

Photocouplers Photorelay

# TLP3451

## 1. Applications

- ATE (Automatic Test Equipment)
- High-Speed Logic IC Testers
- High-Speed Memory Testers
- Measuring Instruments

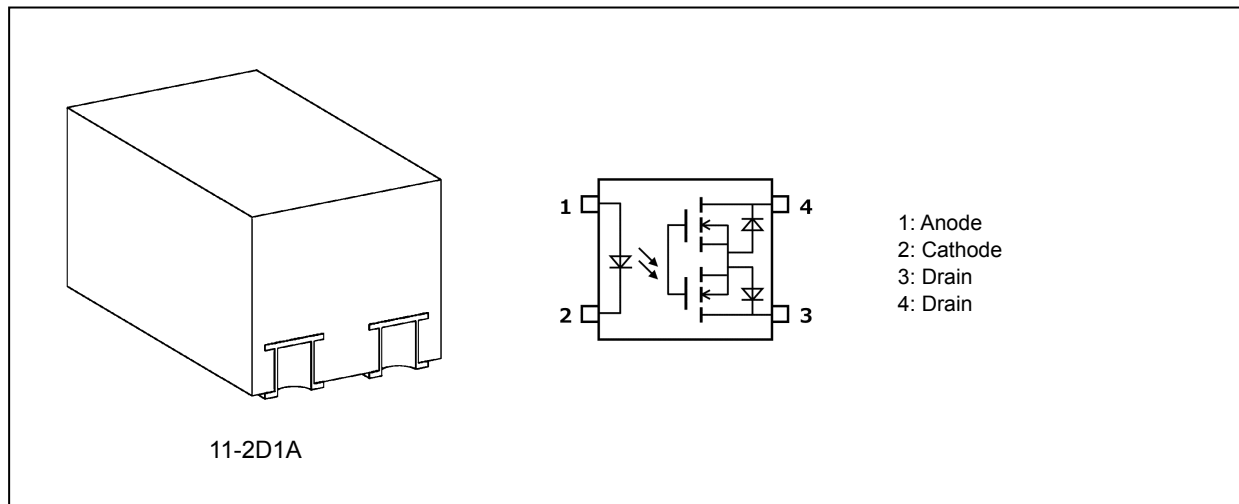
## 2. General

The TOSHIBA TLP3451 is a very small outline non-leaded photorelay suitable for surface-mount assembly. The TLP3451 consists of an infrared LED optically coupled to a photo-MOSFET and is housed in a VSON 4-pin package. The TLP3451 features low output capacitance,  $C_{OFF}$ , and thus fast on/off switching of a high-frequency signal, making it ideal for switching applications in high-speed testers.

## 3. Features

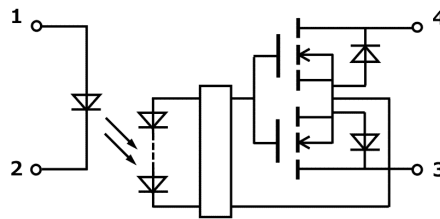
- (1) Normally opened (1-Form-A)
- (2) OFF-state output terminal voltage: 60 V (min)
- (3) Trigger LED current: 3 mA (max)
- (4) ON-state current: 120 mA (max)
- (5) ON-state resistance: 10  $\Omega$  (typ.), 15  $\Omega$  (max)
- (6) Output capacitance: 0.7 pF(typ.), 1.3 pF(max)
- (7) Isolation voltage: 500 Vrms (min)

