

TLP152

1. Applications

- Industrial Inverters
- MOSFET Gate Drivers
- IGBT Gate Drivers

2. General

The TLP152 is a photocoupler in an SO6 package that consists of a infrared light-emitting diode (LED) optically coupled to an integrated high-gain, high-speed photodetector IC chip. The photodetector IC chip has an internal shield to provide a high common-mode transient immunity of $\pm 20 \text{ kV}/\mu\text{s}$ and thus superior noise immunity between the input and output pins. The TLP152 has a totem-pole output that can both sink and source current. It is suitable for directly driving a small IGBT or power MOSFET.

3. Features

- (1) Buffer logic type (totem pole output)
- (2) Output peak current: $\pm 2.5 \text{ A}$ (max)
- (3) Operating temperature: -40 to 100°C
- (4) Supply current: 3.0 mA (max)
- (5) Supply voltage: 10 to 30 V
- (6) Threshold input current: 7.5 mA (max)
- (7) Propagation delay time: $t_{\text{pHL}} = 190 \text{ ns}$ (max), $t_{\text{pLH}} = 170 \text{ ns}$ (max)
- (8) Common-mode transient immunity: $\pm 20 \text{ kV}/\mu\text{s}$ (min)
- (9) Isolation voltage: 3750 Vrms (min)
- (10) Safety standards

UL-recognized: UL 1577, File No.E67349

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

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

CQC-approved: GB4943.1 Thailand Factory

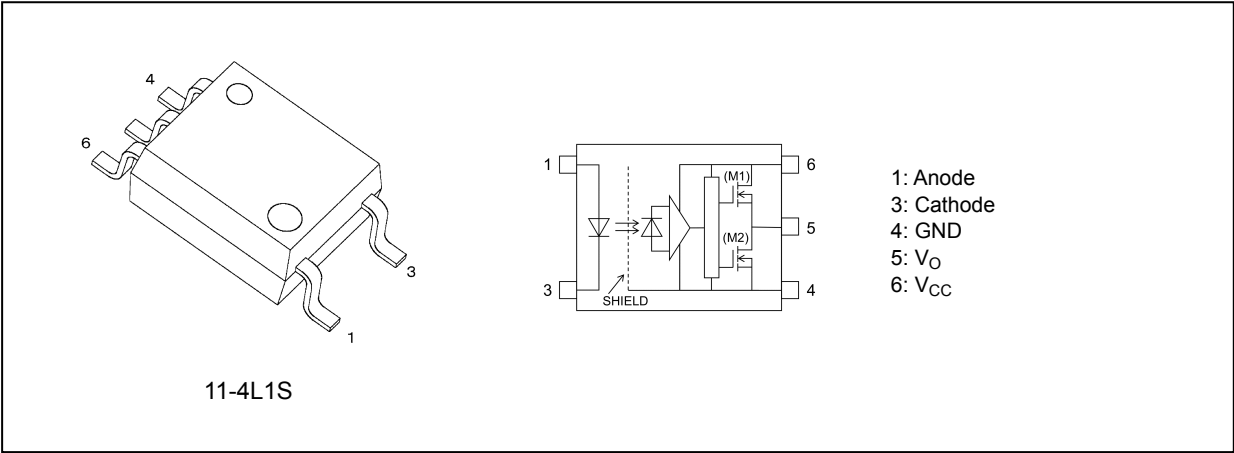


Can only be safely used in areas below 2000m above sea level.

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

Start of commercial production
2012-06

4. Packaging and Pin Assignment



5. Internal Circuit (Note)

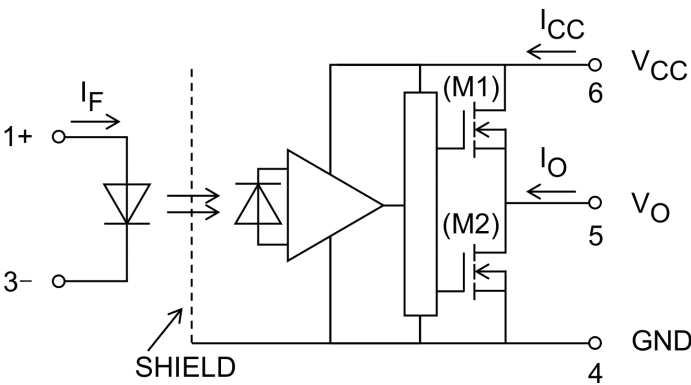


Fig. 5.1 Internal Circuit

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

6. Principle of Operation

6.1. Truth Table

Input	LED	M1	M2	Output
H	ON	ON	OFF	H
L	OFF	OFF	ON	L

6.2. Mechanical Parameters

Characteristics	Size	Unit
Creepage distances	5.0 (min)	mm
Clearance distances	5.0 (min)	
Internal isolation thickness	0.4 (min)	

