

# TLP3545A, TLP3545AF

## 1. Applications

- Mechanical relay replacements
- Heating, ventilation and air conditioning (HVAC)
- Security Systems
- Factory Automation (FA)
- Measuring Instruments

## 2. General

The TLP3545A and TLP3545AF photorelay consist of a photo MOSFET optically coupled to an infrared light emitting diode. It is housed in a 6-pin DIP package. The low ON-state resistance and the high permissible ON-state current of the TLP3545A and TLP3545AF make it suitable for power line control applications.

## 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: 4 A (max) (A connection)
- (5) ON-state resistance: 60 mΩ (max) (A connection)
- (6) Isolation voltage: 2500 Vrms (min)
- (7) Safety standards

UL-recognized: UL 1577, File No.E67349

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

UL-recognized: UL 508, File No.E499232 (**Note 1**)

VDE-approved: EN 60747-5-5 (**Note 2**)

(Note 1):Please refer Absolute Maximum Ratings (UL-recognized UL 508) for UL 508 products.

(Note 2):When a VDE approved type is needed, please designate the **Option (D4)**.

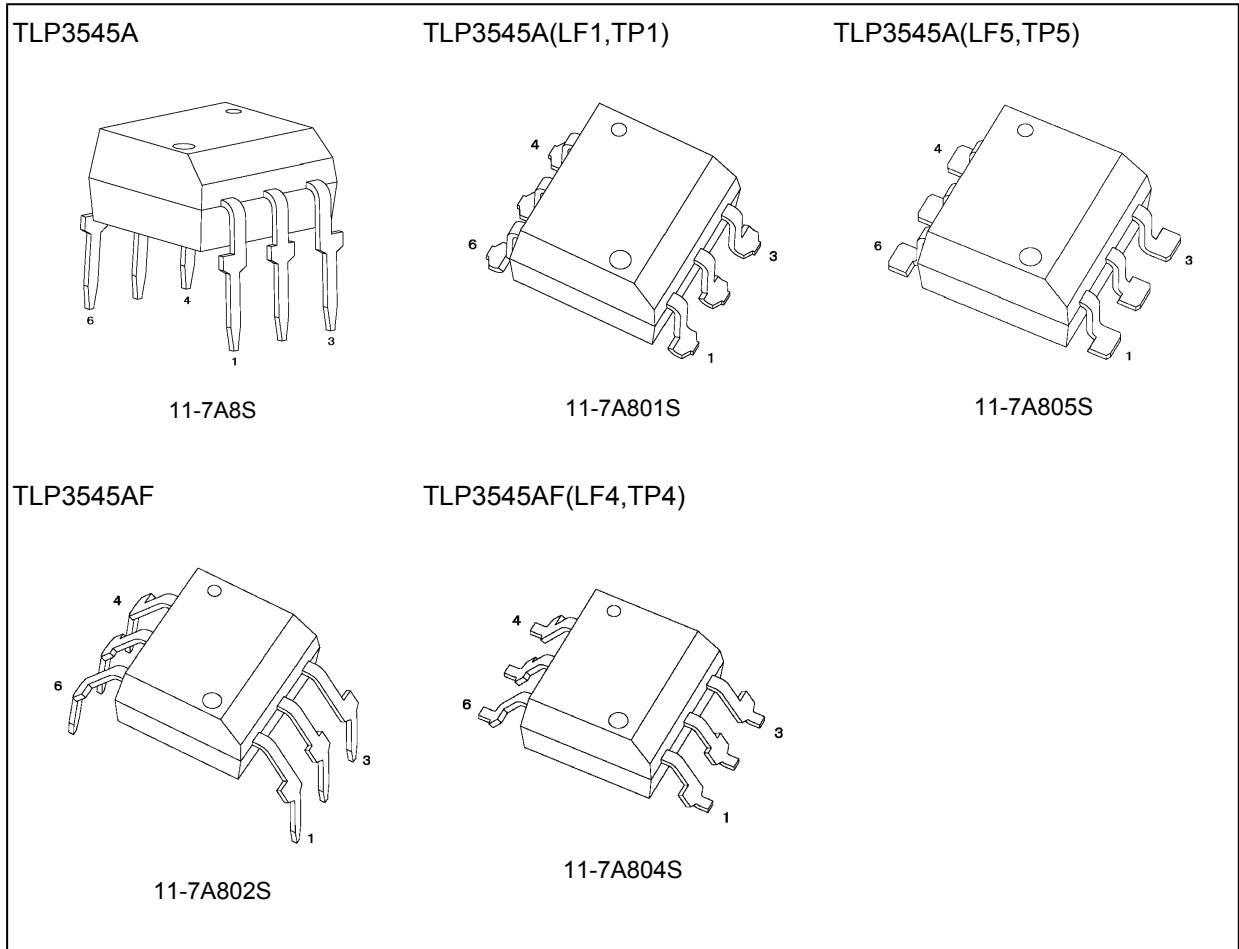
## 4. Mechanical Parameters

| Characteristics              | 7.62-mm pitch<br>TLP3545A | 10.16-mm pitch<br>TLP3545AF | Unit |
|------------------------------|---------------------------|-----------------------------|------|
| Creepage distances           | 7.0 (min)                 | 8.0 (min)                   | mm   |
| Clearance distances          | 7.0 (min)                 | 8.0 (min)                   |      |
| Internal isolation thickness | 0.4 (min)                 | 0.4 (min)                   |      |

Start of commercial production

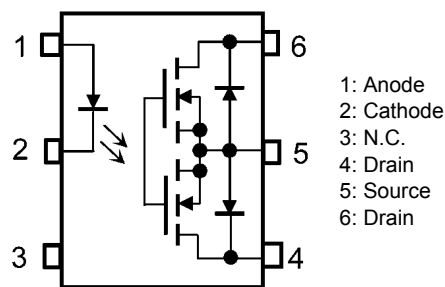
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## 5. Packaging (Note)

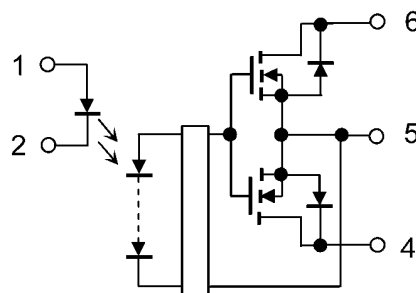


Note: Through-hole type: TLP3545A, TLP3545AF  
 Lead forming option: (LF1), (LF4), (LF5)  
 Taping option: (TP1), (TP4), (TP5)