## 4. Packaging and Pin Assignment



Start of commercial production  
2015-02

## 5. Internal Circuit



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

|          | Characteristics   | Symbol                     | Note     | Rating     | Unit                 |
|----------|---|----------------------------|----------|------------|----------------------|
| LED      | Input forward current   | $I_F$                      |          | 30         | mA                   |
|          | Input forward current derating ( $T_a \geq 25\text{ }^\circ\text{C}$ )    | $\Delta I_F/\Delta T_a$    |          | -0.3       | mA/ $^\circ\text{C}$ |
|          | Input reverse voltage   | $V_R$                      |          | 5          | V                    |
|          | Input power dissipation   | $P_D$                      |          | 50         | mW                   |
|          | Input power dissipation derating ( $T_a \geq 25\text{ }^\circ\text{C}$ )  | $\Delta P_D/\Delta T_a$    |          | -0.5       | mW/ $^\circ\text{C}$ |
|          | Junction temperature  | $T_j$                      |          | 125        | $^\circ\text{C}$     |
| Detector | OFF-state output terminal voltage   | $V_{OFF}$                  |          | 60         | V                    |
|          | ON-state current  | $I_{ON}$                   |          | 120        | mA                   |
|          | ON-state current derating ( $T_a \geq 25\text{ }^\circ\text{C}$ )         | $\Delta I_{ON}/\Delta T_a$ |          | -1.2       | mA/ $^\circ\text{C}$ |
|          | ON-state current (pulsed) ( $t = 100\text{ ms}$ , Duty = 1/10)            | $I_{ONP}$                  |          | 360        | mA                   |
|          | Output power dissipation  | $P_O$                      |          | 216        | mW                   |
|          | Output power dissipation derating ( $T_a \geq 25\text{ }^\circ\text{C}$ ) | $\Delta P_O/\Delta T_a$    |          | -2.16      | mW/ $^\circ\text{C}$ |
|          | Junction temperature  | $T_j$                      |          | 125        | $^\circ\text{C}$     |
| Common   | Storage temperature   | $T_{stg}$                  |          | -40 to 125 |                      |
|          | Operating temperature   | $T_{opr}$                  |          | -40 to 110 |                      |
|          | Lead soldering temperature (10 s)   | $T_{sol}$                  |          | 260        |                      |
|          | Isolation voltage AC, 60 s, R.H. $\leq 60\%$                              | $BV_S$                     | (Note 1) | 500        | 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: This device is considered as a two-terminal device: Pins 1 and 2 are shorted together, and pins 3 and 4 are shorted together.

Note: This device is sensitive to electrostatic discharge (ESD). Extreme ESD conditions should be guarded against by using proper antistatic precautions for the worktable, operator, solder iron, soldering equipment and so on.

## 7. Recommended Operating Conditions (Note)

| Characteristics       | Symbol    | Note | Min | Typ. | Max | Unit             |
|-----------------------|-----------|------|-----|------|-----|------------------|
| Supply voltage        | $V_{DD}$  |      | —   | —    | 48  | V                |
| Input forward current | $I_F$     |      | 5   | 7.5  | 20  | mA               |
| ON-state current      | $I_{ON}$  |      | —   | —    | 120 | mA               |
| Operating temperature | $T_{opr}$ |      | -20 | —    | 85  | $^\circ\text{C}$ |

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.

## 8. Electrical Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$ )

|          | Characteristics       | Symbol    | Note | Test Condition                                       | Min | Typ. | Max | Unit          |
|----------|-----------------------|-----------|------|--|-----|------|-----|---------------|
| LED      | Input forward voltage | $V_F$     |      | $I_F = 10\text{ mA}$                                 | 1.1 | 1.27 | 1.4 | V             |
|          | Input reverse current | $I_R$     |      | $V_R = 5\text{ V}$                                   | —   | —    | 10  | $\mu\text{A}$ |
|          | Input capacitance     | $C_t$     |      | $V = 0\text{ V}, f = 1\text{ MHz}$                   | —   | 30   | —   | pF            |
| Detector | OFF-state current     | $I_{OFF}$ |      | $V_{OFF} = 60\text{ V}$                              | —   | —    | 1   | nA            |
|          | Output capacitance    | $C_{OFF}$ |      | $V = 0\text{ V}, f = 100\text{ MHz}, t < 1\text{ s}$ | —   | 0.7  | 1.3 | pF            |

