Photocouplers Optically Isolation Amplifiers

TLP7820

1. Applications

- Motor phase and rail current sensing
- Power inverter current and voltage sensing

2. General

The TLP7820 of isolation amplifiers is designed for current sensing in electronic motor drives. In a typical implementation, motor currents flow through an external resistor and the resulting analog voltage drop is sensed by the TLP7820.

3. Features

(1) Gain accuracy: ±0.5 % (Gain rank B)
(2) Gain drift: 0.00012 V/V/℃ (typ.)
(3) Nonlinearity (V_{IN} = ±200 mV): 0.02 % (typ.)
(4) Input offset voltage: 0.9 mV (typ.)
(5) V_{OUT} bandwidth (-3 dB): 230 kHz (typ.)
(6) Operating temperature range: -40 to 105 ℃
(7) Common-mode transient immunity: 15 kV/μs (min)
(8) 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)**
CQC-approved: GB4943.1, GB8898 Japan Factory

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

Start of commercial production
2015-09

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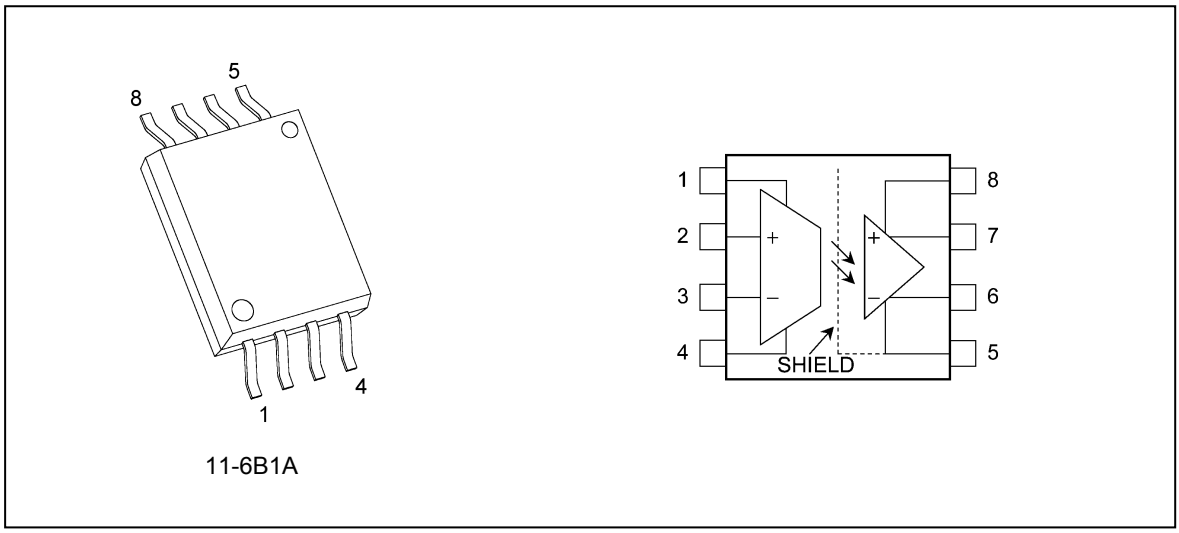
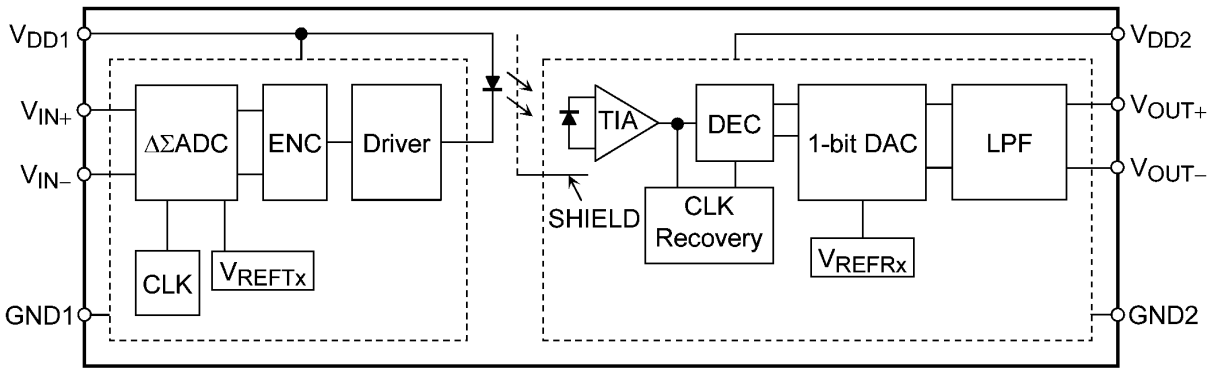
4. Packaging and Pin Assignment



4.1. Pin Assignment

Pin No.	Symbol	Description
1	V_{DD1}	Input side supply voltage
2	V_{IN+}	Positive input
3	V_{IN-}	Negative input
4	GND1	Input side ground
5	GND2	Output side ground
6	V_{OUT-}	Negative output
7	V_{OUT+}	Positive output
8	V_{DD2}	Output side supply voltage

5. Internal Circuit (Note)



Note: A 0.1-μF bypass capacitor must be connected between 1 and 4 pins and between 5 and 8 pins.