7. Absolute Maximum Ratings (Note) (Unless otherwise specified, $T_a = 25\text{ }^{\circ}\text{C}$)

	Characteristics	Symbol	Note	Rating	Unit
LED	Input forward current	I_F		20	mA
	Peak transient input forward current	I_{FPT}	(Note 1)	1	A
	Input reverse voltage	V_R		5	V
	Input power dissipation	P_D		40	mW
Detector	Peak high-level output current ($T_a = -40\text{ to }100\text{ }^{\circ}\text{C}$)	I_{OPH}	(Note 2)	-2.5	A
	Peak low-level output current ($T_a = -40\text{ to }100\text{ }^{\circ}\text{C}$)	I_{OPL}	(Note 2)	+2.5	
	Output voltage	V_O		35	V
	Supply voltage	V_{CC}		35	
	Output power dissipation	P_O		260	mW
	Output power dissipation derating ($T_a \geq 85\text{ }^{\circ}\text{C}$)	$\Delta P_O/\Delta T_a$		-2.0	mW/ $^{\circ}\text{C}$
Common	Operating temperature	T_{opr}		-40 to 100	$^{\circ}\text{C}$
	Storage temperature	T_{stg}		-55 to 125	
	Lead soldering temperature (10 s)	T_{sol}	(Note 3)	260	
	Isolation voltage (AC, 60 s, R.H. $\leq 60\%$)	BV_S	(Note 4)	3750	Vrms

Note: Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings.

Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc.).

Note 1: Pulse width (PW) $\leq 1\text{ }\mu\text{s}$, 300 pps

Note 2: Exponential waveform. Pulse width $\leq 0.2\text{ }\mu\text{s}$, $f \leq 15\text{ kHz}$, $V_{CC} = 20\text{ V}$, $T_a = -40\text{ to }100\text{ }^{\circ}\text{C}$

Exponential waveform. Pulse width $\leq 0.08\text{ }\mu\text{s}$, $f \leq 25\text{ kHz}$, $V_{CC} = 15\text{ V}$, $T_a = -40\text{ to }100\text{ }^{\circ}\text{C}$

Note 3: $\geq 2\text{ mm}$ below seating plane.

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

8. Recommended Operating Conditions (Note)

Characteristics	Symbol	Note	Min	Typ.	Max	Unit
Input on-state current	$I_{F(ON)}$	(Note 1)	10	—	15	mA
Input off-state voltage	$V_{F(OFF)}$		0	—	0.8	V
Peak high-level output current	I_{OPH}		—	—	-2.0	A
Peak low-level output current	I_{OPL}		—	—	+2.0	
Operating frequency	f	(Note 2)	—	—	250	kHz

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: Exponential waveform. $I_{OPH} \geq -0.65\text{ A}$ ($\leq 80\text{ ns}$), $I_{OPL} \leq 0.65\text{ A}$ ($\leq 80\text{ ns}$), $T_a = 100\text{ }^{\circ}\text{C}$, $V_{CC} = 20\text{ V}$