## 9. Coupled Electrical Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$ )

| Characteristics     | Symbol   | Note | Test Condition  | Min | Typ. | Max | Unit     |
|---------------------|----------|------|---|-----|------|-----|----------|
| Trigger LED current | $I_{FT}$ |      | $I_{ON} = 100\text{ mA}$                                    | —   | 0.9  | 3   | mA       |
| Return LED current  | $I_{FC}$ |      | $I_{OFF} = 10\text{ }\mu\text{A}$                           | 0.1 | —    | —   |          |
| ON-state resistance | $R_{ON}$ |      | $I_{ON} = 120\text{ mA}, I_F = 5\text{ mA}, t < 1\text{ s}$ | —   | 10   | 15  | $\Omega$ |

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

| Characteristics                     | Symbol | Note     | Test Condition                       | Min | Typ.      | Max | Unit     |
|-------------------------------------|--------|----------|--------------------------------------|-----|-----------|-----|----------|
| Total capacitance (input to output) | $C_S$  | (Note 1) | $V_S = 0\text{ V}, f = 1\text{ MHz}$ | —   | 1         | —   | pF       |
| Isolation resistance                | $R_S$  | (Note 1) | $V_S = 500\text{ V}, R.H. \leq 60\%$ | —   | $10^{14}$ | —   | $\Omega$ |
| Isolation voltage                   | $BV_S$ | (Note 1) | AC, 60 s                             | 500 | —         | —   | Vrms     |

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

## 11. Switching Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$ )

| Characteristics | Symbol    | Note | Test Condition   | Min | Typ. | Max | Unit          |
|-----------------|-----------|------|--|-----|------|-----|---------------|
| Turn-on time    | $t_{ON}$  |      | See Fig. 11.1.<br>$R_L = 200\text{ }\Omega, V_{DD} = 20\text{ V}, I_F = 5\text{ mA}$ | —   | 50   | 200 | $\mu\text{s}$ |
| Turn-off time   | $t_{OFF}$ |      |  | —   | 15   | 200 |               |

