Photorelay TLP241B
Thermal Resistance Characteristics

Description

This Application Note describes the thermal resistance characteristics of photorelay TLP241B.

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1. What is photorelay ?

1.1. Structure

Photorelay is a semiconductor-relay. In input side there is infrared LED and in output side there are Photo Diode Array (referred to as PDA) and MOSFETs. It is isolated electrically between input side and output side by resin.

Figure 1.1 shows an internal structure of photorelay. Input LED and Output PDA are facing and isolated by resin.

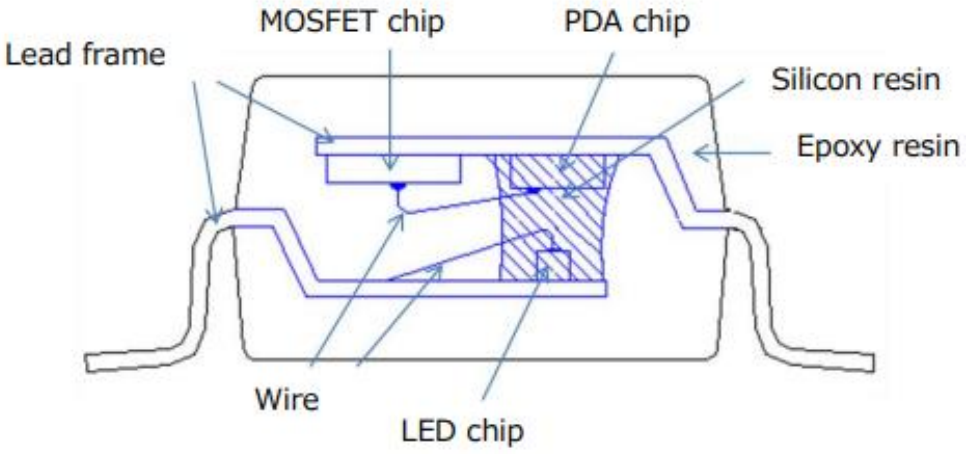

Figure 1.1 Photorelay internal structure

1.2. Operating principle of the photorelay

To turn on of the photorelay (normally open type), apply input LED current so that the LED emits infrared light. The infrared light is received by output PDA and the PDA has electromotive force. This electromotive force drives the gate of the output MOSFETs, turning on the output side.

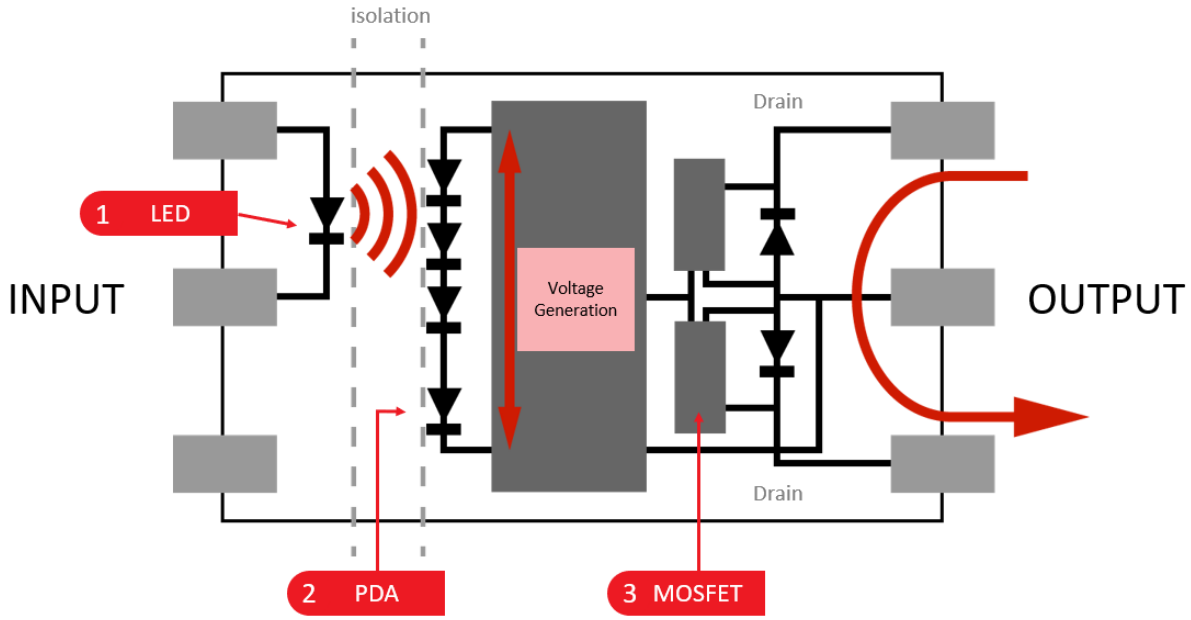

Figure 1.1 Photorelay internal structure

2. TLP241B

As an actual example of thermal resistance measurement, we will discuss the TLP241B, one of Toshiba's photorelay. Its main specifications are shown in Table 2.1. Although the package of the product is DIP4, the thermal resistance is measured as a surface-mount lead formed as shown in Figure 2.1, which is mounted on a board designated by JEDEC as described later.