9. Electrical Characteristics (Note) (Unless otherwise specified, $T_a = -40$ to $100\text{ }^{\circ}\text{C}$)

Characteristics	Symbol	Note	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Input forward voltage	V_F		—	$I_F = 10\text{ mA}$, $T_a = 25\text{ }^{\circ}\text{C}$	1.40	1.57	1.80	V
Input forward voltage temperature coefficient	$\Delta V_F / \Delta T_a$		—	$I_F = 10\text{ mA}$	—	-1.8	—	mV/ $^{\circ}\text{C}$
Input reverse current	I_R		—	$V_R = 5\text{ V}$, $T_a = 25\text{ }^{\circ}\text{C}$	—	—	10	μA
Input capacitance	C_t		—	$V = 0\text{ V}$, $f = 1\text{ MHz}$, $T_a = 25\text{ }^{\circ}\text{C}$	—	45	—	pF
Peak high-level output current	I_{OPH}	(Note 1)	Fig. 12.1.1	$I_F = 10\text{ mA}$, $V_{CC} = 15\text{ V}$, $V_{6-5} = 4\text{ V}$	—	-2.2	-1.0	A
				$I_F = 10\text{ mA}$, $V_{CC} = 15\text{ V}$, $V_{6-5} = 10\text{ V}$	—	-3.4	-2.0	
Peak low-level output current	I_{OPL}	(Note 1)	Fig. 12.1.2	$I_F = 0\text{ mA}$, $V_{CC} = 15\text{ V}$, $V_{5-4} = 2\text{ V}$	1.0	2.4	—	
				$I_F = 0\text{ mA}$, $V_{CC} = 15\text{ V}$, $V_{5-4} = 10\text{ V}$	2.0	3.5	—	
High-level output voltage	V_{OH}		Fig. 12.1.3	$I_F = 10\text{ mA}$, $V_{CC} = 10\text{ V}$, $I_O = -100\text{ mA}$	6.0	8.5	—	V
Low-level output voltage	V_{OL}		Fig. 12.1.4	$V_F = 0.8\text{ V}$, $V_{CC} = 10\text{ V}$, $I_O = 100\text{ mA}$	—	0.1	1.0	
High-level supply current	I_{CCH}		Fig. 12.1.5	$I_F = 10\text{ mA}$, $V_{CC} = 10$ to 30 V , $V_O = \text{Open}$	—	1.9	3.0	mA
Low-level supply current	I_{CCL}		Fig. 12.1.6	$I_F = 0\text{ mA}$, $V_{CC} = 10$ to 30 V , $V_O = \text{Open}$	—	1.8	3.0	
Threshold input current (L/H)	I_{FLH}		—	$V_{CC} = 15\text{ V}$, $V_O > 1\text{ V}$	—	1.5	7.5	
Threshold input voltage (H/L)	V_{FHL}		—	$V_{CC} = 15\text{ V}$, $V_O < 1\text{ V}$	0.8	1.47	—	V
Supply voltage	V_{CC}		—	—	10	—	30	
UVLO threshold voltage	V_{UVLO+}		—	$I_F = 5\text{ mA}$, $V_O > 2.5\text{ V}$	7.8	8.7	9.7	
	V_{UVLO-}		—	$I_F = 5\text{ mA}$, $V_O < 2.5\text{ V}$	7.5	8.4	9.4	
UVLO hysteresis	$UVLO_{HYS}$		—	$I_F = 5\text{ mA}$, $V_O > 2.5\text{ V}$	—	0.3	—	

Note: All typical values are at $T_a = 25\text{ }^{\circ}\text{C}$.

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

Note 1: I_O application time $\leq 50\text{ }\mu\text{s}$, single pulse.

10. Isolation Characteristics (Unless otherwise specified, $T_a = 25\text{ }^{\circ}\text{C}$)

Characteristics	Symbol	Note	Test Conditions	Min	Typ.	Max	Unit
Total capacitance (input to output)	C_S	(Note 1)	$V_S = 0\text{ V}$, $f = 1\text{ MHz}$	—	0.35	—	pF
Isolation resistance	R_S	(Note 1)	$V_S = 500\text{ V}$, R.H. $\leq 60\%$	1×10^{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: 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 $100\text{ }^{\circ}\text{C}$)

Characteristics	Symbol	Note	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Propagation delay time (L/H)	t_{pLH}	(Note 1)	Fig. 12.1.7	$I_F = 0 \rightarrow 10\text{ mA}$, $V_{CC} = 30\text{ V}$, $R_g = 20\text{ }\Omega$, $C_g = 10\text{ nF}$, $T_a = 25\text{ }^{\circ}\text{C}$	60	95	145	ns
Propagation delay time (H/L)	t_{pHL}	(Note 1)		$I_F = 10 \rightarrow 0\text{ mA}$, $V_{CC} = 30\text{ V}$, $R_g = 20\text{ }\Omega$, $C_g = 10\text{ nF}$, $T_a = 25\text{ }^{\circ}\text{C}$	60	110	165	
Propagation delay time (L/H)	t_{pLH}	(Note 1)		$I_F = 0 \rightarrow 10\text{ mA}$, $V_{CC} = 30\text{ V}$, $R_g = 20\text{ }\Omega$, $C_g = 10\text{ nF}$	50	95	170	
Propagation delay time (H/L)	t_{pHL}	(Note 1)		$I_F = 10 \rightarrow 0\text{ mA}$, $V_{CC} = 30\text{ V}$, $R_g = 20\text{ }\Omega$, $C_g = 10\text{ nF}$	50	110	190	
Propagation delay skew (device to device)	t_{psk}	(Note 1) (Note 4)		$I_F = 0 \leftrightarrow 10\text{ mA}$, $V_{CC} = 30\text{ V}$, $R_g = 20\text{ }\Omega$, $C_g = 10\text{ nF}$	-85	—	85	
Pulse width distortion	$ t_{pHL} - t_{pLH} $	(Note 1)		$I_F = 0 \leftrightarrow 10\text{ mA}$, $V_{CC} = 30\text{ V}$, $R_g = 20\text{ }\Omega$, $C_g = 10\text{ nF}$	—	15	50	
Rise time	t_r	(Note 1)		$I_F = 0 \rightarrow 10\text{ mA}$, $V_{CC} = 30\text{ V}$, $R_g = 20\text{ }\Omega$, $C_g = 10\text{ nF}$	—	18	—	
Fall time	t_f	(Note 1)		$I_F = 10 \rightarrow 0\text{ mA}$, $V_{CC} = 30\text{ V}$, $R_g = 20\text{ }\Omega$, $C_g = 10\text{ nF}$	—	22	—	
High-level common-mode transient immunity	CM_H	(Note 2)	Fig. 12.1.8	$V_{CM} = 1000\text{ V}_{p-p}$, $I_F = 10\text{ mA}$, $V_{CC} = 30\text{ V}$, $T_a = 25\text{ }^{\circ}\text{C}$, $V_{O(min)} = 26\text{ V}$	± 20	—	—	kV/ μs
Low-level common-mode transient immunity	CM_L	(Note 3)		$V_{CM} = 1000\text{ V}_{p-p}$, $I_F = 0\text{ mA}$, $V_{CC} = 30\text{ V}$, $T_a = 25\text{ }^{\circ}\text{C}$, $V_{O(max)} = 1\text{ V}$	± 20	—	—	

