Photocouplers Photorelay

# TLP3547,TLP3547F

## 1. Applications

- Mechanical relay replacements
- Factory Automation (FA)
- Programmable Logic Controllers (PLCs)
- Measuring Instruments
- ATE (Automatic Test Equipment)

## 2. General

The TLP3547 and TLP3547F photorelay consist of a photo MOSFET optically coupled to an infrared LED. It is housed in a 8-pin DIP package. The low ON-state resistance and the high permissible ON-state current of the TLP3547 and TLP3547F 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: 5.0 mA (max)
(4) ON-state current: 5 A (max) (A connection)
(5) ON-state resistance: 50 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 TLP3547 | 10.16-mm Pitch TLP3547F | 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) | |

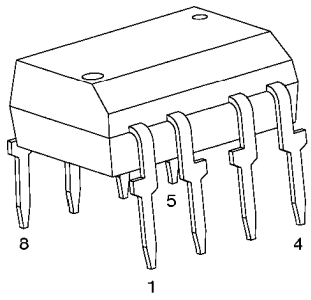
Start of commercial production
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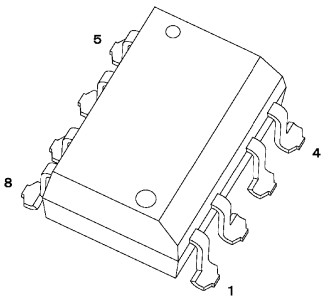
## 5. Packaging (Note)

TLP3547



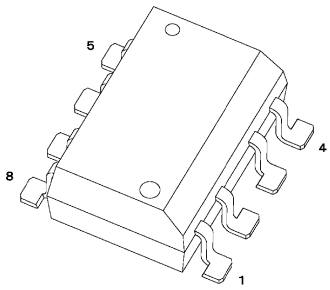

11-10C4S

TLP3547(LF1,TP1)



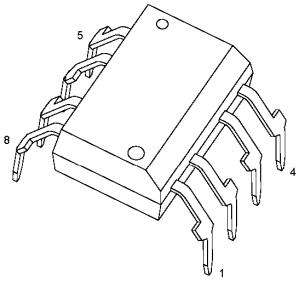

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TLP3547(LF5,TP5)



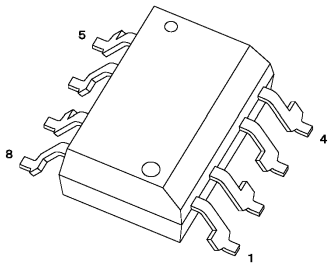

11-10C405S

TLP3547F




11-10C402S

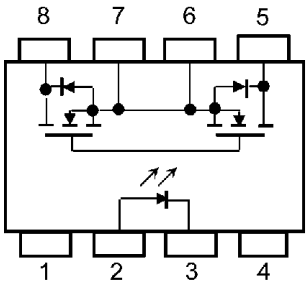
TLP3547F(LF4,TP4)




11-10C404S

Note: Through-hole type: TLP3547, TLP3547F
Lead forming option: (LF1), (LF4), (LF5)
Taping option: (TP1), (TP4), (TP5)