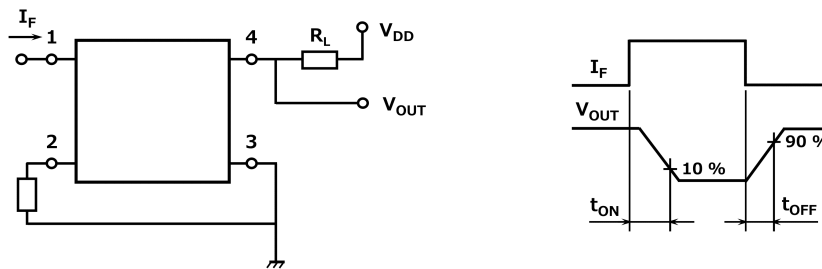


Fig. 11.1 Switching Time Test Circuit and Waveform

## 12. Characteristics Curves (Note)

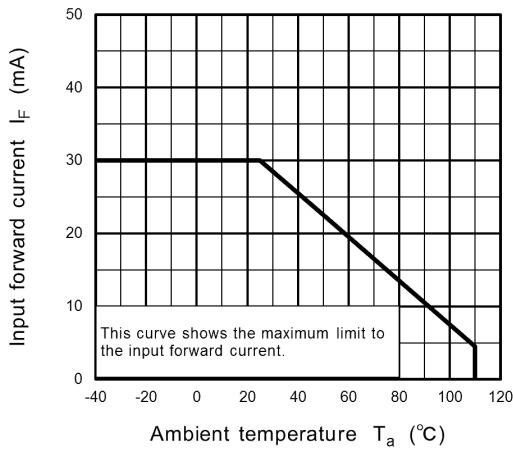


Fig. 12.1  $I_F - T_a$

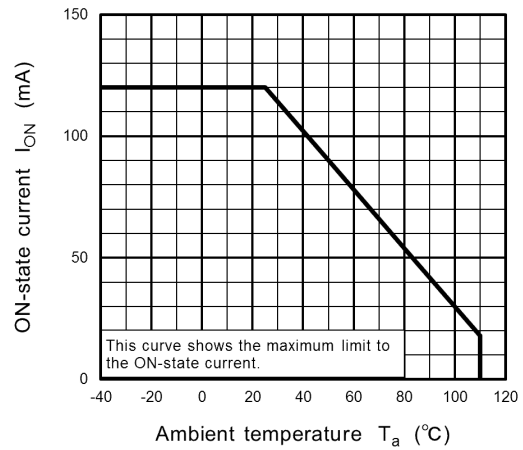


Fig. 12.2  $I_{ON} - T_a$

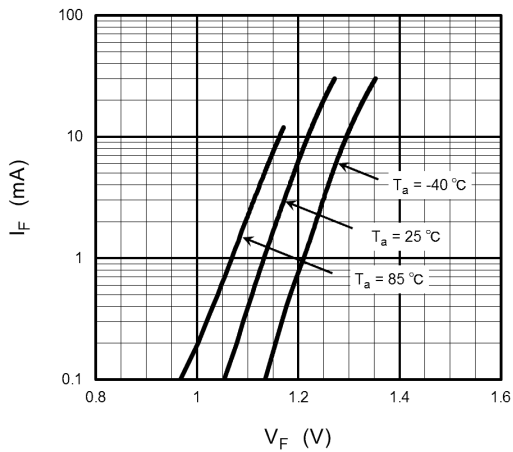


Fig. 12.3  $I_F - V_F$

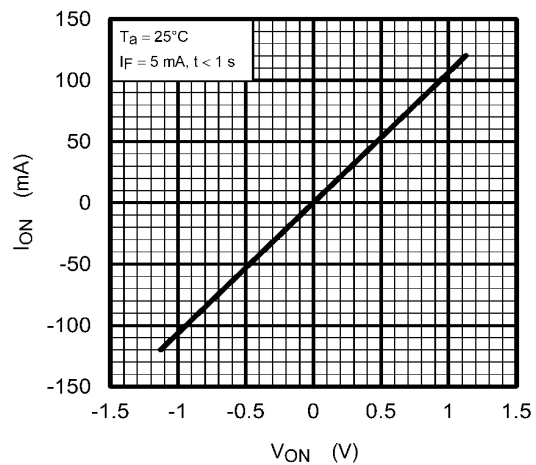


Fig. 12.4  $I_{ON} - V_{ON}$

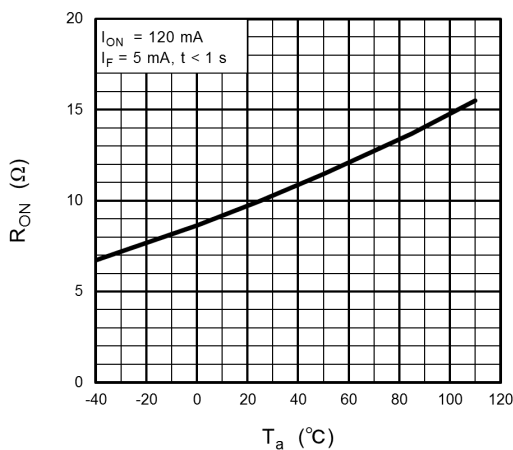


Fig. 12.5  $R_{ON} - T_a$