## 6. Pin Assignment



## 7. Internal Circuit



### 8. 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<br>( $T_a \geq 25\text{ }^\circ\text{C}$ )           | $\Delta I_F / \Delta T_a$    |          | -0.3       | mA/ $^\circ\text{C}$ |                      |
|          | Input forward current (pulsed)<br>(100 $\mu\text{s}$ pulse, 100 pps)                | $I_{FP}$                     |          | 1          | A                    |                      |
|          | Input reverse voltage   | $V_R$                        |          | 6          | V                    |                      |
|          | Input power dissipation   | $P_D$                        |          | 50         | mW                   |                      |
|          | Input power dissipation derating<br>( $T_a \geq 25\text{ }^\circ\text{C}$ )         | $\Delta P_D / \Delta T_a$    |          | -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 (A connection)   | $I_{ON}$                     | (Note 1) | 4          | A                    |                      |
|          | ON-state current (B connection)   |                              |          | 4          |                      |                      |
|          | ON-state current (C connection)   |                              |          | 8          |                      |                      |
|          | ON-state current derating (A connection)<br>( $T_a \geq 25\text{ }^\circ\text{C}$ ) | $\Delta I_{ON} / \Delta T_a$ | (Note 1) | -40        | mA/ $^\circ\text{C}$ |                      |
|          | ON-state current derating (B connection)<br>( $T_a \geq 25\text{ }^\circ\text{C}$ ) |                              |          | -40        |                      |                      |
|          | ON-state current derating (C connection)<br>( $T_a \geq 25\text{ }^\circ\text{C}$ ) |                              |          | -80        |                      |                      |
|          | ON-state current (pulsed)<br>( $t = 100\text{ ms}$ , duty = 1/10)                   | $I_{ONP}$                    |          |            | 12                   | A                    |
|          | Output power dissipation  | $P_O$                        |          |            | 700                  | mW                   |
|          | Output power dissipation derating<br>( $T_a \geq 25\text{ }^\circ\text{C}$ )        | $\Delta P_O / \Delta T_a$    |          |            | -7.0                 | mW/ $^\circ\text{C}$ |
|          | Junction temperature  | $T_j$                        |          |            | 125                  | $^\circ\text{C}$     |
| Common   | Storage temperature   | $T_{stg}$                    |          | -55 to 125 | $^\circ\text{C}$     |                      |
|          | Operating temperature   | $T_{opr}$                    |          | -40 to 110 | $^\circ\text{C}$     |                      |
|          | Lead soldering temperature<br>(10 s)  | $T_{sol}$                    |          | 260        | $^\circ\text{C}$     |                      |
|          | Isolation voltage<br>(AC, 60 s, R.H. $\leq 60\%$ )                                  | $BV_S$                       | (Note 2) |            | 2500                 | 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: For an application circuit example, see Chapter 16.2.

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             |
|--------------------------------|-----------|------|-----|------|-----|------------------|
| Supply voltage                 | $V_{DD}$  |      | —   | —    | 48  | V                |
| Input forward current          | $I_F$     |      | 5   | 10   | 25  | mA               |
| ON-state current(A connection) | $I_{ON}$  |      | —   | —    | 4   | A                |
| Operating temperature          | $T_{opr}$ |      | -40 | —    | 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.

### 10. Absolute Maximum Ratings (UL-recognized: UL 508) (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 forward current (pulsed) (100 $\mu\text{s}$ pulse, 100 pps)                | $I_{FP}$                     |          | 1          | A                    |                      |
|          | Input reverse voltage  | $V_R$                        |          | 6          | 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   | $T_j$                        |          | 105        | $^\circ\text{C}$     |                      |
| Detector | OFF-state output terminal voltage  | $V_{OFF}$                    |          | 60         | V                    |                      |
|          | ON-state current (A connection)  | $I_{ON}$                     | (Note 1) | 4          | A                    |                      |
|          | ON-state current (B connection)  |                              |          | 4          |                      |                      |
|          | ON-state current (C connection)  |                              |          | 8          |                      |                      |
|          | ON-state current derating (A connection) ( $T_a \geq 25\text{ }^\circ\text{C}$ ) | $\Delta I_{ON} / \Delta T_a$ | (Note 1) | -40        | mA/ $^\circ\text{C}$ |                      |
|          | ON-state current derating (B connection) ( $T_a \geq 25\text{ }^\circ\text{C}$ ) |                              |          | -40        |                      |                      |
|          | ON-state current derating (C connection) ( $T_a \geq 25\text{ }^\circ\text{C}$ ) |                              |          | -80        |                      |                      |
|          | ON-state current (pulsed) ( $t = 100\text{ ms}$ , duty = 1/10)                   | $I_{ONP}$                    |          |            | 12                   | A                    |
|          | Output power dissipation   | $P_O$                        |          |            | 700                  | mW                   |
|          | Output power dissipation derating ( $T_a \geq 25\text{ }^\circ\text{C}$ )        | $\Delta P_O / \Delta T_a$    |          |            | -7.0                 | mW/ $^\circ\text{C}$ |
|          | Junction temperature   | $T_j$                        |          |            | 105                  | $^\circ\text{C}$     |
| Common   | Storage temperature  | $T_{stg}$                    |          | -55 to 125 | $^\circ\text{C}$     |                      |
|          | Case temperature   | $T_c$                        |          | 105        | $^\circ\text{C}$     |                      |
|          | Operating temperature  | $T_{opr}$                    |          | -40 to 85  | $^\circ\text{C}$     |                      |
|          | Lead soldering temperature (10 s)  | $T_{sol}$                    |          | 260        | $^\circ\text{C}$     |                      |
|          | Isolation voltage (AC, 60 s, R.H. $\leq 60\%$ )                                  | $BV_S$                       | (Note 2) |            | 2500                 | 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: For an application circuit example, see Chapter 16.2.

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.

### 11. Recommended Operating Conditions (UL-recognized: UL 508) (Note)

| Characteristics                | Symbol    | Note     | Min | Typ. | Max  | Unit             |
|--------------------------------|-----------|----------|-----|------|------|------------------|
| Supply voltage                 | $V_{DD}$  |          | —   | —    | 48   | V                |
| Input forward current          | $I_F$     | (Note 1) | 5   | 10   | 19.5 | mA               |
| ON-state current(A connection) | $I_{ON}$  | (Note 1) | —   | —    | 2.6  | A                |
| 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.

Note 1: The above recommended operating conditions are at  $T_a = 60\text{ }^\circ\text{C}$ .

However, within the derating range of the characteristic curves of " $I_F - T_a$ ", " $I_{ON} - T_a$ ", it can be used up to  $85\text{ }^\circ\text{C}$ .