## 6. Pin Assignment

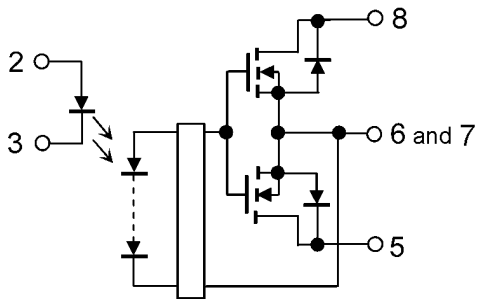



1: N.C.
2: Anode
3: Cathode
4: N.C.
5: Drain
6: Source
7: Source
8: Drain

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## 7. Internal Circuit




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

| | Characteristics | | Symbol | Note | Rating | Unit |
|---|---|---|---|---|---|---|
| LED | Input forward current | | $I_F$ | | 30 | mA |
| | Input forward current derating | ($T_a \geq$ 25 °C) | $\Delta I_F/\Delta T_a$ | | -0.3 | mA/°C |
| | Input forward current (pulsed) | (100 μs pulse, 100 pps) | $I_{FP}$ | | 1 | A |
| | Input reverse voltage | | $V_R$ | | 5 | V |
| | Input power dissipation | | $P_D$ | | 50 | mW |
| | Input power dissipation derating | ($T_a \geq$ 25 °C) | $\Delta P_D/\Delta T_a$ | | -0.5 | mW/°C |
| | Junction temperature | | $T_j$ | | 125 | °C |
| Detector | OFF-state output terminal voltage | | $V_{OFF}$ | | 60 | V |
| | ON-state current (A connection) | | $I_{ON}$ | (Note 1) | 5 | A |
| | ON-state current (B connection) | | | | 5 | |
| | ON-state current (C connection) | | | | 10 | |
| | ON-state current derating (A connection) | ($T_a \geq$ 25 °C) | $\Delta I_{ON}/\Delta T_a$ | (Note 1) | -50 | mA/°C |
| | ON-state current derating (B connection) | ($T_a \geq$ 25 °C) | | | -50 | |
| | ON-state current derating (C connection) | ($T_a \geq$ 25 °C) | | | -100 | |
| | ON-state current (pulsed) | (t = 100 ms, duty = 1/10) | $I_{ONP}$ | | 15 | A |
| | Output power dissipation | | $P_O$ | | 750 | mW |
| | Output power dissipation derating | ($T_a \geq$ 25 °C) | $\Delta P_O/\Delta T_a$ | | -7.5 | mW/°C |
| | Junction temperature | | $T_j$ | | 125 | °C |
| Common | Storage temperature | | $T_{stg}$ | | -55 to 125 | |
| | Operating temperature | | $T_{opr}$ | | -40 to 85 | |
| | Lead soldering temperature | (10 s) | $T_{sol}$ | | 260 | |
| | Isolation voltage | AC, 60 s, R.H. ≤ 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, 3 and 4 are shorted together, and pins 5, 6, 7 and 8 are shorted together.

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## 9. Recommended Operating Conditions (Note)

| Characteristics | Symbol | Note | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| Supply voltage | $V_{DD}$ | | — | — | 48 | V |
| Input forward current | $I_F$ | | — | 5 | 25 | mA |
| ON-state current (A connection) | $I_{ON}$ | | — | — | 5 | A |
| Operating temperature | $T_{opr}$ | | -40 | — | 85 | °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 °C)

| | Characteristics | | Symbol | Note | Rating | Unit |
|---|---|---|---|---|---|---|
| LED | Input forward current | | $I_F$ | | 30 | mA |
| | Input forward current derating | ($T_a \geq 25$ °C) | $\Delta I_F/\Delta T_a$ | | -0.3 | mA/°C |
| | Input forward current (pulsed) | (100 μs pulse, 100 pps) | $I_{FP}$ | | 1 | A |
| | Input reverse voltage | | $V_R$ | | 5 | V |
| | Input power dissipation | | $P_D$ | | 50 | mW |
| | Input power dissipation derating | ($T_a \geq 25$ °C) | $\Delta P_D/\Delta T_a$ | | -0.5 | mW/°C |
| | Junction temperature | | $T_j$ | | 105 | °C |
| Detector | OFF-state output terminal voltage | | $V_{OFF}$ | | 60 | V |
| | ON-state current (A connection) | | $I_{ON}$ | (Note 1) | 5 | A |
| | ON-state current (B connection) | | | | 5 | |
| | ON-state current (C connection) | | | | 10 | |
| | ON-state current derating (A connection) | ($T_a \geq 25$ °C) | $\Delta I_{ON}/\Delta T_a$ | (Note 1) | -50 | mA/°C |
| | ON-state current derating (B connection) | ($T_a \geq 25$ °C) | | | -50 | |
| | ON-state current derating (C connection) | ($T_a \geq 25$ °C) | | | -100 | |
| | ON-state current (pulsed) | (t = 100 ms, duty = 1/10) | $I_{ONP}$ | | 15 | A |
| | Output power dissipation | | $P_O$ | | 750 | mW |
| | Output power dissipation derating | ($T_a \geq 25$ °C) | $\Delta P_O/\Delta T_a$ | | -7.5 | mW/°C |
| | Junction temperature | | $T_j$ | | 105 | °C |
| Common | Storage temperature | | $T_{stg}$ | | -55 to 125 | °C |
| | Case temperature | | $T_c$ | | 105 | °C |
| | Operating temperature | | $T_{opr}$ | | -40 to 85 | °C |
| | Lead soldering temperature | (10 s) | $T_{sol}$ | | 260 | °C |
| | Isolation voltage | (AC, 60 s, R.H. ≤ 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, 3 and 4 are shorted together, and pins 5, 6, 7 and 8 are shorted together.