Note: All typical values are at $T_a = 25\text{ }^{\circ}\text{C}$.

Note 1: Input signal ($f = 125\text{ kHz}$, duty = 50 %, $t_r = t_f = 5\text{ ns}$ or less).

CL is approximately 15 pF which includes probe and stray wiring capacitance.

Note 2: CM_H is the maximum rate of fall of the common mode voltage that can be sustained with the output voltage in the logic high state ($V_O > 26\text{ V}$).

Note 3: CM_L is the maximum rate of rise of the common mode voltage that can be sustained with the output voltage in the logic low state ($V_O < 1\text{ V}$).

Note 4: 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).

12. Test Circuits and Characteristics Curves

12.1. Test Circuits

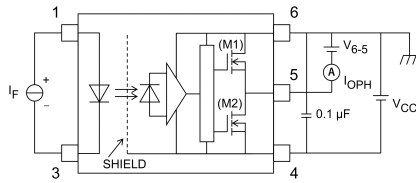


Fig. 12.1.1 I_{OPH} Test Circuit

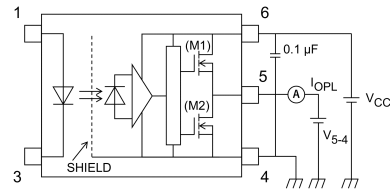


Fig. 12.1.2 I_{OPL} Test Circuit

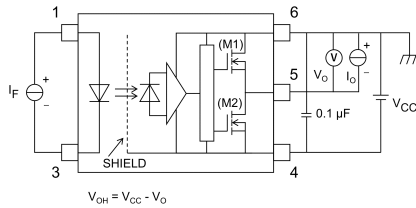


Fig. 12.1.3 V_{OH} Test Circuit

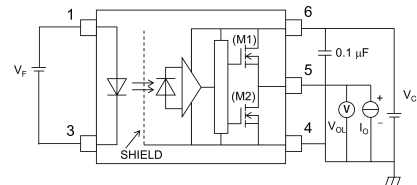


Fig. 12.1.4 V_{OL} Test Circuit

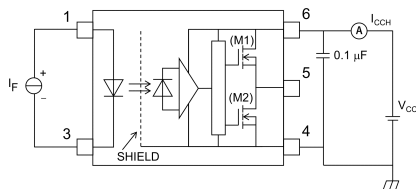


Fig. 12.1.5 I_{CCH} Test Circuit

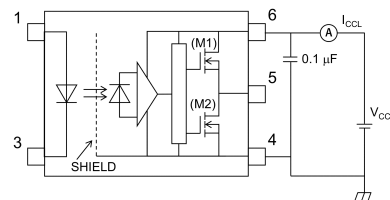


Fig. 12.1.6 I_{CCL} Test Circuit

$I_F = 10 \text{ mA}$ (Pulse Generator)
($f = 125 \text{ kHz}$, duty = 50 %, $t_r = t_f = 5 \text{ ns}$)