### 12. 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 | $V_F$     |      | $I_F = 10\text{ mA}$               | 1.50 | 1.64 | 1.80 | V             |
|          | Input reverse current | $I_R$     |      | $V_R = 5\text{ V}$                 | —    | —    | 10   | $\mu\text{A}$ |
|          | Input capacitance     | $C_t$     |      | $V = 0\text{ V}, f = 1\text{ MHz}$ | —    | 70   | —    | pF            |
| Detector | OFF-state current     | $I_{OFF}$ |      | $V_{OFF} = 60\text{ V}$            | —    | 0.01 | 1    | $\mu\text{A}$ |
|          | Output capacitance    | $C_{OFF}$ |      | $V = 0\text{ V}, f = 1\text{ MHz}$ | —    | 640  | —    | pF            |

### 13. 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                | $I_{FT}$ |          | $I_{ON} = 1\text{ A}$                                    | —    | 0.3  | 3   | mA         |
| Return LED current                 | $I_{FC}$ |          | $I_{OFF} = 10\text{ }\mu\text{A}$                        | 0.01 | —    | —   |            |
| ON-state resistance (A connection) | $R_{ON}$ | (Note 1) | $I_{ON} = 3\text{ A}, I_F = 5\text{ mA}, t < 1\text{ s}$ | —    | 35   | 60  | m $\Omega$ |
| ON-state resistance (B connection) |          |          | $I_{ON} = 4\text{ A}, I_F = 5\text{ mA}, t < 1\text{ s}$ | —    | 18   | —   |            |
| ON-state resistance (C connection) |          |          | $I_{ON} = 8\text{ A}, I_F = 5\text{ mA}, t < 1\text{ s}$ | —    | 9    | —   |            |

Note 1: For an application circuit example, see Chapter 16.2.

### 14. 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) | $V_S = 0\text{ V}, f = 1\text{ MHz}$ | —                  | 0.8       | —   | pF       |
| Isolation resistance                | $R_S$  | (Note 1) | $V_S = 500\text{ V}, R.H. \leq 60\%$ | $5 \times 10^{10}$ | $10^{14}$ | —   | $\Omega$ |
| Isolation voltage                   | $BV_S$ | (Note 1) | AC, 60 s                             | 2500               | —         | —   | 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.

### 15. 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. 15.1.<br>$R_L = 200\text{ }\Omega, V_{DD} = 20\text{ V}, I_F = 5\text{ mA}$  | —   | 1.2  | 5   | ms   |
| Turn-off time   | $t_{OFF}$ |      |   | —   | 0.1  | 0.5 |      |
| Turn-on time    | $t_{ON}$  |      | See Fig. 15.1.<br>$R_L = 200\text{ }\Omega, V_{DD} = 20\text{ V}, I_F = 10\text{ mA}$ | —   | 0.5  | 3   |      |
| Turn-off time   | $t_{OFF}$ |      |   | —   | 0.1  | 0.5 |      |