Table 2.1 TLP241B main specifications

Item	Symbol	Specification
Output	—	1-form-A
Package	—	DIP4
Isolation Voltage (Min)	BV_S	5,000 V_{rms}
OFF-state output terminal voltage	V_{OFF}	100 V
OFF-state current (Max) (V_{OFF}=100 V)	I_{OFF}	1 μA
ON-state current (Max)	I_{ON}	2.0 A
Trigger LED current (Max)	I_{FT}	3 mA
Return LED current (Min)	I_{FC}	0.01 mA
On-state resistance (Max)	R_{ON}	0.2 Ω
Turn-on time (Max) (I_F=5 mA)	t_{ON}	3 ms
Turn-off time (Max) (I_F=5 mA)	t_{OFF}	0.5 ms
Operating temperature	T_{opr}	-40 to 110 °C

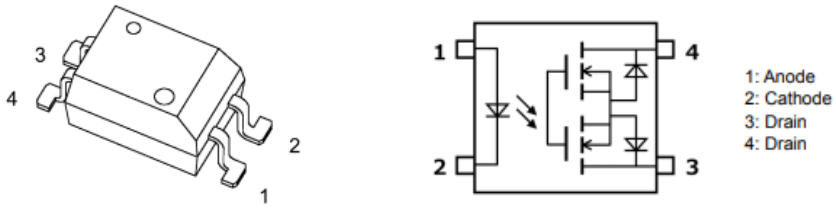

Figure 2.1 Packaging(surface-mount leads) and pin assignment of TLP241B

3. Parameters for thermal resistance measurement of photorelays

The internal circuit of TLP241B is shown in Figure 3.1.

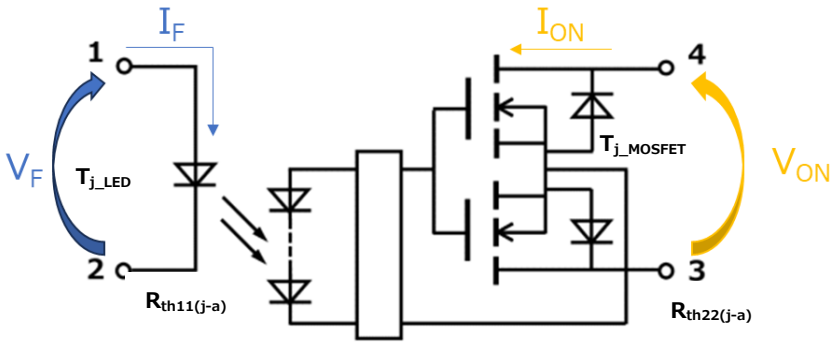

Figure 3.1 Internal circuit of TLP241B

Following parameters are necessary for calculating thermal resistance of photorelays.

I_F:	LED forward current
V_F:	LED forward voltage
I_{ON}:	On-state current (MOSFET)
V_{ON}:	On-state voltage (MOSFET)
T_{j_LED}:	Junction temperature (LED)
T_{j_MOSFET}:	Junction temperature (MOSFET)
T_a:	Ambient temperature
$R_{th11(j-a)}$:	Static thermal resistance between the LED junction and ambient
$R_{th22(j-a)}$:	Static thermal resistance between the MOSFET junction and ambient

The next chapter describes the method, measurement condition and results of thermal resistance of TLP241B.

4. Measurement of the thermal resistance

4.1. Method (JEDEC JESD51-14)

The cooling method that complies with the JEDEC JESD51-14 standard is used for acquiring thermal resistance data. For details, please refer to related documents.

4.2. Measurement condition

Samples of TLP241B are surface-mounted on a test board specified by the JEDEC JESD51-7 standard. The board is suspending in midair and shielding with a case to prevent external airflow interference. The measurement conditions are shown in Table 4.1.

For measuring the output-side thermal resistance, a forward current of 5 mA is applied to the input-side LED for driving MOSFETs.

Table 4.1 Measurement condition

Item	Heating current [A]	Application time [s]	Ambient temperature [°C]	Note
Input side LED	0.03	1800	25	—
Output side MOSFET	2	1800	25	I_F = 5 mA

4.3. Specification of the test board (JEDEC JESD51-7)

PCB for measurement is standardized by JEDEC JESD51-7 as shown in Table 4.2. Figure 4.2 is the picture of a board.