6. Principle of Operation

6.1. Mechanical Parameters

Characteristics	Size	Unit
Height	2.3 (max)	mm
Creepage distances	8.0 (min)	
Clearance	8.0 (min)	
Internal isolation thickness	0.4 (min)	

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

Characteristics		Symbol	Note	Rating	Unit
Supply Voltages		V_{DD1}, V_{DD2}		-0.5 to 6	V
Steady-state input voltages		V_{IN+}, V_{IN-}		-0.5 to V_{DD1} + 0.5	V
Two-second transient input voltages		V_{IN+}, V_{IN-}		-6 to V_{DD1} + 0.5	V
Input power dissipation		P_D		72	mW
Input power dissipation derating	($T_a \geq$ 110.6 °C)	$\Delta P_D/\Delta T_a$		-5.0	mW/°C
Output voltages		V_{OUT+}, V_{OUT-}		-0.5 to V_{DD2} + 0.5	V
Output power dissipation		P_O		60	mW
Output power dissipation derating	($T_a \geq$ 113.0 °C)	$\Delta P_O/\Delta T_a$		-5.0	mW/°C
Operating temperature		T_{opr}		-40 to 105	°C
Storage temperature		T_{stg}		-55 to 125	°C
Lead soldering temperature	(10 s)	T_{sol}	(Note 1)	260	°C
Isolation voltage	(AC, 60 s, R.H. ≤ 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: Ceramic capacitors (0.1 μF) should be connected between 1 and 4 pins and between 5 and 8 pins to stabilize the operation. Otherwise, this photocoupler may not switch properly. The bypass capacitors should be placed as close as possible to each pin.

Note 1: ≥ 2 mm below seating plane.

Note 2: This device is considered as a two-terminal device: Pins 1, 2, 3 and 4 are shorted together, and pins 5, 6, 7 and 8 are shorted together.

8. Recommended Operating Conditions (Note)

Characteristics	Symbol	Note	Min	Typ.	Max	Unit
Input side supply voltage	V_{DD1}		4.5	5	5.5	V
Output side supply voltage	V_{DD2}		3	—	5.5	
Analog input voltage	V_{IN+}, V_{IN-}	(Note 1), (Note 2)	-200	—	200	mV
Ambient temperature	T_a		-40	—	105	°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 1: Full-Scale Differential Voltage Input Range(FSR) = ±300 mV (typ.)

Note 2: When either V_{IN+} or V_{IN-} or both are equal to or greater than V_{DD1} - 2 V (e.g., if V_{DD1} = 5 V, when V_{IN+} and/or V_{IN-} are equal to or greater than 5 V - 2 V = 3 V), isolation amplifiers go into one of the test modes. Do not raise either V_{IN+} or V_{IN-} above this voltage to keep the device in functional mode.

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9. Electrical Characteristics

9.1. DC Characteristics (Unless otherwise specified, T_a = -40 to 105 °C, V_{DD1} = 4.5 to 5.5 V, V_{DD2} = 3 to 5.5 V, V_{IN+} = -200 to 200 mV, V_{IN-} = 0 V)

Characteristics	Symbol	Note	Test Condition	Min	Typ.	Max	Unit
Input offset voltage	V_{OS}		T_a = 25 °C	-0.6	0.9	2.4	mV
Input offset voltage drift vs ambient temperature	$\lvert dV_{OS}/dT_a \rvert$			—	2	6	μV/°C
Input offset voltage drift vs input side supply voltage	$\lvert dV_{OS}/dV_{DD1} \rvert$			—	120	—	μV/V
Gain (Rank B)	G_0	(Note 1)	T_a = 25 °C	8.16	8.2	8.24	V/V
Gain (Rank A)	G_1	(Note 1)	T_a = 25 °C	8.12	8.2	8.28	
Gain (None)	G_3	(Note 1)	T_a = 25 °C	7.95	8.2	8.44	
Gain drift vs ambient temperature	$\lvert dG/dT_a \rvert$			—	0.00012	—	V/V/°C
V_{OUT} non-linearity (±200 mV)	NL_{200}	(Note 2)	V_{IN+} = -200 to 200 mV, T_a = 25 °C	—	0.02	0.13	%
V_{OUT} non-linearity (±200 mV) drift vs ambient temperature	$\lvert dNL_{200}/dT_a \rvert$			—	0.00007	—	%/°C
V_{OUT} non-linearity (±100 mV)	NL_{100}	(Note 2)	V_{IN+} = -100 to 100 mV, T_a = 25 °C	—	0.015	0.06	%
High-level output voltage	V_{OH}		V_{IN+} = 400 mV, T_a = 25 °C	—	2.497	—	V
Low-level output voltage	V_{OL}		V_{IN+} = -400 mV, T_a = 25 °C	—	0.0009	—	V
Input common-mode rejection ratio	$CMRR_{IN}$			—	80	—	dB
Equivalent input resistance	R_{IN}			—	80	—	kΩ
Input bias current	I_{IN+}		V_{IN+} = 0 V, T_a = 25 °C	-1	-0.055	—	μA
Input side supply current (V_{DD1})	I_{DD1}		V_{IN+} = 0 V	—	8.6	12	mA
Output side supply current (V_{DD2})	I_{DD2}		V_{IN+} = 0 V	—	6.2	10	mA
V_{OUT} output resistance	R_{OUT}		V_{OUT+} or V_{OUT-}	—	21	—	Ω

Note 1: See section 9.1.1. for gain rank values.