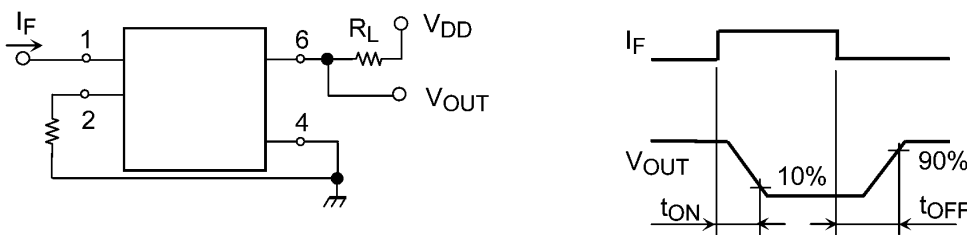


Fig. 15.1 Switching Time Test Circuit and Waveform

## 16. Characteristics Curves and Circuit Connections

### 16.1. Characteristics Curves (Note)

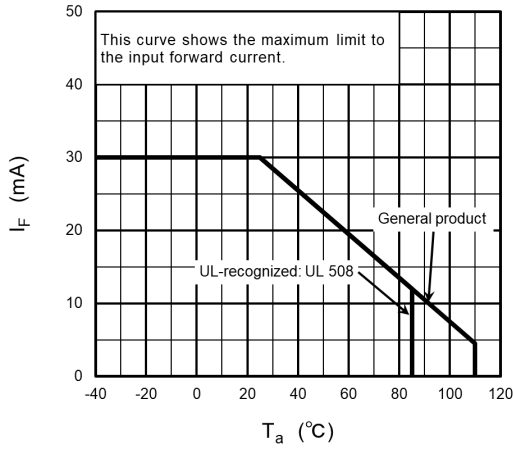


Fig. 16.1.1  $I_F - T_a$

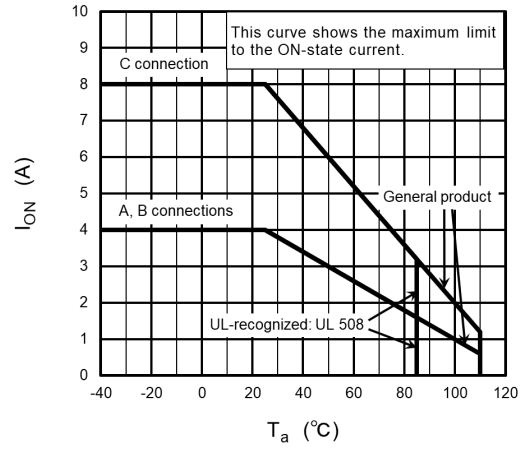


Fig. 16.1.2  $I_{ON} - T_a$

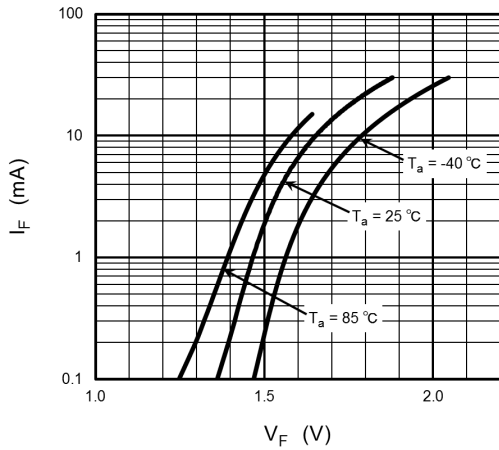


Fig. 16.1.3  $I_F - V_F$

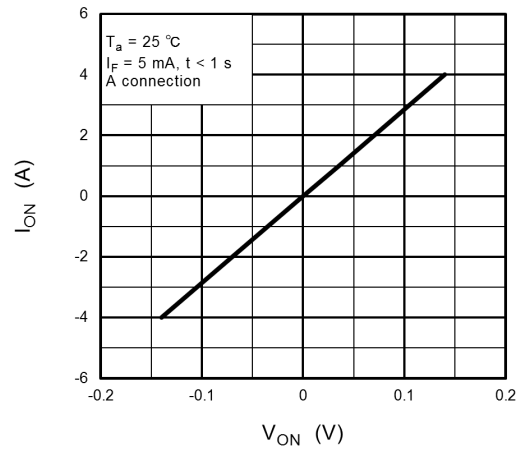


Fig. 16.1.4  $I_{ON} - V_{ON}$

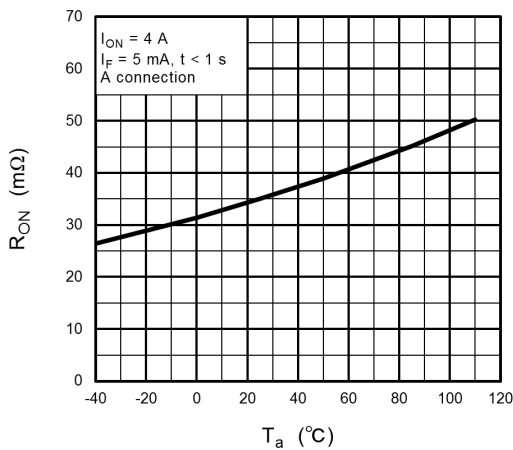


Fig. 16.1.5  $R_{ON} - T_a$

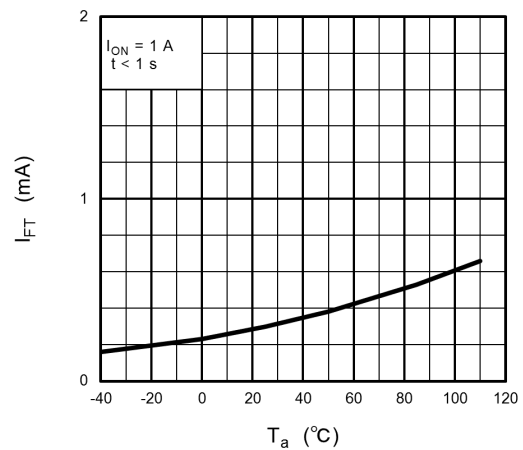


Fig. 16.1.6  $I_{FT} - T_a$

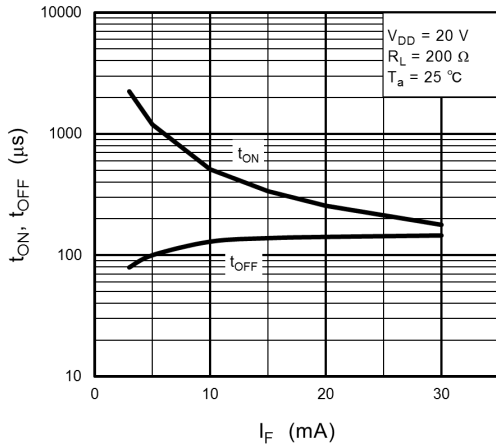


Fig. 16.1.7  $t_{ON}, t_{OFF} - I_F$

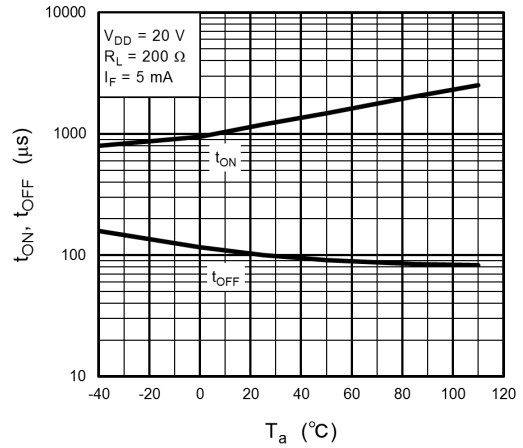


Fig. 16.1.8  $t_{ON}, t_{OFF} - T_a$

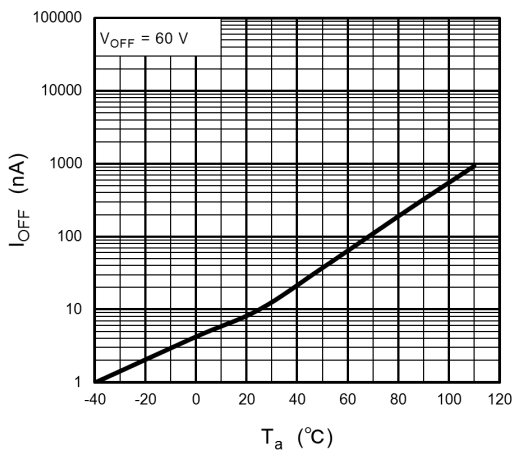


Fig. 16.1.9  $I_{OFF} - T_a$

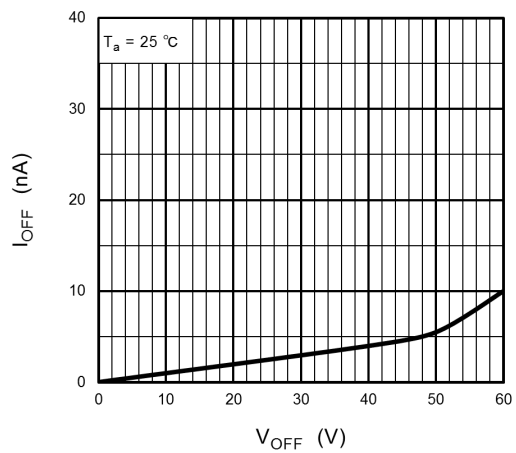


Fig. 16.1.10  $I_{OFF} - V_{OFF}$

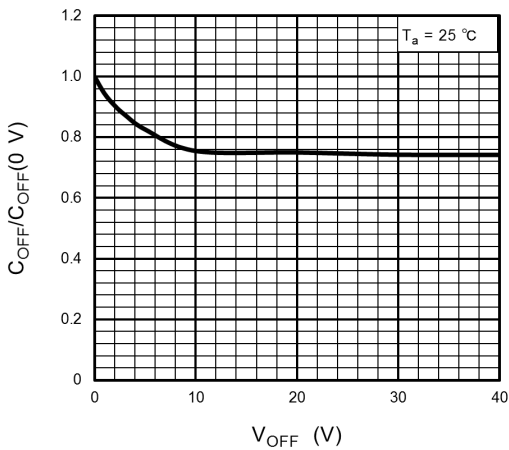
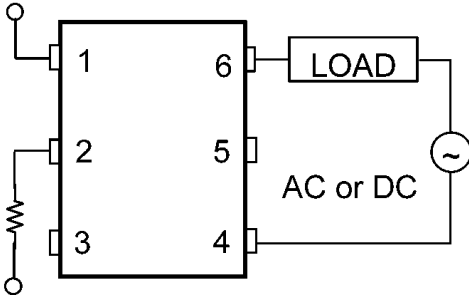


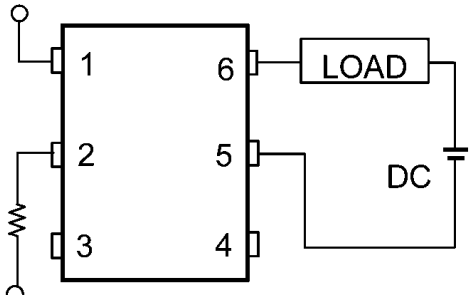
Fig. 16.1.11  $C_{OFF}/C_{OFF}(0\text{ V}) - V_{OFF}$