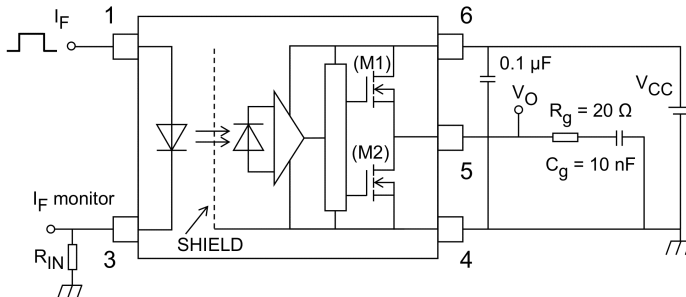


Fig. 12.1.7 Switching Time Test Circuit and Waveform

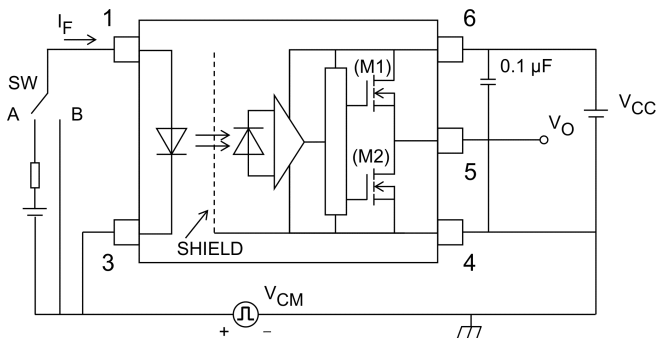
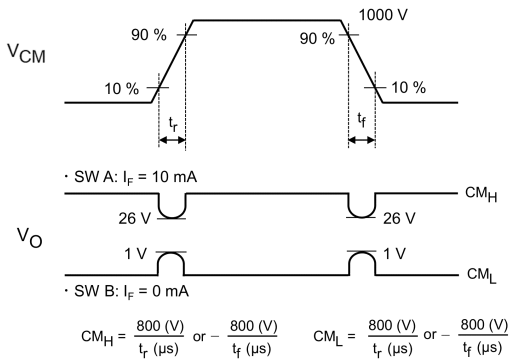


Fig. 12.1.8 Common-Mode Transient Immunity Test Circuit and Waveform



13. Soldering and Storage

13.1. Precautions for Soldering

The soldering temperature should be controlled as closely as possible to the conditions shown below, irrespective of whether a soldering iron or a reflow soldering method is used.

- When using soldering reflow.

The soldering temperature profile is based on the package surface temperature.
(See the figure shown below, which is based on the package surface temperature.)
Reflow soldering must be performed once or twice.
The mounting should be completed with the interval from the first to the last mountings being 2 weeks.

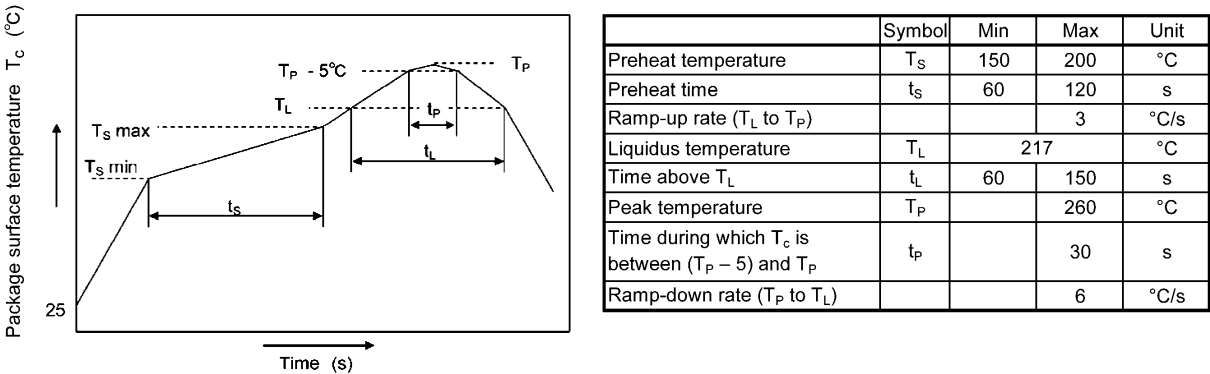


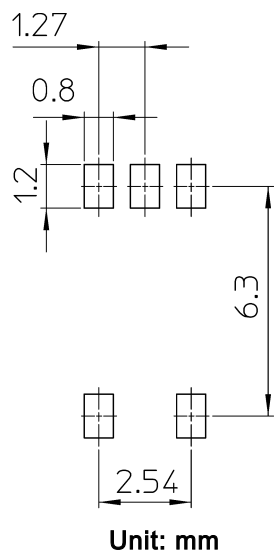
Fig. 13.1.1 An Example of a Temperature Profile When Lead(Pb)-Free Solder Is Used

- 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.