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## 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 | 19.5 | mA |
| ON-state current(A connection) | $I_{ON}$ | (Note 1) | — | — | 3.3 | A |
| Operating temperature | $T_{opr}$ | | -20 | — | 85 | °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 °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 °C.

## 12. Electrical Characteristics (Unless otherwise specified, $T_a$ = 25 °C)

| | Characteristics | Symbol | Note | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|---|---|
| LED | Input forward voltage | $V_F$ | | $I_F$ = 10 mA | 1.50 | 1.64 | 1.80 | V |
| | Input reverse current | $I_R$ | | $V_R$ = 5 V | — | — | 10 | μA |
| | Input capacitance | $C_t$ | | V = 0 V, f = 1 MHz | — | 70 | — | pF |
| Detector | OFF-state current | $I_{OFF}$ | | $V_{OFF}$ = 60 V | — | 0.01 | 1 | μA |
| | Output capacitance | $C_{OFF}$ | | V = 0 V, f = 1 MHz | — | 850 | — | pF |

## 13. Coupled Electrical Characteristics (Unless otherwise specified, $T_a$ = 25 °C)

| Characteristics | Symbol | Note | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|---|
| Trigger LED current | $I_{FT}$ | | $I_{ON}$ = 1 A | — | 0.28 | 5.0 | mA |
| Return LED current | $I_{FC}$ | | $I_{OFF}$ = 1 μA | 0.01 | 0.19 | — | |
| ON-state resistance (A connection) | $R_{ON}$ | (Note 1) | $I_{ON}$ = 1 A, $I_F$ = 5 mA, t < 1 s | — | 22 | 50 | mΩ |
| ON-state resistance (B connection) | | | $I_{ON}$ = 1 A, $I_F$ = 2 mA, t < 1 s | — | — | 25 | |
| ON-state resistance (C connection) | | | $I_{ON}$ = 1 A, $I_F$ = 2 mA, t < 1 s | — | — | 13 | |

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

## 14. 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 | — | 0.8 | — | pF |
| Isolation resistance | $R_S$ | (Note 1) | $V_S$ = 500 V, R.H. ≤ 60 % | $5\times10^{10}$ | $10^{14}$ | — | Ω |
| 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, 3 and 4 are shorted together, and pins 5, 6, 7 and 8 are shorted together.

## 15. Switching Characteristics (Unless otherwise specified, $T_a$ = 25 °C)

| Characteristics | Symbol | Note | Test Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|---|
| Turn-on time | $t_{ON}$ | | See Fig. 15.1. $R_L$ = 200 Ω, $V_{DD}$ = 20 V, $I_F$ = 5 mA | — | 2.5 | 5.0 | ms |
| Turn-off time | $t_{OFF}$ | | | — | 0.1 | 1.0 | |

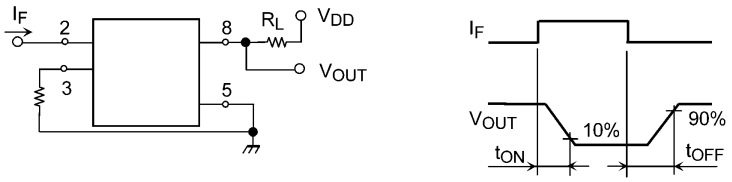



**Fig. 15.1 Switching Time Test Circuit and Waveform**



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# 16. Characteristics Curves and Circuit Connections