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

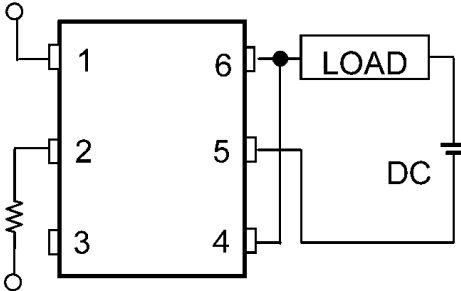
**16.2. Circuit Connections**



**Fig. 16.2.1 A Connection**



**Fig. 16.2.2 B Connection**



**Fig. 16.2.3 C Connection**



### 17. Soldering and Storage

#### 17.1. 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.

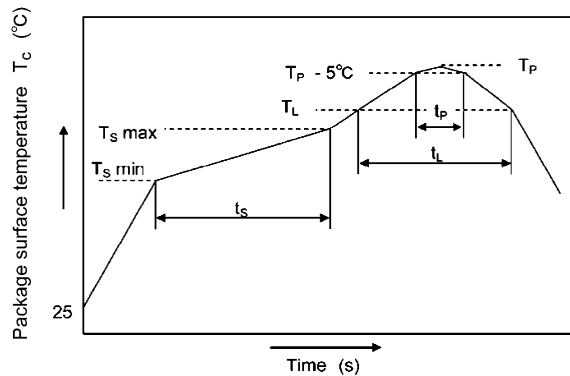
- When using soldering reflow.

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**

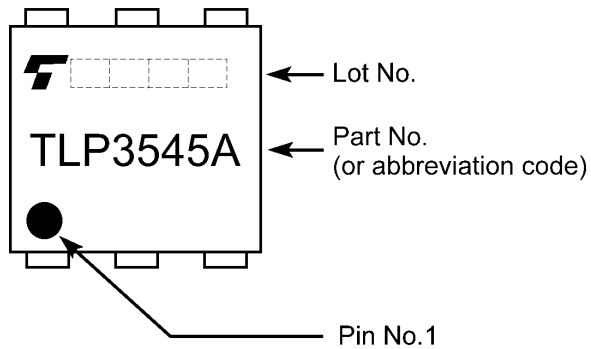
- When using soldering flow  
Preheat the device at a temperature of 150 °C (package surface temperature) for 60 to 120 seconds.  
Mounting condition of 260 °C within 10 seconds is recommended.  
Flow soldering must be performed once.
- When using soldering Iron  
Complete soldering within 10 seconds 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.

#### 17.2. Precautions for General Storage

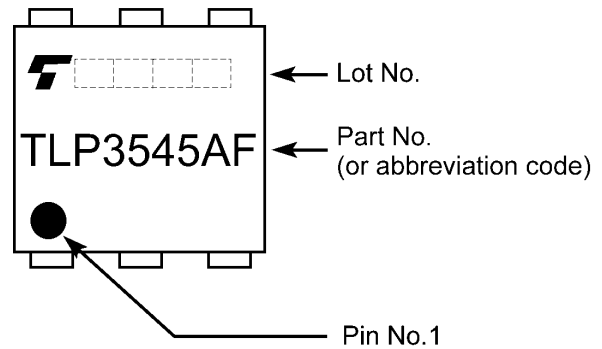
- Avoid storage locations where devices may be exposed to moisture or direct sunlight.
- Follow the precautions printed on the packing label of the device for transportation and storage.
- Keep the storage location temperature and humidity within a range of 5 °C to 35 °C and 45 % to 75 %, respectively.
- 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.