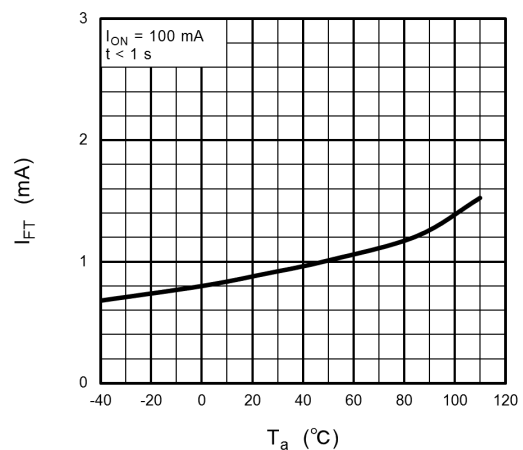


Fig. 12.6  $I_{FT} - T_a$

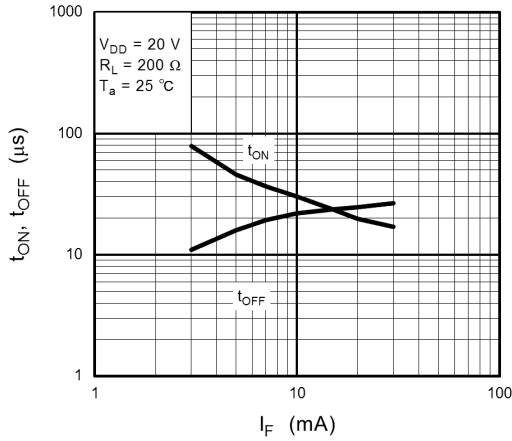


Fig. 12.7  $t_{ON}, t_{OFF} - I_F$

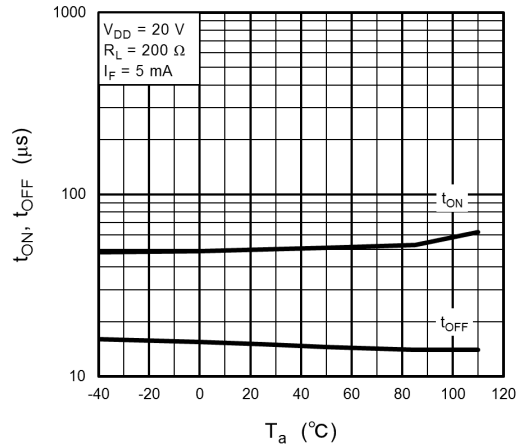


Fig. 12.8  $t_{ON}, t_{OFF} - T_a$

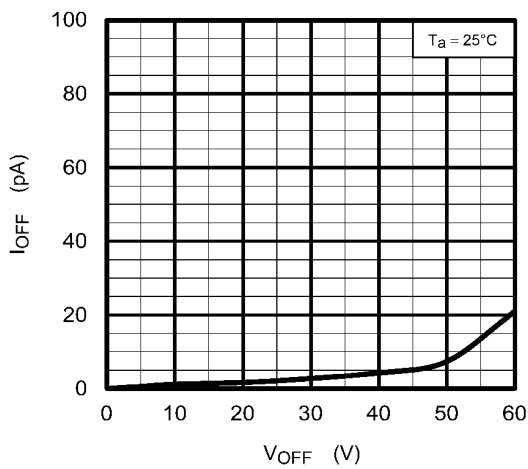


Fig. 12.9  $I_{OFF} - V_{OFF}$

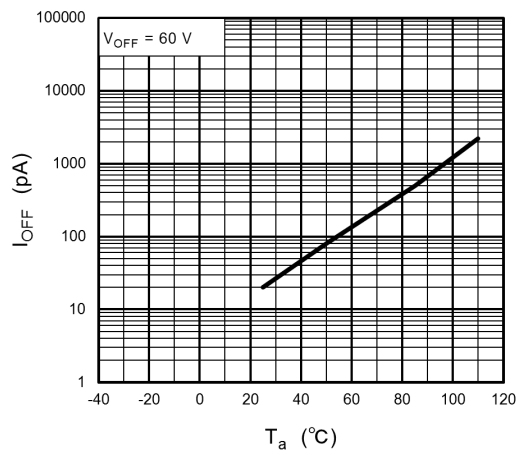


Fig. 12.10  $I_{OFF} - T_a$

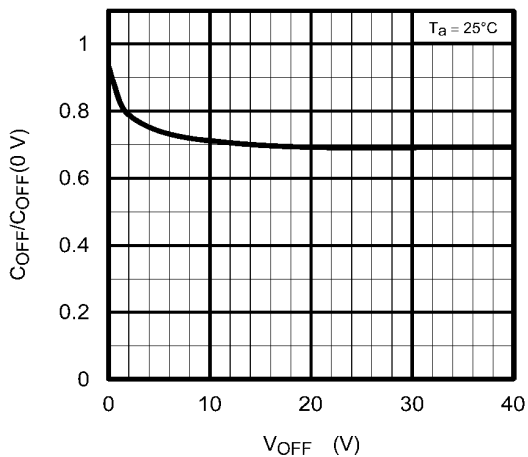


Fig. 12.11  $C_{OFF}/C_{OFF}(0 V) - V_{OFF}$

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.