Table 4.2 Specification of the PCB for thermal resistance measurement

Item	Specification
Device mount	Surface mount
Board material	FR4
Number of layers	4
Board size (L×W×t)	76.2 × 114.3 × 1.6 mm
Cu layer thickness	0.07 mm (top and bottom layer) 0.035 mm (2nd, 3rd layer)
Through hole via pitch	2.54 mm
Through hole via diameter	0.85 mm
Plating	Au

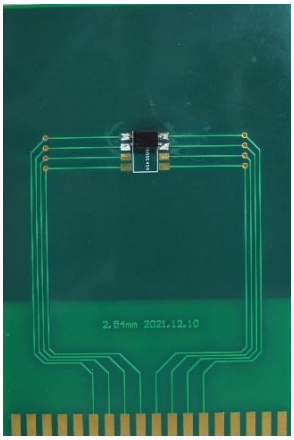

Figure 4.1 PCB for thermal resistance measurement (example)

5. Results

Figure 5.1 and Figure 5.2 are transitional thermal resistances of input side and output side respectively. Table 5.1 shows both static thermal resistances $R_{th(j-a)}$. Please note that those results are not guranteened and reference values.

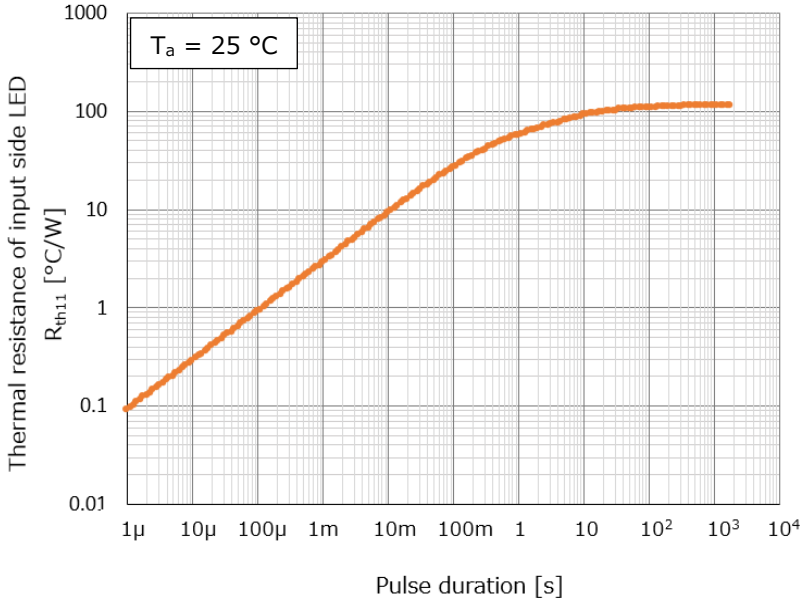

Figure 5.1 Input side thermal resistance characteristic of TLP241B (reference)

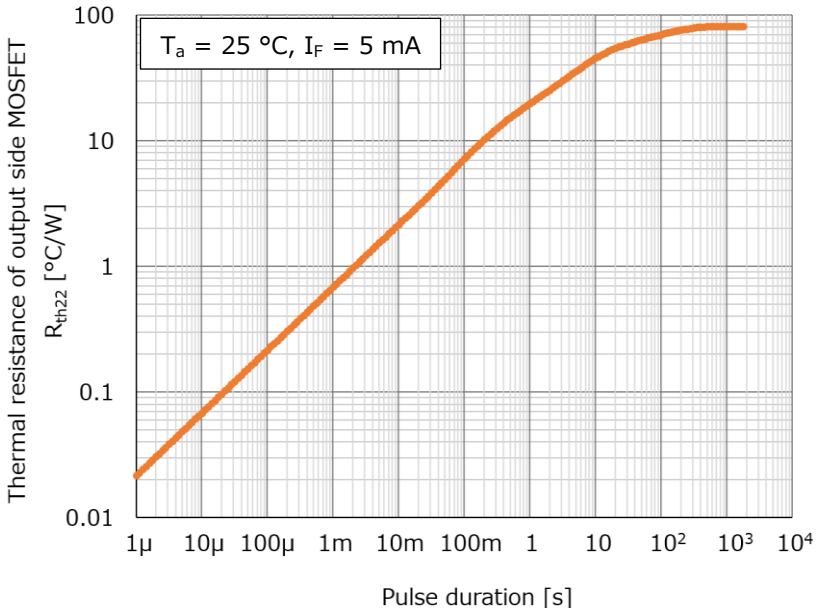

Figure 5.2 Output side thermal resistance characteristic of TLP241B (reference)

Table 5.1 Static thermal resistance of TLP241B (reference)

	Symbol	Rating	Unit
Static thermal resistance between the LED junction and ambient	$R_{th11(j-a)}$	114	°C/W
Static thermal resistance between the MOSFET junction and ambient	$R_{th22(j-a)}$	82	°C/W

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