Note 2: The slope of the optimum line is derived by the method of least squares between differential input voltage (V_{IN+} - V_{IN-}) and differential output voltage (V_{OUT+} - V_{OUT-}). Nonlinearity is defined as a fraction of the half of the peak-to-peak value of differential output voltage deviation divided by the full-scale differential output voltage (OVR).

9.1.1. Gain Rank (Note) (Unless otherwise specified, T_a = 25 °C)

Rank	Gain Rank Marking	Gain (Min)	Gain (Typ.)	Gain (Max)	Unit
None (±3 %)	Blank, A, B	7.95	8.2	8.44	V/V
Rank A (±1 %)	A, B	8.12	8.2	8.28	
Rank B (±0.5 %)	B	8.16	8.2	8.24	

Note: The gain is defined as the slope of the optimum line derived by the method of least squares between differential input voltage (V_{IN+} - V_{IN-}) and differential output voltage (V_{OUT+} - V_{OUT-}) in the recommended voltage range.

Note: Specify both the part number and a rank in this format when ordering.
Example: Rank B: TLP7820(B

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10. AC Characteristics (Note) (Unless otherwise specified, T_a = -40 to 105 °C, V_{DD1} = 4.5 to 5.5 V, V_{DD2} = 3 to 5.5 V)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
V_{OUT} bandwidth (-3 dB)	f_{-3dB}	V_{IN+} = 400 mV_{p-p} , sine wave	140	230	—	kHz
V_{IN} to V_{OUT} propagation delay time (10 %-10 %)	t_{pD10}	V_{IN+} = 0 to 200 mV/μs step C_L = 15 pF	—	1.9	2.3	μs
V_{IN} to V_{OUT} propagation delay time (50 %-50 %)	t_{pD50}		—	2.3	2.6	
V_{IN} to V_{OUT} propagation delay time (90 %-90 %)	t_{pD90}		—	2.8	3.3	
V_{OUT} rise time	t_r		—	1.7	—	
V_{OUT} fall time	t_f		—	1.7	—	
Common-mode transient immunity	CMTI	V_{CM} = 1 kV, T_a = 25 °C	15	20	—	kV/μs

Note: All typical values are at T_a = 25 °C.
C_L is approximately 15 pF which includes probe and stray wiring capacitance.

11. 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	—	1.0	—	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	5000	—	—	Vrms

Note 1: This device is considered as a two-terminal device: Pins 1, 2, 3 and 4 are shorted together, and pins 5, 6, 7 and 8 are shorted together.

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12. Characteristics Curves (Note)