## 16.1. Characteristics Curves (Note)

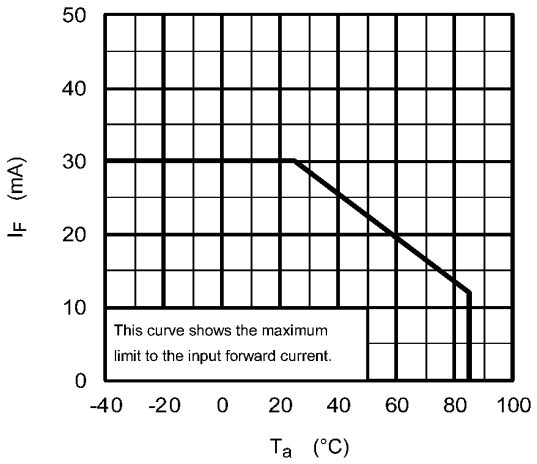



Fig. 16.1.1 $I_F$ - $T_a$

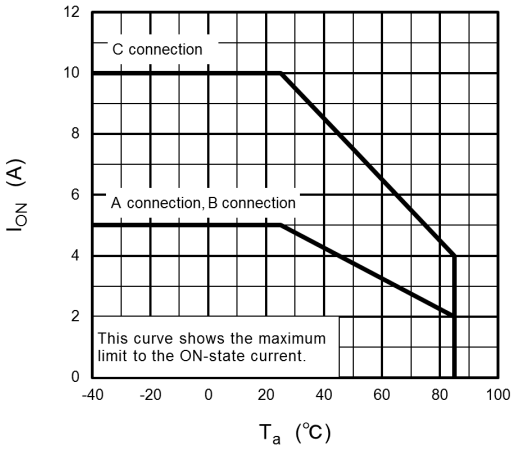



Fig. 16.1.2 $I_{ON}$ - $T_a$

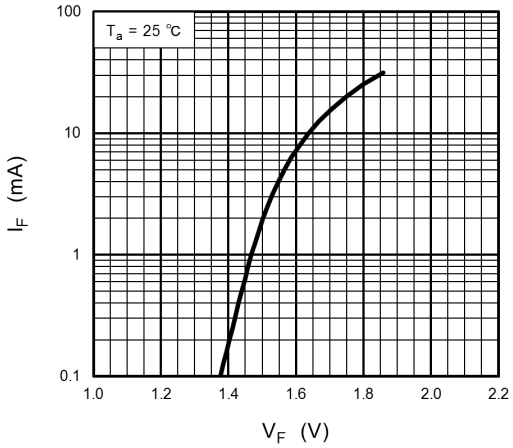



Fig. 16.1.3 $I_F$ - $V_F$

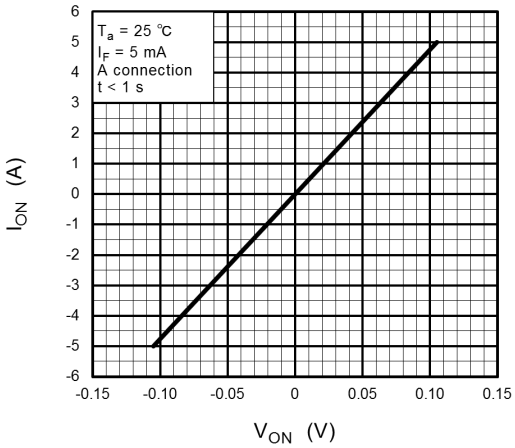



Fig. 16.1.4 $I_{ON}$ - $V_{ON}$

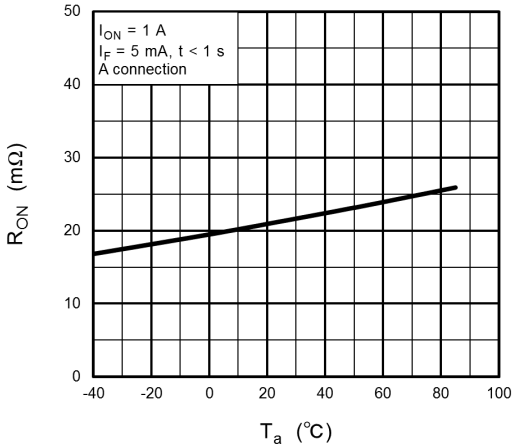



Fig. 16.1.5 $R_{ON}$ - $T_a$

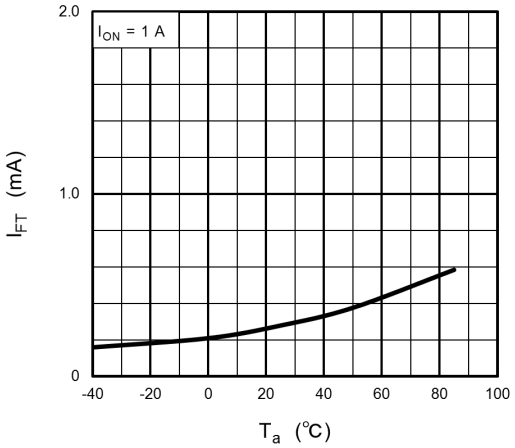



