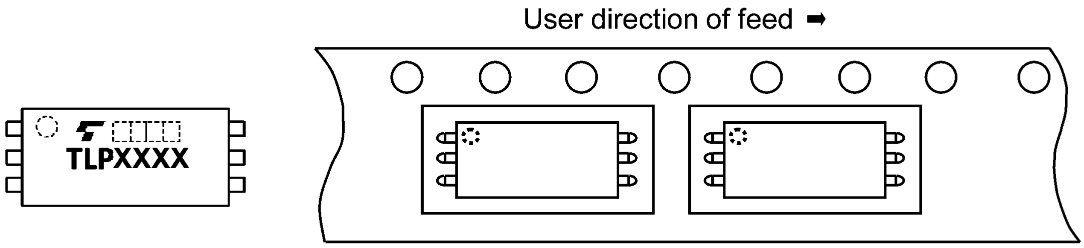
Note 1: Please contact your Toshiba sales representative for details on environmental information such as the product's RoHS compatibility.
RoHS is the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

18.3. Tape Dimensions Specification

Tape Type	Division	Packing Amount (A unit per reel)
TP / TP4	—	1500

18.3.1. Orientation of Device in Relation to Direction of Feed

Device orientation in the carrier cavities as shown in the following figure.



Orientation of Device in Relation to Direction of Tape Movement

18.3.2. Empty Device Recesses

Characteristics	Standard	Remarks
Occurrences of 2 or more successive empty cavities	0 device	Within any given 40-mm section of tape, not including leader and trailer
Single empty cavity	6 devices (max) per reel	Not including leader and trailer

18.3.3. Tape Leader and Trailer

The start of the tape has 14 or more empty holes. The end of the tape has 34 or more empty holes and a cover tape of 30 mm or longer.

18.3.4. Tape Dimensions

Tape material: Plastic (for protection against static electricity)

Unit: mm

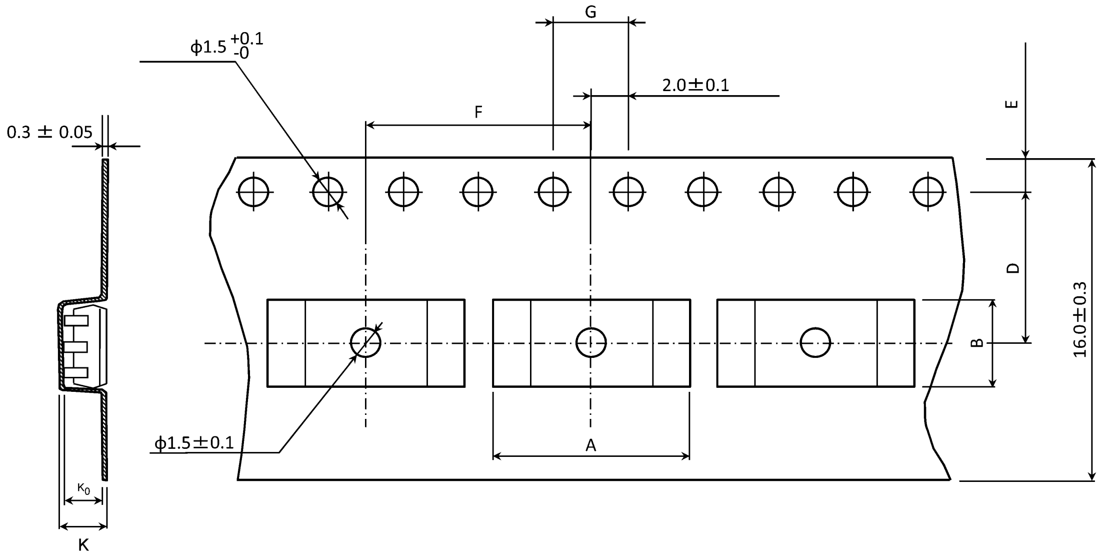


Table Tape Dimensions (unit: mm, tolerance: ±0.1)

Symbol	Dimension (standard)	Dimension (LF4)	Remark
A	10.4	11.55	—
B	4.24	4.24	—
D	7.5	7.5	Center line of embossed cavity and sprocket hole
E	1.75	1.75	Distance between tape edge and sprocket hole center
F	12.0	16.0	Cumulative error +0.1/-0.3 per 10 empty cavities holes
G	4.0	4.0	Cumulative error +0.1/-0.3 per 10 sprocket holes
K	2.7	2.8	—
K_0	2.4	2.4	Internal space

18.3.5. Reel Specification

Material: Plastic (for protection against static electricity)