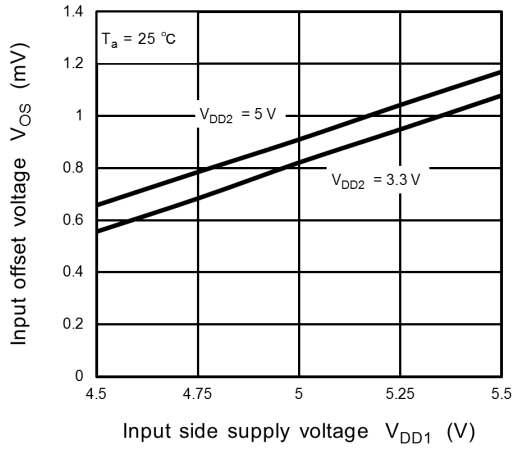

Fig. 12.1 V_{OS} - V_{DD1}

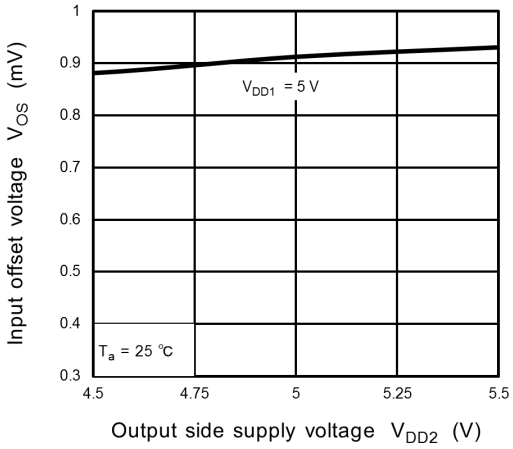

Fig. 12.2 V_{OS} - V_{DD2}

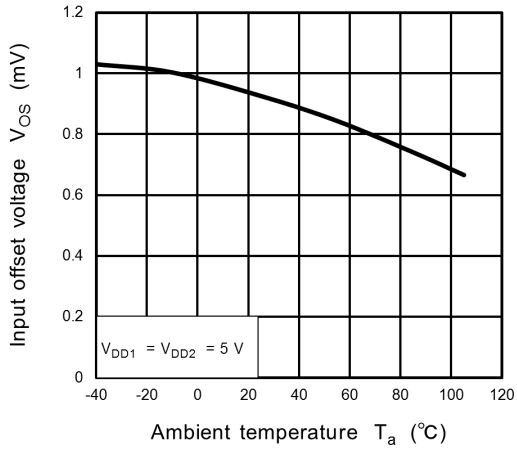

Fig. 12.3 V_{OS} - T_a

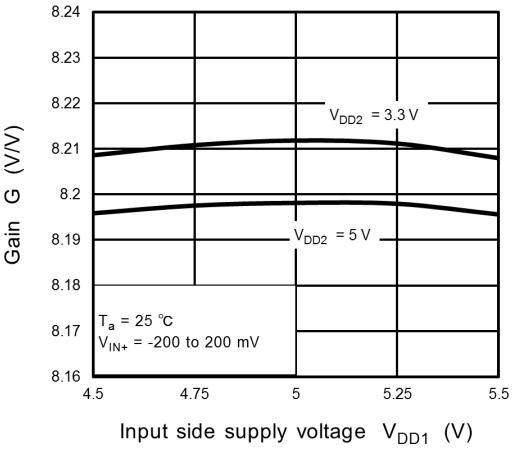

Fig. 12.4 G - V_{DD1}

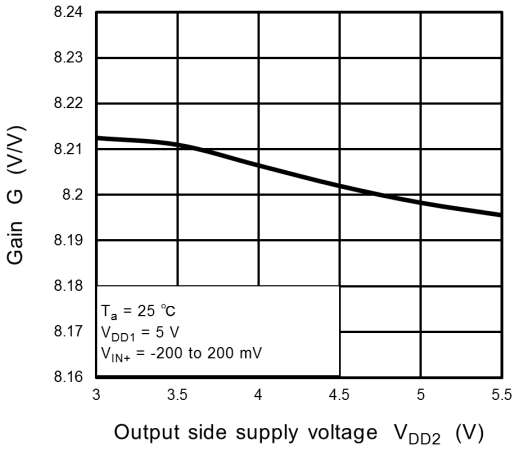

Fig. 12.5 G - V_{DD2}

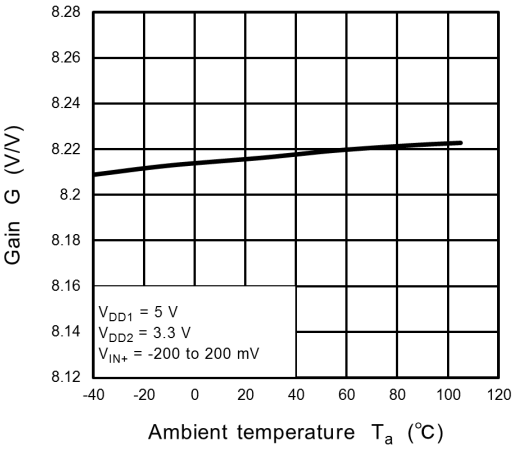

Fig. 12.6 G - T_a

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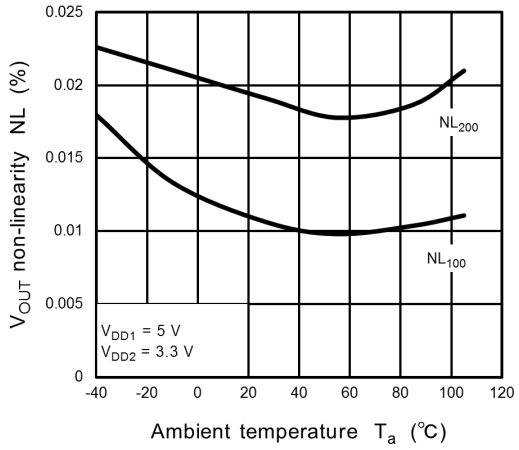