Fig. 16.1.6 $I_{FT}$ - $T_a$

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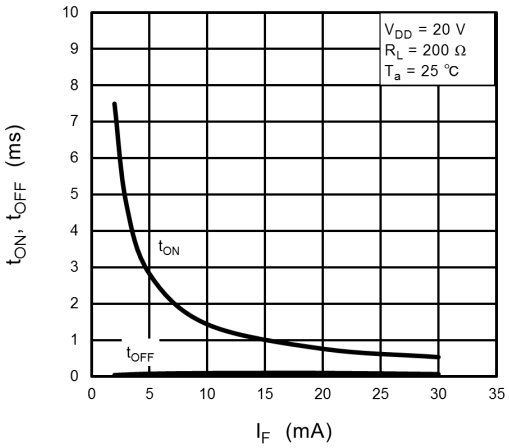



Fig. 16.1.7 $t_{ON}$, $t_{OFF}$ - $I_F$

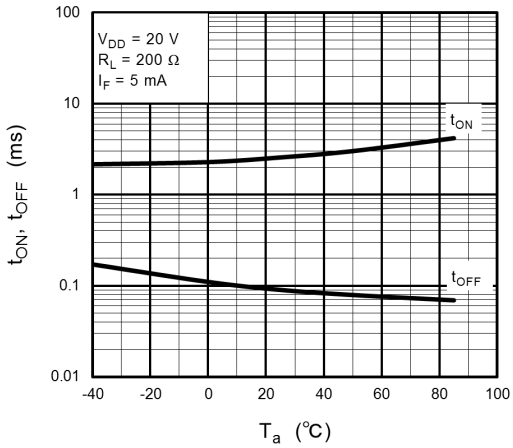



Fig. 16.1.8 $t_{ON}$, $t_{OFF}$ - $T_a$

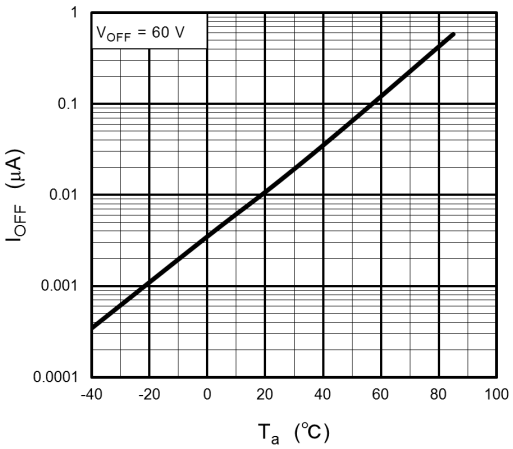



Fig. 16.1.9 $I_{OFF}$ - $T_a$

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



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## 16.2. Circuit Connections