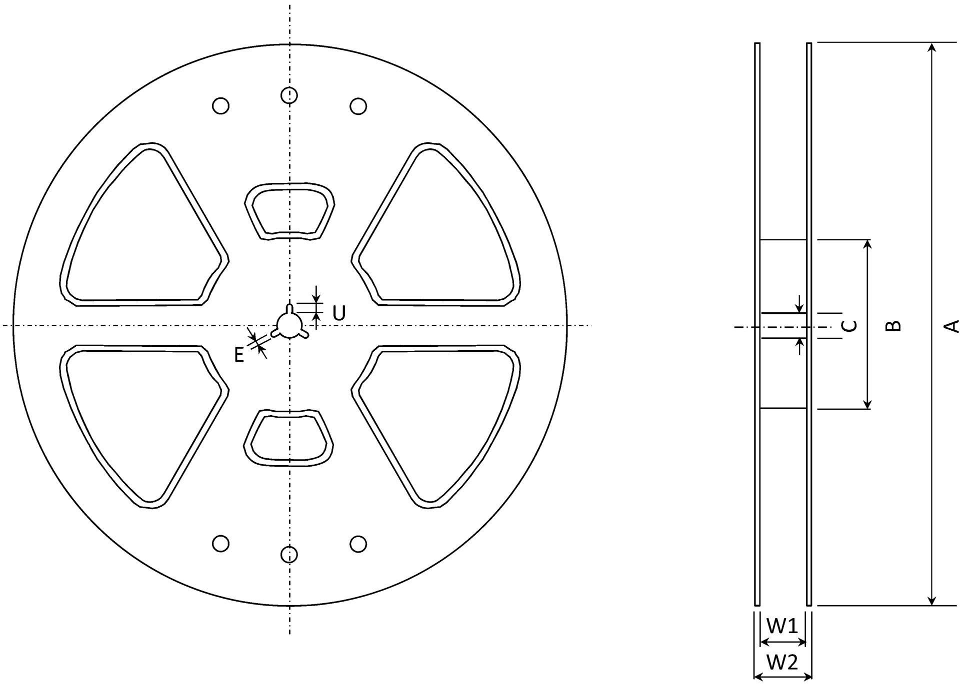
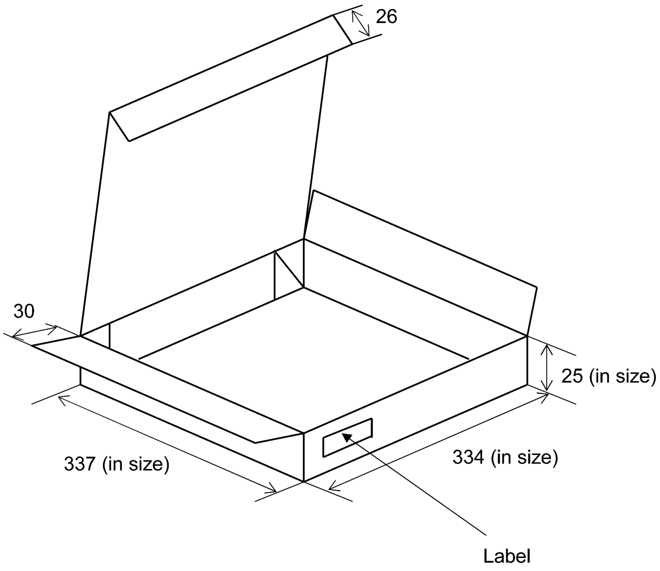


Table Reel Dimensions (unit: mm)

Symbol	Dimension
A	ϕ330 ± 2.0
B	ϕ100 ± 1.0
C	ϕ13 ± 0.5
E	2.0 ± 0.5
U	4.0 ± 0.5
W1	17.4 ± 1.0
W2	21.4 ± 1.0

18.4. Packing (Note)



1 reel/carton (unit: mm)

Note: Taping reel diameter: ϕ330 mm

18.5. Label Format

(1) Carton: The label provides the part number, quantity, lot number, the Toshiba logo, etc.

(2) Reel: The label provides the part number, the taping name, quantity, lot number, etc.