## 18. Marking

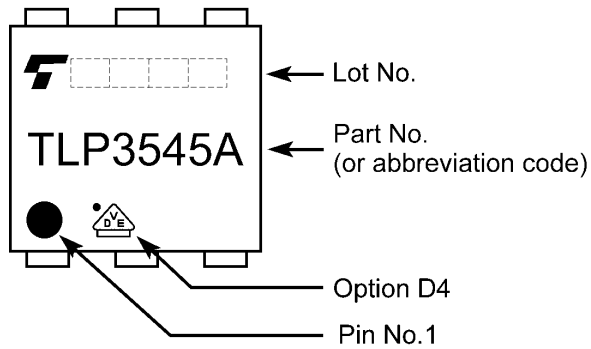
TLP3545A



TLP3545AF

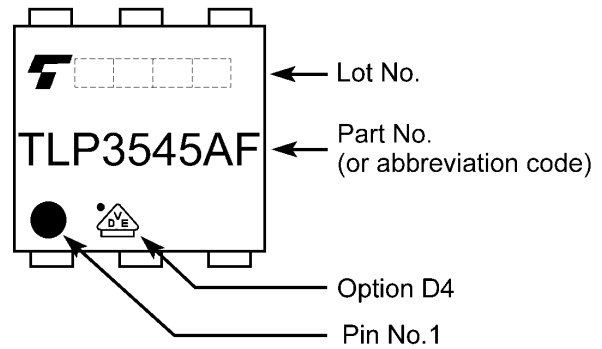


TLP3545A



**Marking of EN 60747-5-5 option  
(VDE-approved) (Note 1)**

TLP3545AF



**Marking of EN 60747-5-5 option  
(VDE-approved) (Note 1)**

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

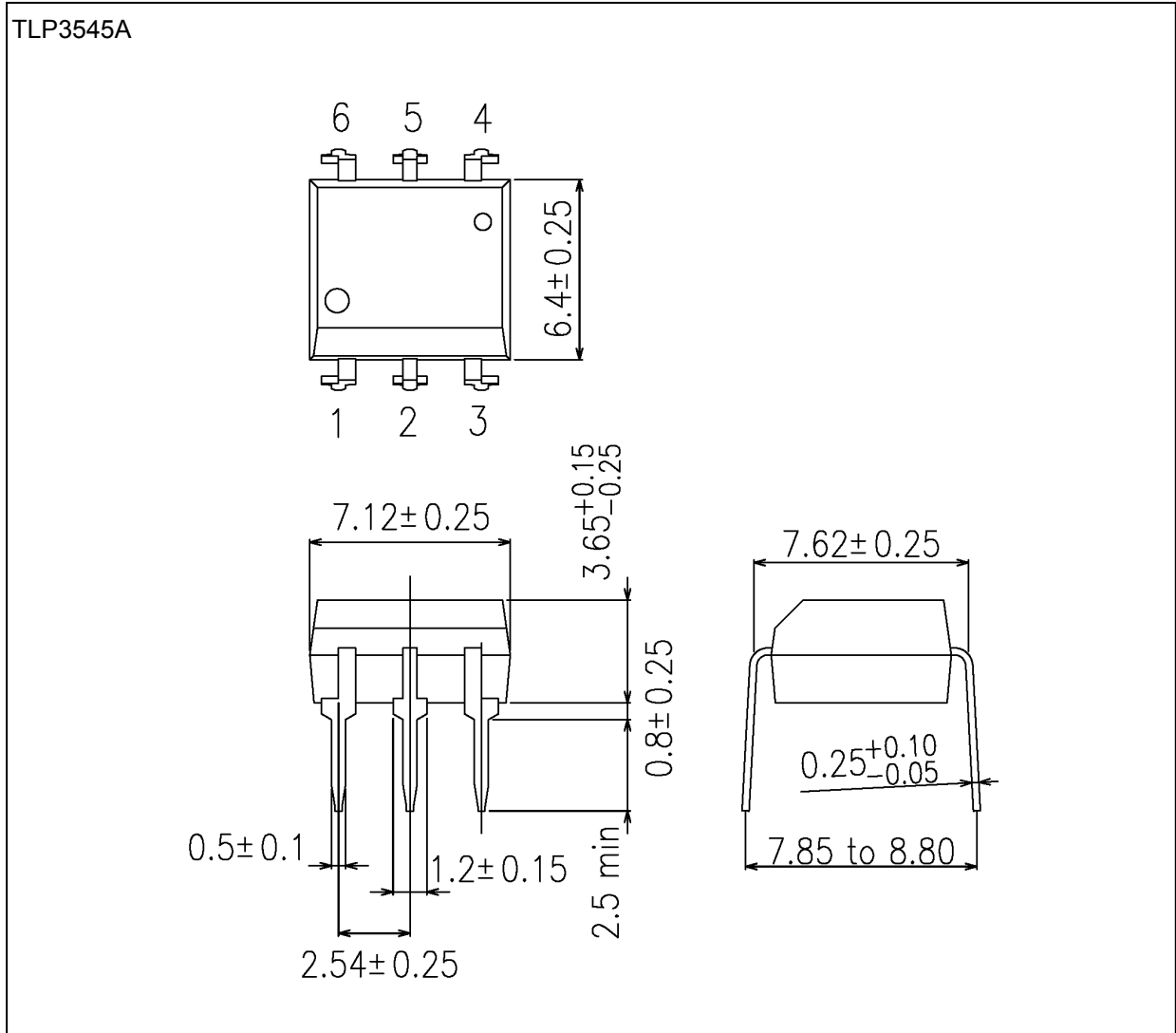
## 19. Ordering Information (Example of Item Name)

| Item Name         | Packaging (Note 1) | VDE Option   | Packing (MOQ)            |
|-------------------|--------------------|--------------|--------------------------|
| TLP3545A(F)       | TH                 |              | Magazine (50 pcs)        |
| TLP3545A(LF1,F)   | LF1                |              | Magazine (50 pcs)        |
| TLP3545A(LF5,F)   | LF5                |              | Magazine (50 pcs)        |
| TLP3545A(TP1,F)   | LF1                |              | Tape and reel (1500 pcs) |
| TLP3545A(TP5,F)   | LF5                |              | Tape and reel (1500 pcs) |
| TLP3545A(D4,F)    | TH                 | EN 60747-5-5 | Magazine (50 pcs)        |
| TLP3545A(D4LF1,F) | LF1                | EN 60747-5-5 | Magazine (50 pcs)        |
| TLP3545A(D4LF5,F) | LF5                | EN 60747-5-5 | Magazine (50 pcs)        |
| TLP3545A(D4TP1,F) | LF1                | EN 60747-5-5 | Tape and reel (1500 pcs) |
| TLP3545A(D4TP5,F) | LF5                | EN 60747-5-5 | Tape and reel (1500 pcs) |
| TLP3545AF(F)      | TH, Wide forming   |              | Magazine (50 pcs)        |
| TLP3545AF(LF4,F)  | LF4, Wide forming  |              | Magazine (50 pcs)        |
| TLP3545AF(TP4,F)  | LF4, Wide forming  |              | Tape and reel (1000 pcs) |
| TLP3545AF(D4,F)   | TH, Wide forming   | EN 60747-5-5 | Magazine (50 pcs)        |
| TLP3545AF(D4LF4F) | LF4, Wide forming  | EN 60747-5-5 | Magazine (50 pcs)        |
| TLP3545AF(D4TP4F) | LF4, Wide forming  | EN 60747-5-5 | Tape and reel (1000 pcs) |