Fig. 12.7 NL - T_a

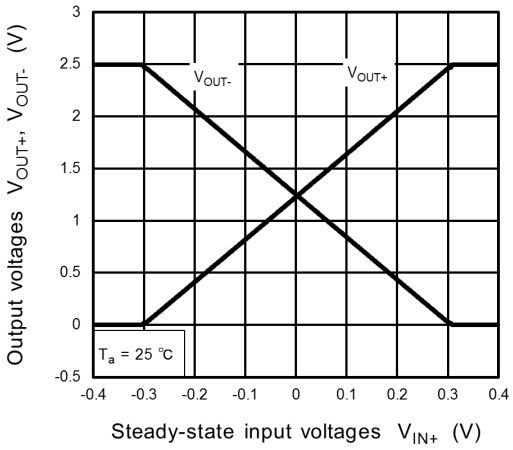


Fig. 12.8 V_{OUT} - V_{IN+}

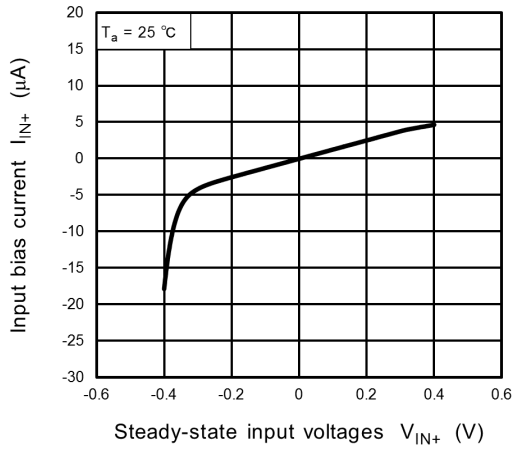


Fig. 12.9 I_{IN+} - V_{IN+}

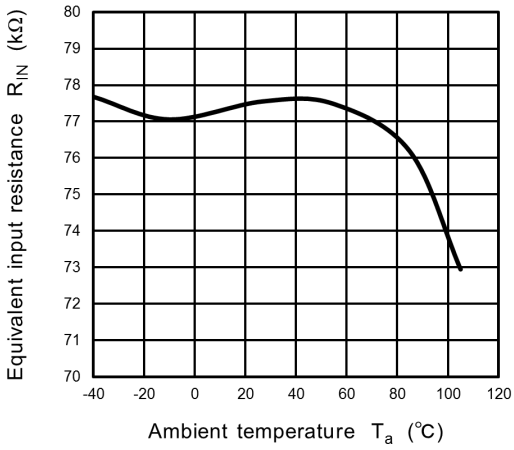


Fig. 12.10 R_{IN} - T_a

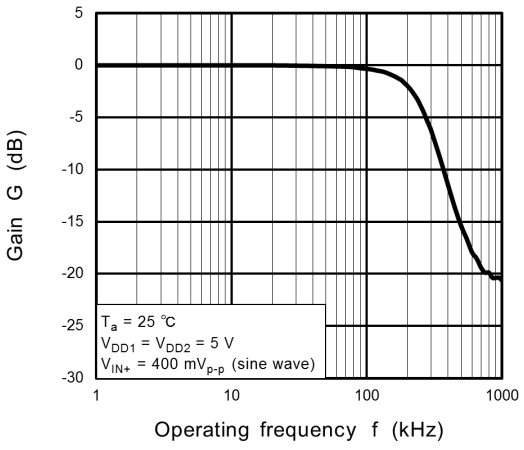


Fig. 12.11 G[dB] - f

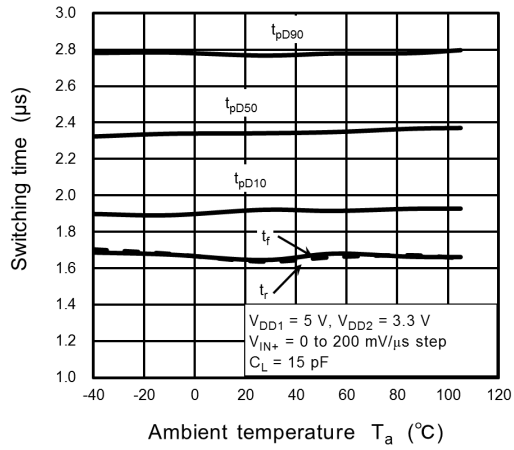


Fig. 12.12 Switching Time - T_a

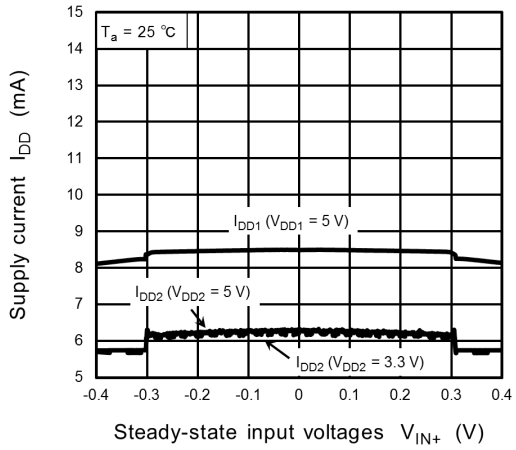


Fig. 12.13 I_{DD} - V_{IN+}

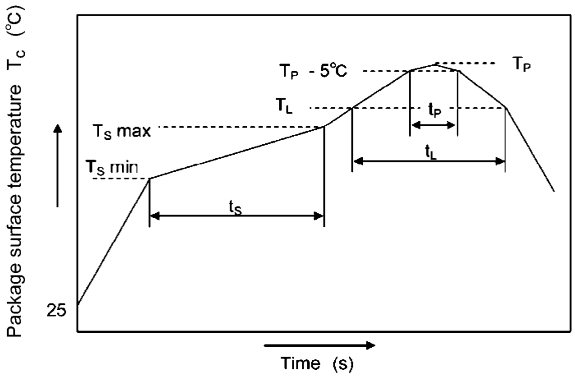
Note: The above characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.

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.



	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.

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.

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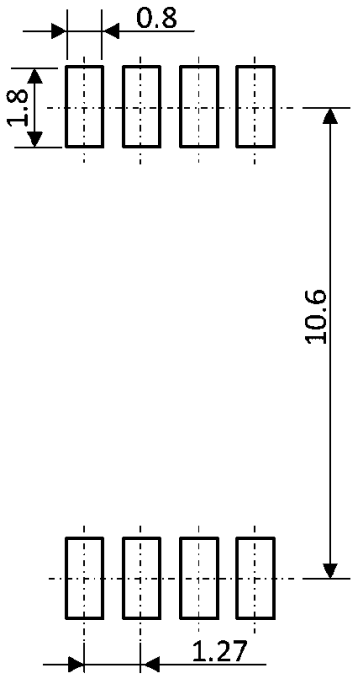
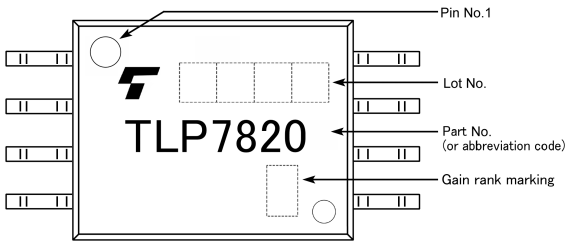
14. Land Pattern Dimensions (for reference only)



Unit: mm

15. Marking



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

- Part number: TLP7820 **(Note 1)**
- The following part naming conventions are used for the devices that have been qualified according to option (D4) of EN60747.