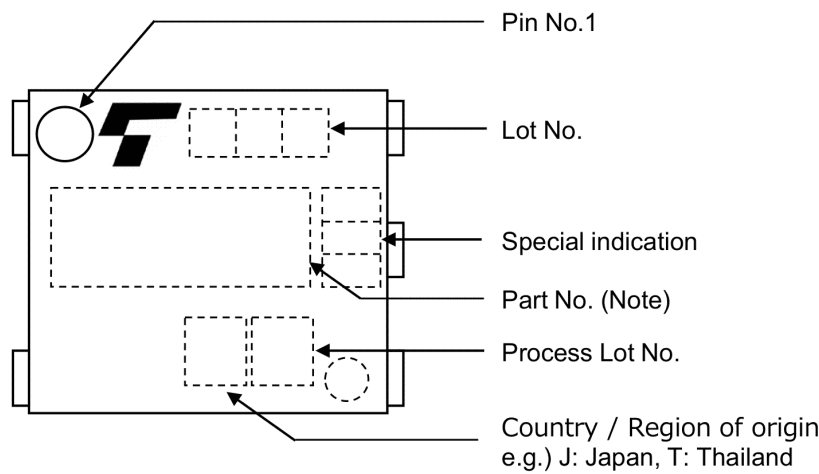
13.2. Precautions for General Storage

- 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.

14. Land Pattern Dimensions (for reference only)



15. Marking



Note: P152 (Abbreviation code)

16. EN IEC 60747-5-5 Option (V4) Specification

- Part number: TLP152 (Note 1)
- The following part naming conventions are used for the devices that have been qualified according to option (V4) of EN IEC 60747.

Example: TLP152(V4-TPL,E

V4: EN IEC 60747 option

TPL: Tape type

E: [[G]]/RoHS COMPATIBLE (Note 2)

Note 1: Use TOSHIBA standard type number for safety standard application.

e.g., TLP152(V4-TPL,E → TLP152

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 V _{rms} for rated mains voltage ≤ 300 V _{rms}		I-IV I-III	—
Climatic classification		40 / 100 / 21	—
Pollution degree		2	—
Maximum operating insulation voltage	V _{IORM}	707	V _{peak}
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	V _{peak}
Input to output test voltage, method B V _{pr} = 1.875 × V _{IORM} , 100% production test t _p = 1 s, partial discharge < 5pC	V _{pr}	1325	V _{peak}
Highest permissible overvoltage (transient overvoltage, t _{pr} = 60 s)	V _{TR}	6000	V _{peak}
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. 16.1 EN IEC 60747 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	500

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

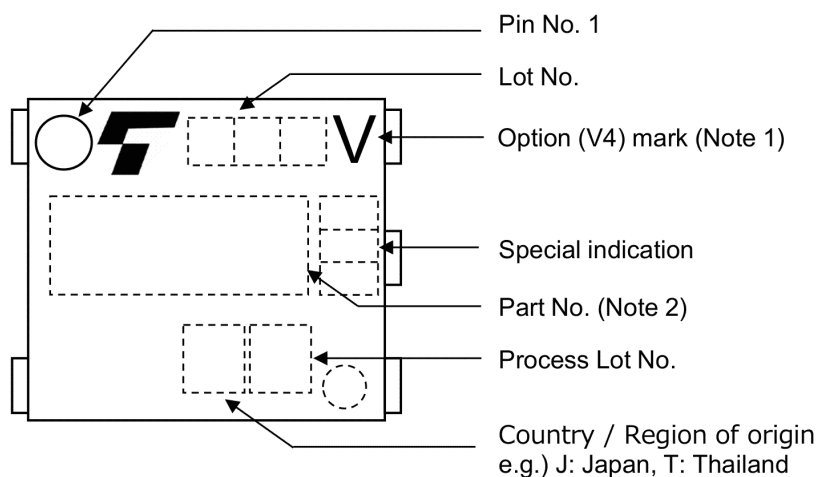


Fig. 16.4 Marking Example

Note 1: The above marking is applied to the photocouplers that have been qualified according to option (D4) of EN IEC 60747.

Note 2: P152 (Abbreviation code)