Note 1: TH: Through-hole, LF: Lead forming for surface mount

## Package Dimensions

Unit: mm

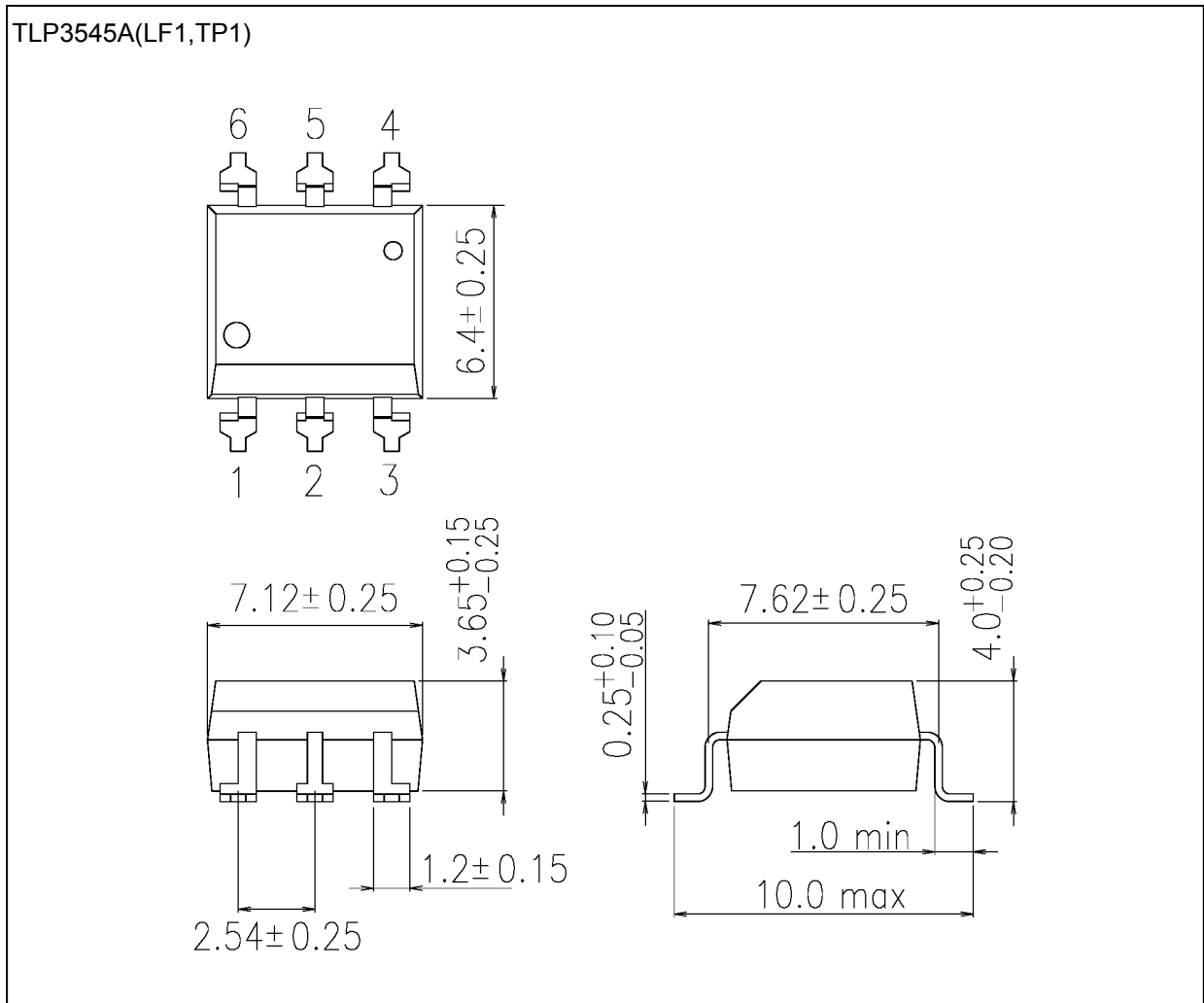


Weight: 0.4 g (typ.)

| Package Name(s)  |
|------------------|
| TOSHIBA: 11-7A8S |

## Package Dimensions

Unit: mm

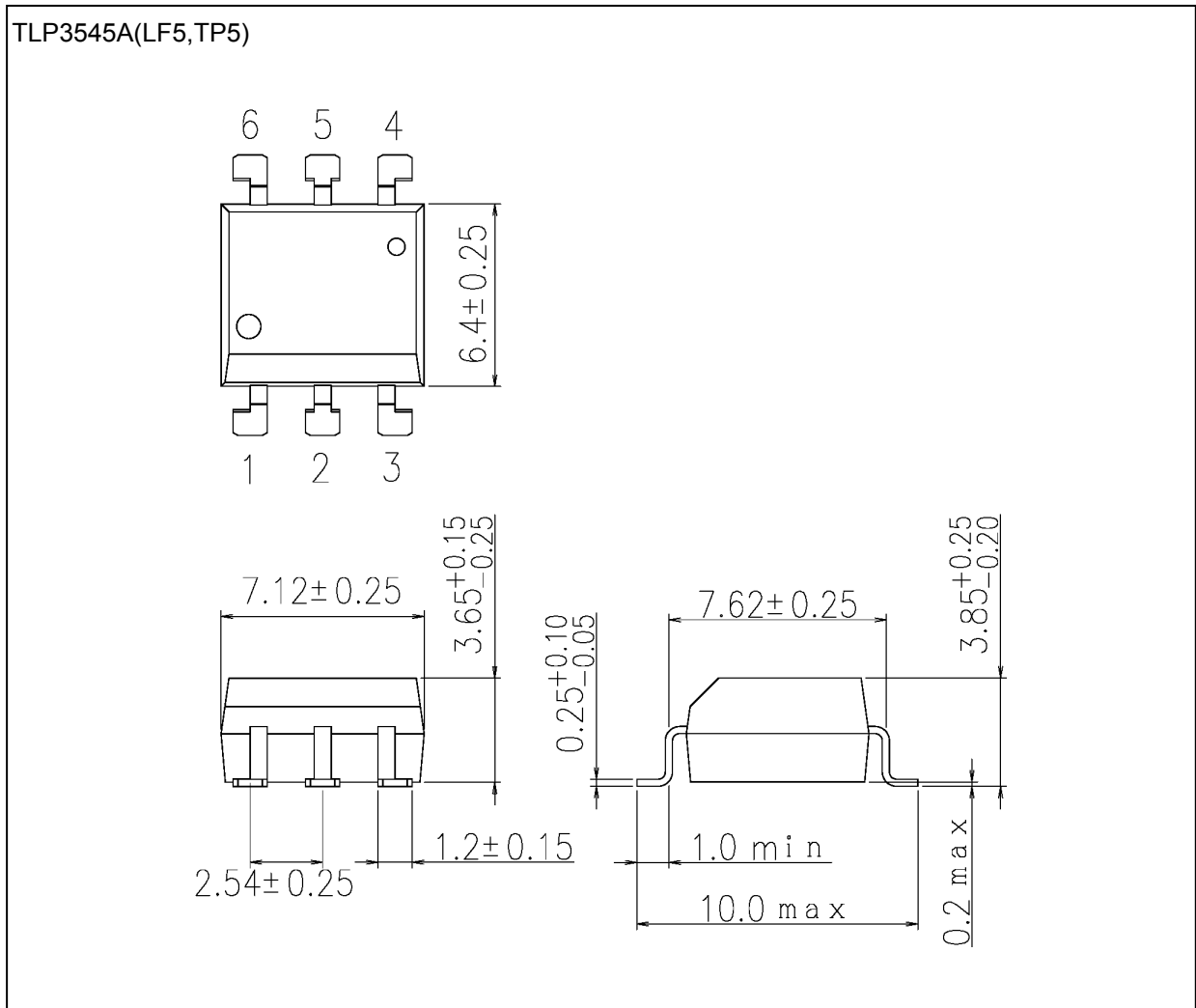


Weight: 0.39 g (typ.)