Example: TLP7820(D4ATP4,E

D4 : EN60747 option
A : Gain rank
TP4 : Tape type
E : [[G]]/RoHS COMPATIBLE **(Note 2)**

Note 1: Use TOSHIBA standard type number for safety standard application.
e.g., TLP7820(D4ATP4,E → TLP7820

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		40 / 105 / 21	—
Pollution degree		2	—
Maximum operating insulation voltage	V_{IORM}	1230	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}	1970	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}	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	 300 700 150	 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}	≥ 10^{12} ≥ 10^{11} ≥ 10^9	Ω

Fig. 16.1 EN60747 Insulation Characteristics

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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. 16.2 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. 16.3 Marking on Packing for EN60747

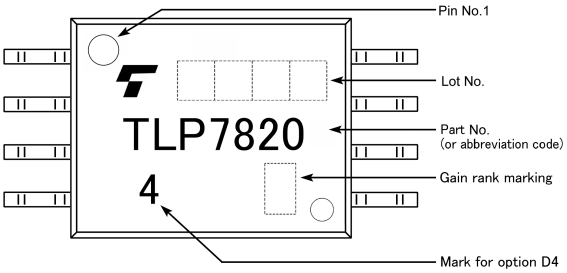

Fig. 16.4 Marking Example (Note)

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

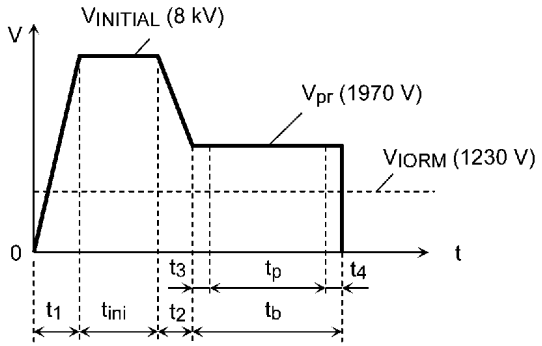

Figure 2 Partial discharge measurement procedure according to EN60747
Non-destructive test for 100 % inspection.

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

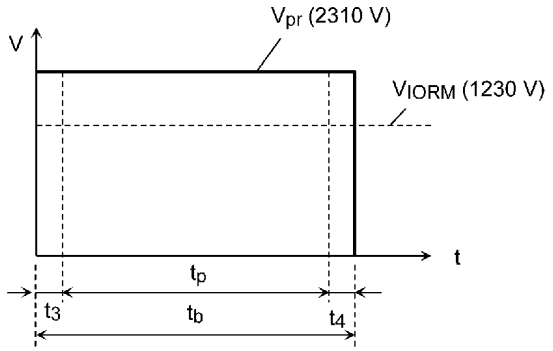

Figure 3 Dependency of maximum safety ratings on ambient temperature

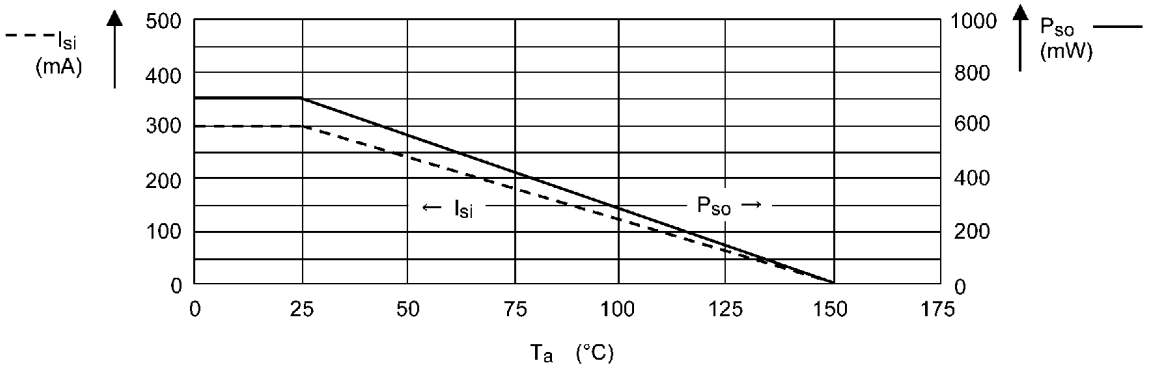

Fig. 16.5 Measurement Procedure

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17. Specifications for Embossed-Tape Packing

17.1. Applicable Package

Package Name	Product Type
SO8L(LF4)	Long creepage mini flat coupler

17.2. 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) TLP7820(A-TP4,E

Part number: TLP7820
Gain rank: A
Tape type: TP4
[[G]]/RoHS COMPATIBLE: E **(Note 1)**