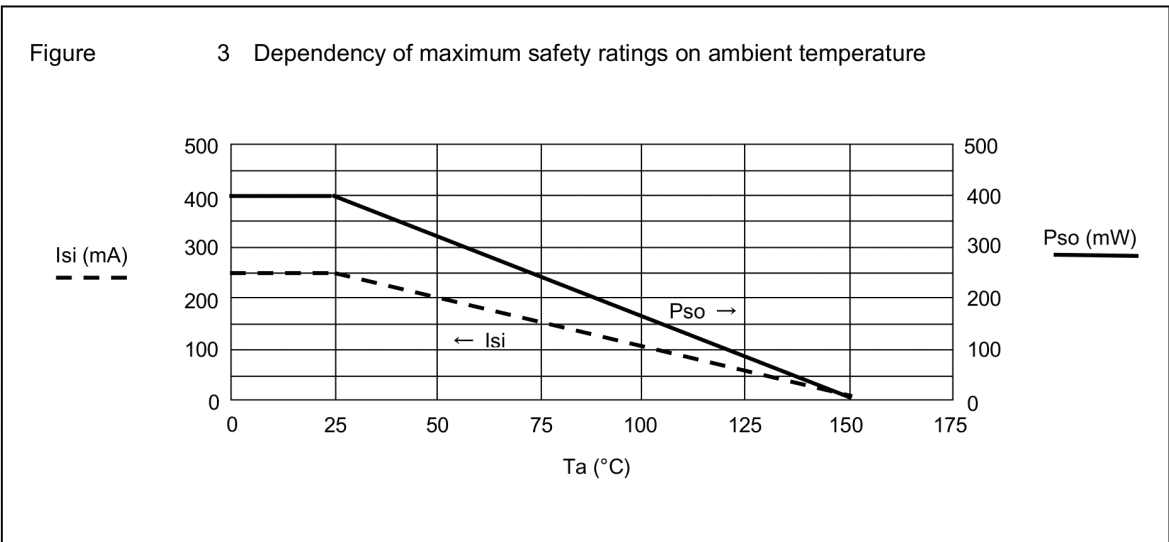
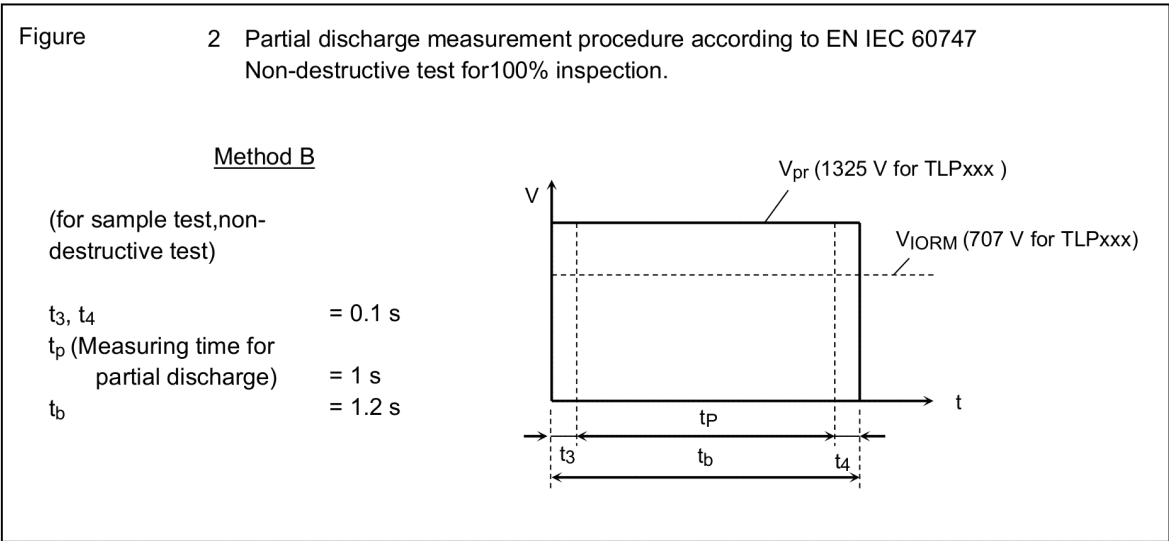
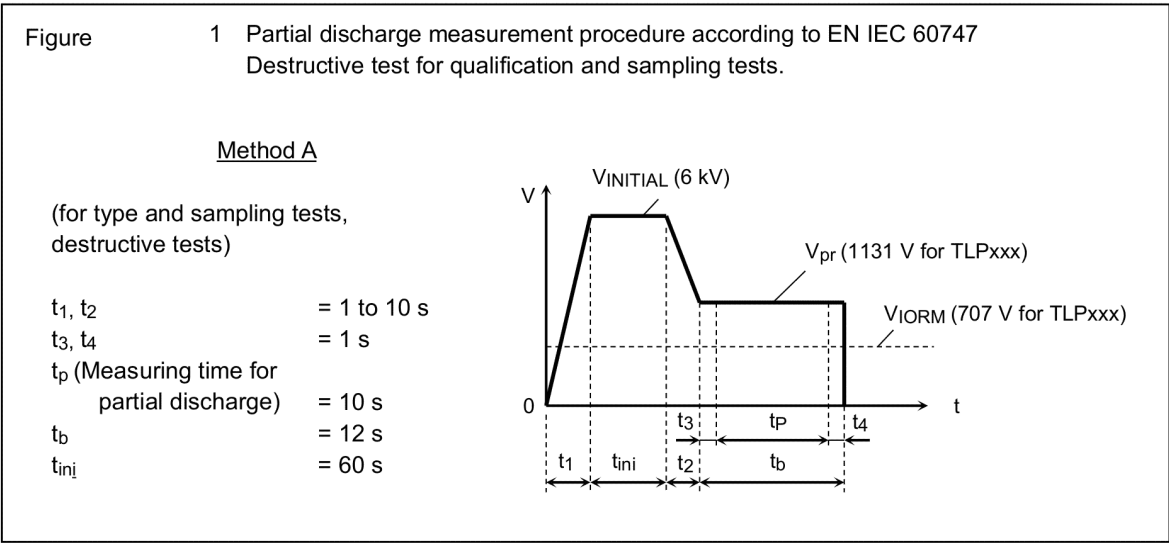


Fig. 16.5 Measurement Procedure

16.1. Ordering Information

When placing an order, please specify the part number, tape type and quantity as shown in the following example.