| Package Name(s)    |
|--------------------|
| TOSHIBA: 11-7A801S |

## Package Dimensions

Unit: mm

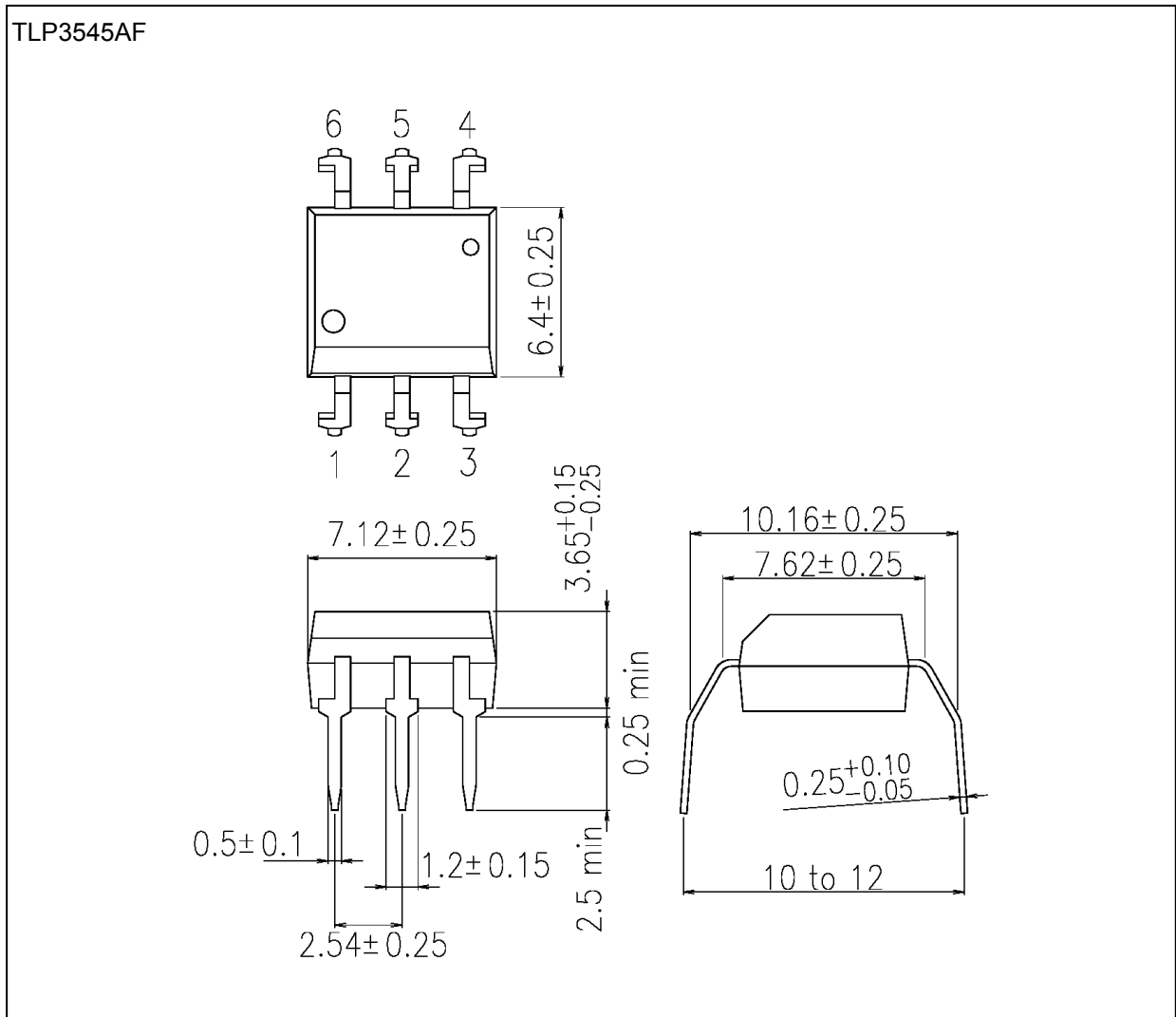


Weight: 0.39 g (typ.)

| Package Name(s)    |
|--------------------|
| TOSHIBA: 11-7A805S |

## Package Dimensions

Unit: mm

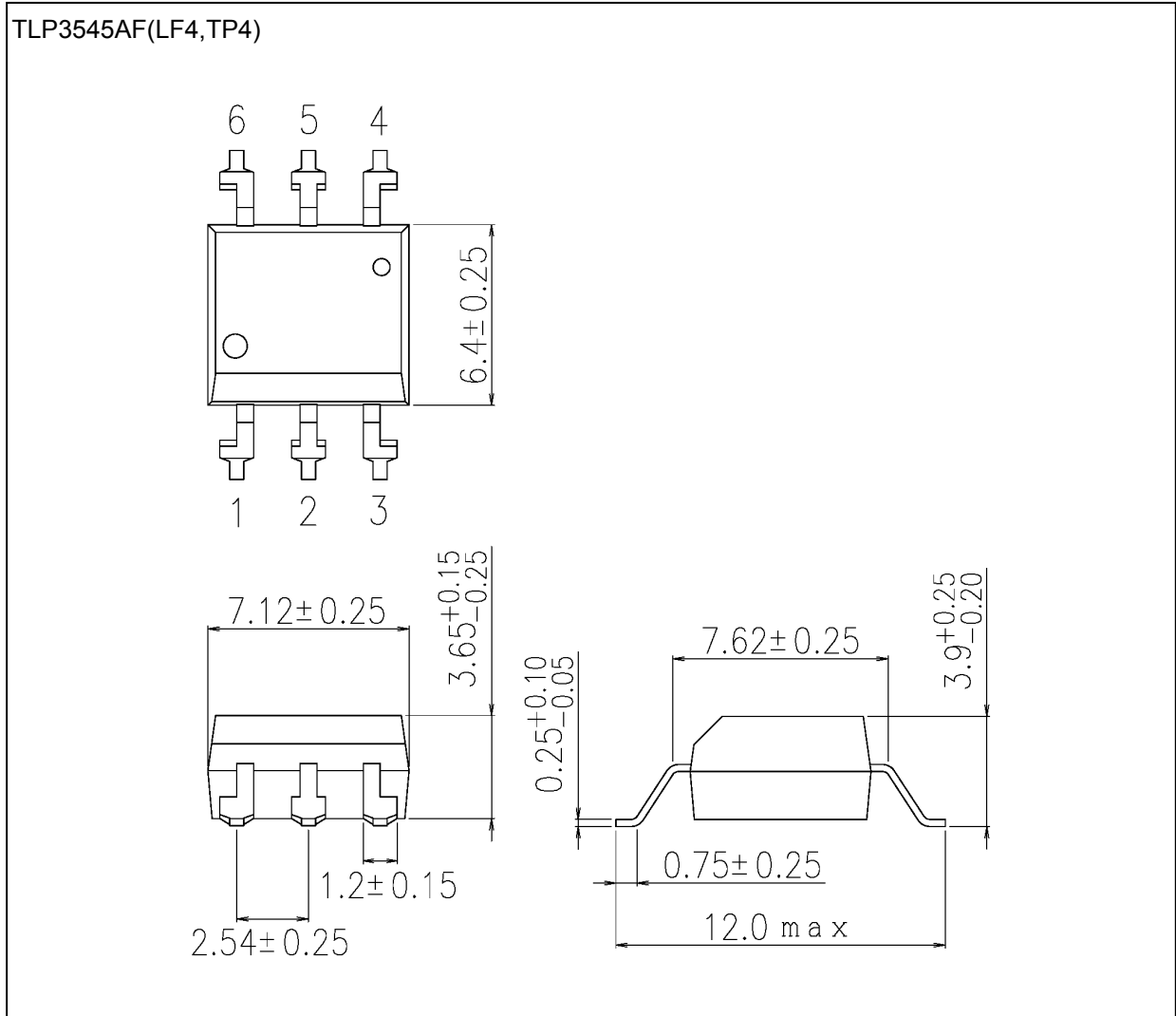


Weight: 0.4 g (typ.)

| Package Name(s)    |
|--------------------|
| TOSHIBA: 11-7A802S |

## Package Dimensions

Unit: mm



Weight: 0.39 g (typ.)

| Package Name(s)    |
|--------------------|
| TOSHIBA: 11-7A804S |



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