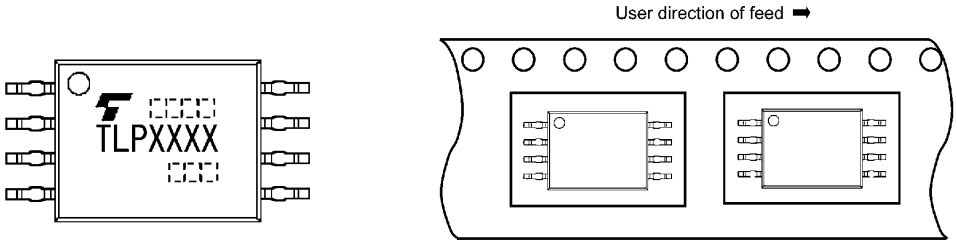
Note 1: Please contact your Toshiba sales representative for details on environmental information such as the product's RoHS compatibility.
RoHS is the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical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

17.3. Tape Dimensions Specification

Tape type	Quantity (pcs/reel)
TP4	1500

17.3.1. Orientation of Device in Relation to Direction of Feed

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



Device Orientation

17.3.2. Empty Cavities

Characteristics	Criterion	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

17.3.3. Tape Leader and Trailer

The start end of the tape has 50 or more empty cavities. The hub end of the tape has 50 or more empty cavities and two empty turns only for a cover tape.

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17.3.4. Tape Dimensions

Tape material: Plastic (for protection against static electricity)

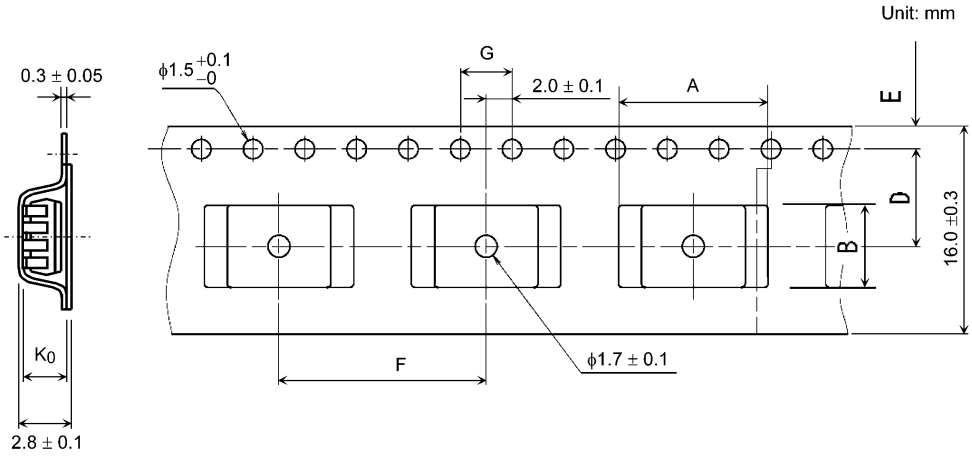

Table Tape Dimensions (unit: mm, tolerance: ±0.1)

Symbol	Dimension	Remark
A	11.55	—
B	6.35	—
D	7.5	Center line of embossed cavity and sprocket hole
E	1.75	Distance between tape edge and sprocket hole center
F	16.0	Cumulative error +0.1/-0.3 per 10 empty cavities holes
G	4.0	Cumulative error +0.1/-0.3 per 10 sprocket holes
K_0	2.4	Internal space

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17.3.5. Reel Specification

Material: Plastic (for protection against static electricity)

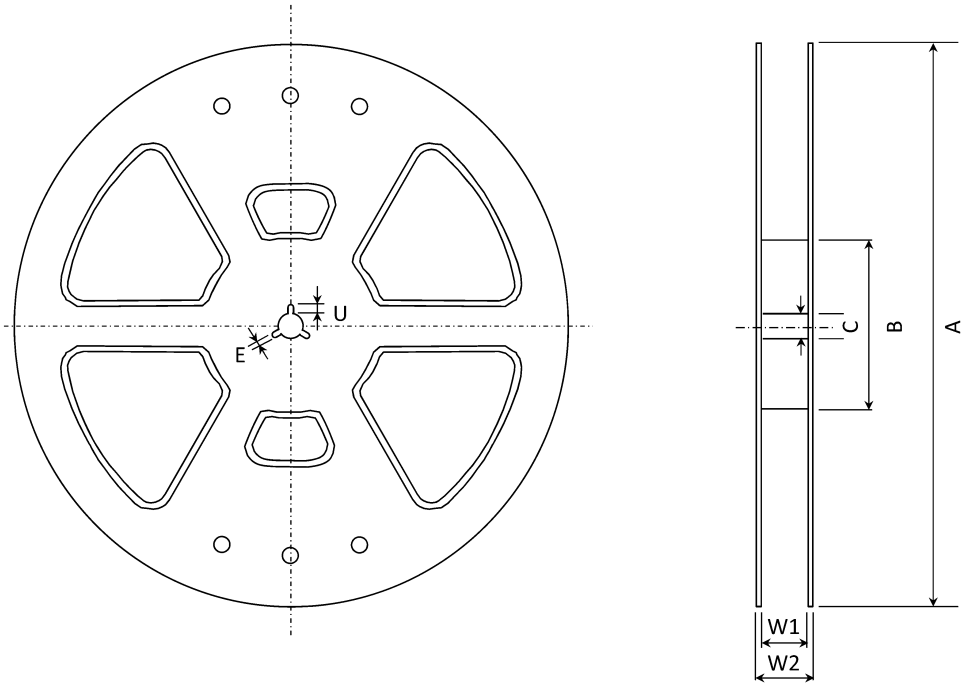
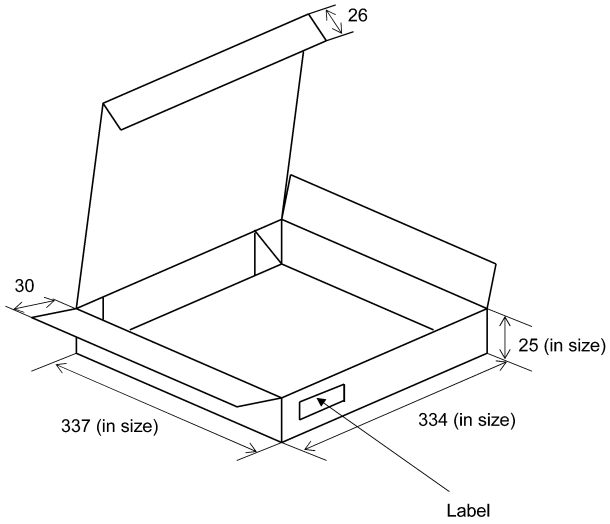