Example) TLP152(TPL,E(T 3000 pcs

Part number: TLP152

Tape type: TPL

[[G]]/RoHS COMPATIBLE: E (**Note 1**)

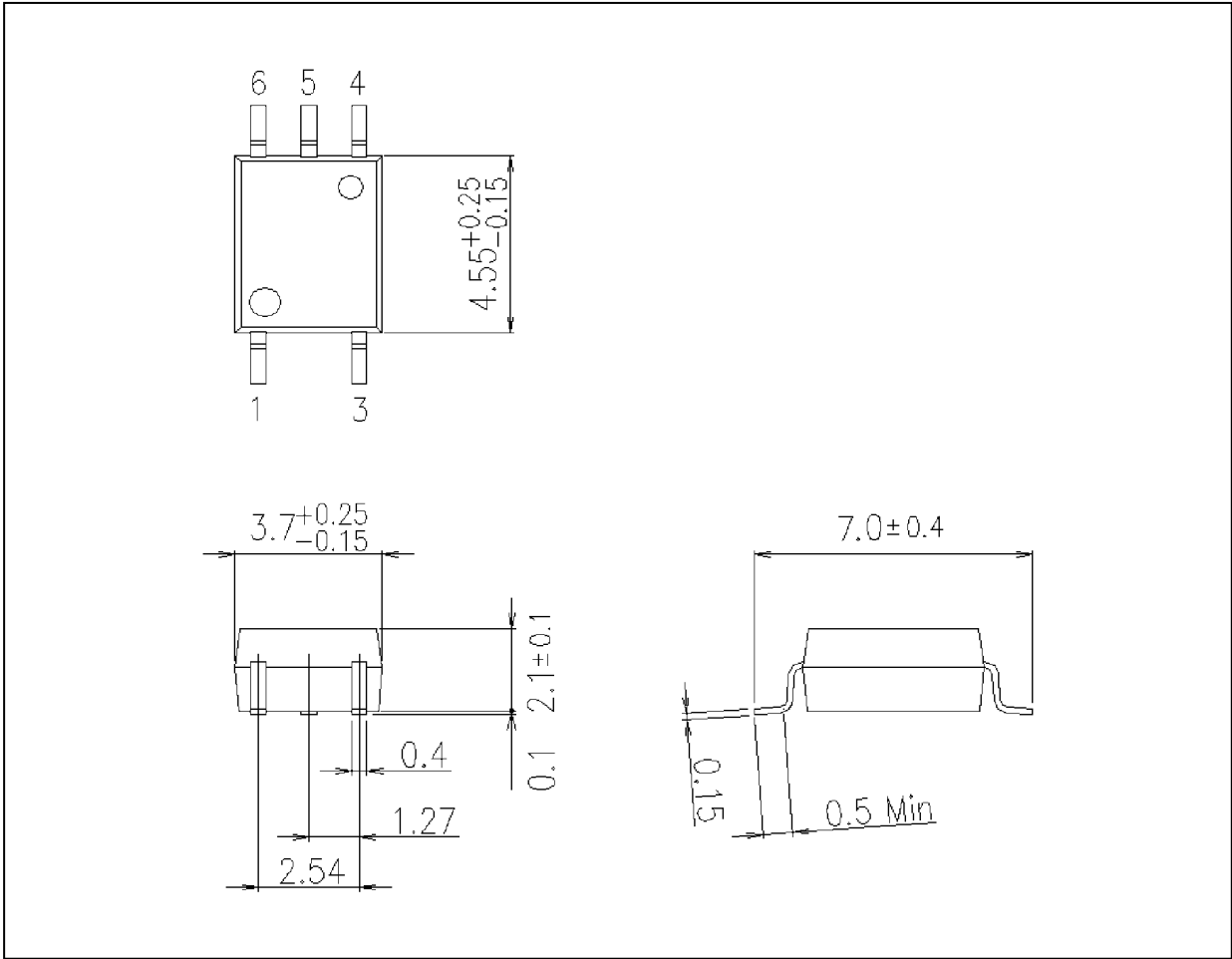
Quantity (must be a multiple of 3000): 3000 pcs

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.

Package Dimensions

Unit: mm



Weight: 0.08 g (typ.)

Package Name(s)
TOSHIBA: 11-4L1S

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