- When using soldering reflow

(See the figure shown below, which is based on the package surface temperature.)

Reflow soldering may be performed up to twice.

The first reflow soldering should be performed within 168 hours after opening the moisture-proof packaging.

The second reflow soldering must be performed within 168 hours of the first reflow.



|  | 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 |

- When using soldering Iron

Complete soldering within 10 seconds for lead temperature not exceeding 260 °C.

Heating by soldering iron must be done only once per lead.

## 13.2. Precautions for General Storage

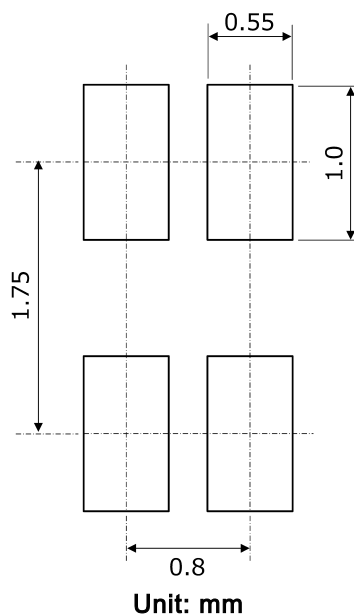
- Avoid storage locations where devices may be exposed to moisture or direct sunlight.
- Do not store the products in locations with poisonous gases (especially corrosive gases) or in dusty conditions.
- Store the products in locations with minimal temperature fluctuations. Rapid temperature changes during storage can cause condensation, resulting in lead oxidation or corrosion, which will deteriorate the solderability of the leads.
- 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.
- Follow the precautions printed on the packing label of the device for transportation and storage.
- Thermal stress may cause a crack in surface-mount products during surface-mount assembly if they have absorbed atmospheric moisture. To prevent a crack, please observe the following precautions.
  1. Moisture-proof bags may be stored unopened for up to 12 months under the following conditions.
    - Temperature: 5 °C to 30 °C
    - Humidity: 90 % (max)
  2. After opening the moisture-proof bag, the devices should be assembled within 168 hours in an environment of 5 °C to 30 °C/70 %RH or below.
  3. If, upon opening, the moisture indicator card shows a humidity of 30 % or above (i.e., has turned pink) or the expiration date has passed, the devices should be baked in tape and reel.

After baking, use the baked devices within 72 hours, but perform baking only once.

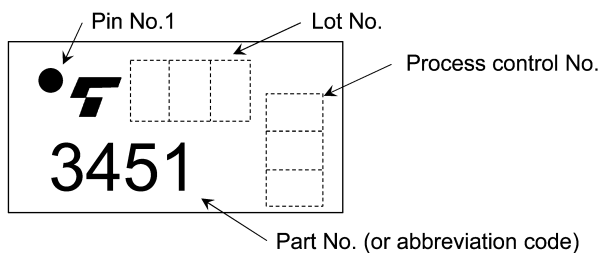
    - Baking conditions: 60±5 °C, for 64 to 72 hours.
    - Expiration date: 12 months from the sealing date, which is imprinted on the label affixed.
  4. Repeated baking can affect the peeling strength of taping and cause a trouble during mounting.

Furthermore, protect the devices against static electricity for baking.
  5. If the laminated packing material is broken, its hermeticity deteriorates. Therefore, do not throw or drop the packed devices.
  6. When restoring devices after removal from their packing, use anti-static containers.