Table Reel Dimensions (unit: mm)

Symbol	Dimension
A	ϕ330 ± 2
B	ϕ100 ± 1
C	ϕ13 ± 0.5
E	2.0 ± 0.5
U	4.0 ± 0.5
W1	17.4 ± 1.0
W2	21.4 ± 1.0

17.4. Packing (Note)



1 reel/carton (unit: mm)

Note: Taping reel diameter: ϕ330 mm

17.5. 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.

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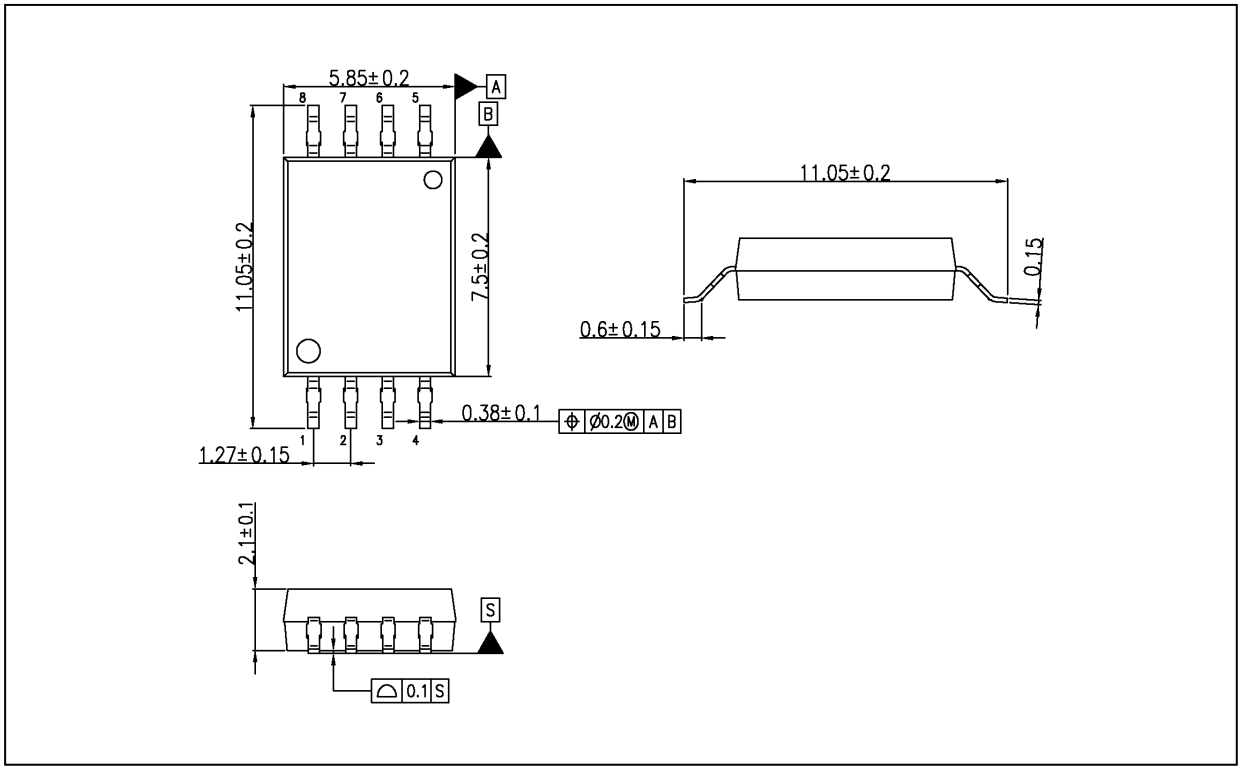
Package Dimensions

Unit: mm



Weight: 0.205 g (typ.)

Package Name(s)
TOSHIBA: 11-6B1A

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