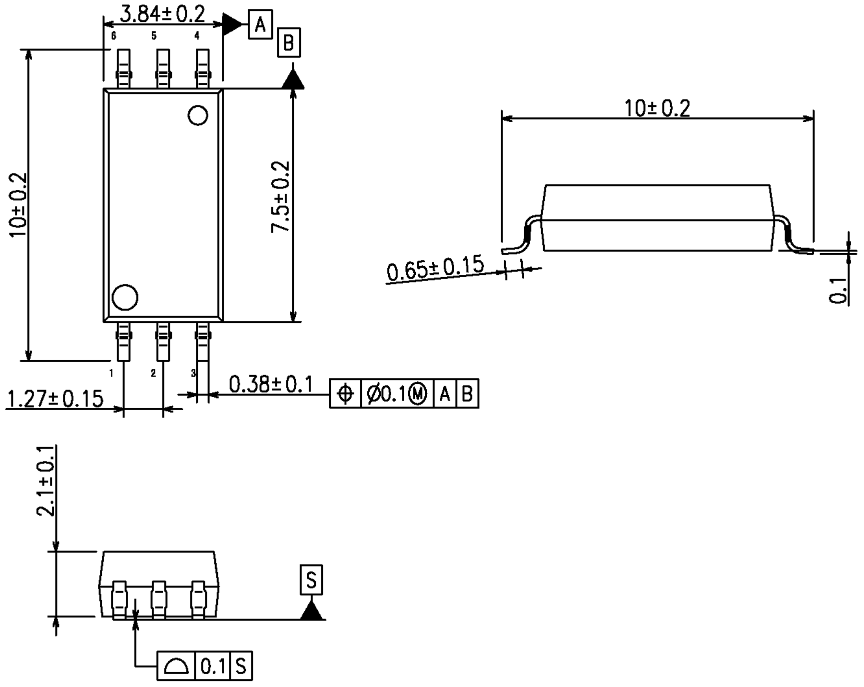
19. Ordering Information (Example of Item Name)

Item Name	Packaging	VDE Option	Packing (MOQ)
TLP2748(E			Magazine (125 pcs)
TLP2748(TP,E			Tape and reel (1500 pcs)
TLP2748(D4,E		EN60747-5-5	Magazine (125 pcs)
TLP2748(D4-TP,E		EN60747-5-5	Tape and reel (1500 pcs)
TLP2748(LF4,E	LF4, Wide forming		Magazine (125 pcs)
TLP2748(TP4,E	LF4, Wide forming		Tape and reel (1500 pcs)
TLP2748(D4-LF4,E	LF4, Wide forming	EN60747-5-5	Magazine (125 pcs)
TLP2748(D4-TP4,E	LF4, Wide forming	EN60747-5-5	Tape and reel (1500 pcs)

Package Dimensions

Unit: mm

TLP2748



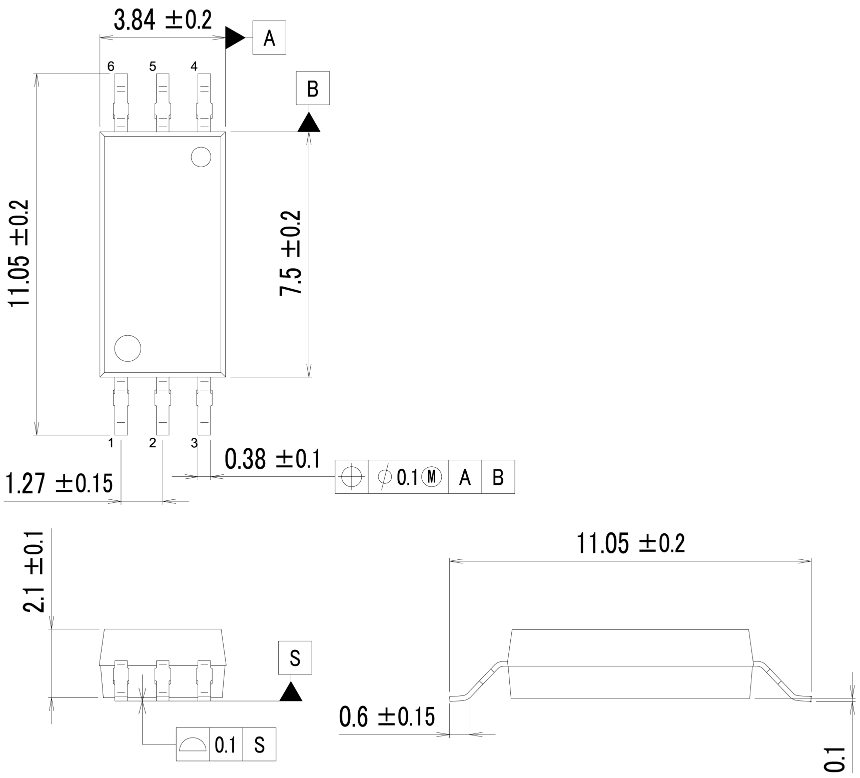
Weight: 0.126 g (typ.)

Package Name(s)
TOSHIBA: 11-4N1A

Package Dimensions

Unit: mm

TLP2748(LF4)



Weight: 0.126 g (typ.)

Package Name(s)
TOSHIBA: 11-4N101A