## 14. Land Pattern Dimensions (for reference only)



## 15. Marking



## 16. Ordering Information

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

Example) TLP3451(TP,F 3000 pcs

Part number: TLP3451

Tape type: TP

[[G]]/RoHS COMPATIBLE: F (Note 1)

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

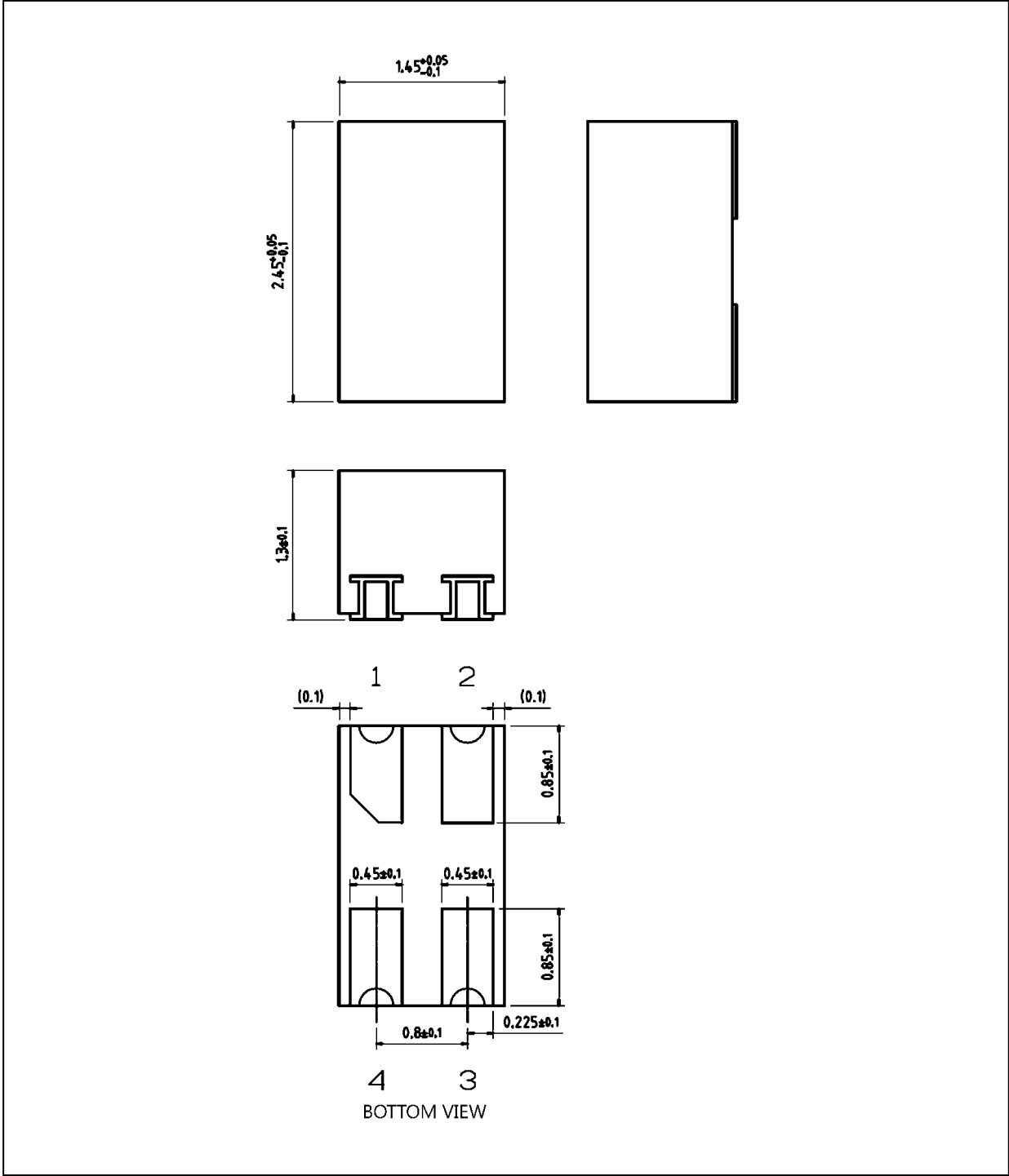
Note 1: Please contact your Toshiba sales representative for details on environmental information such as the product's RoHS compatibility.

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: 10 mg (typ.)

| Package Name(s)  |
|------------------|
| TOSHIBA: 11-2D1A |

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