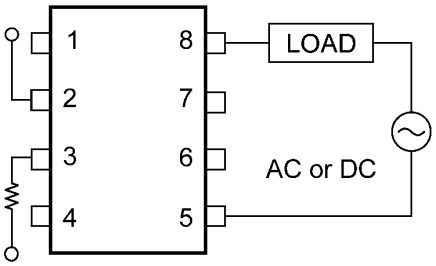



Fig. 16.2.1 A Connection

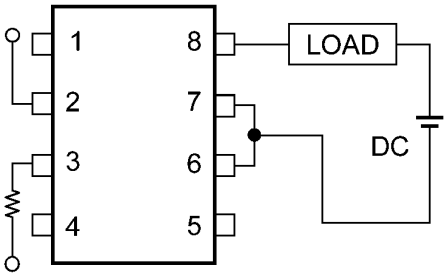



Fig. 16.2.2 B Connection

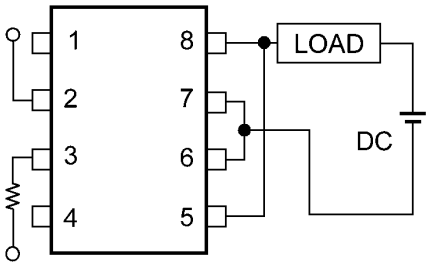



Fig. 16.2.3 C Connection



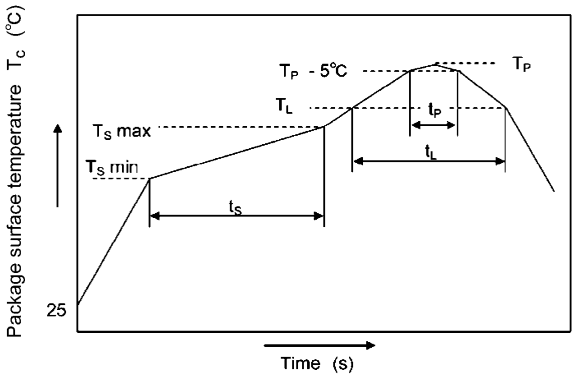
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# 17. Soldering and Storage

## 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 |

**Fig. 17.1.1 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.

## 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.

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

(Unit: mm)

TLP3547

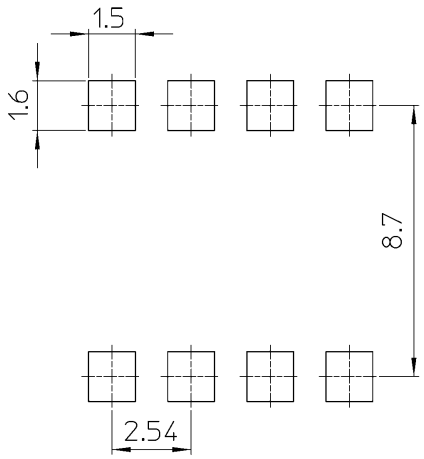



**Fig. 18.1 Lead forming and taping option**
(LF1), (TP1), (LF5), (TP5)

TLP3547F

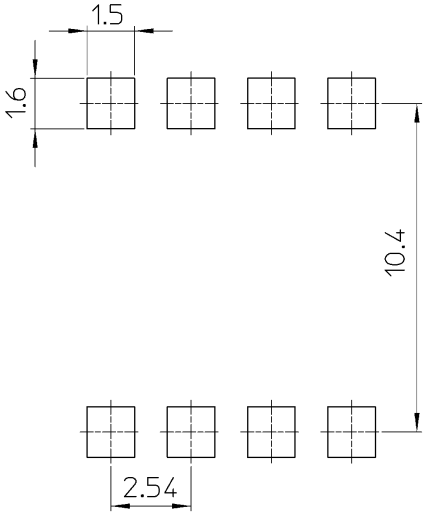
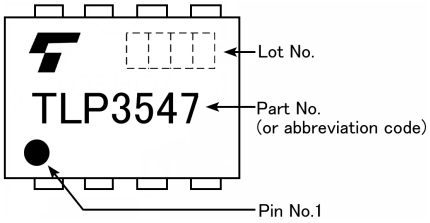


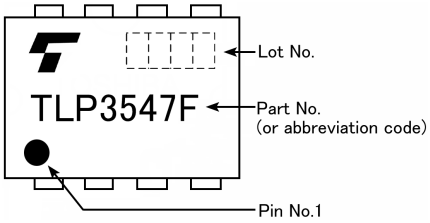

**Fig. 18.2 Lead forming and taping option**
(LF4), (TP4)

## 19. Marking

TLP3547




TLP3547F






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## 20. EN 60747-5-5 Option (D4) Specification

- Part number: TLP3547, TLP3547F **(Note)**
- The following part naming conventions are used for the devices that have been qualified according to option (D4) of EN 60747.

Example: TLP3547(D4,TP1,F

D4: EN 60747 option
TP1: Tape type
F: [[G]]/RoHS COMPATIBLE **(Note 1)**

Note: Use TOSHIBA standard type number for safety standard application.
e.g., TLP3547(D4,TP1,F → TLP3547

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.

| Description | | Symbol | Rating | Unit |
|---|---|---|---|---|
| Application classification<br><br>for rated mains voltage ≤ 300 Vrms<br>for rated mains voltage ≤ 600 Vrms | | | <br><br>I-IV<br>I-III | — |
| Climatic classification | | | 40 / 85 / 21 | — |
| Pollution degree | | | 2 | — |
| Maximum operating insulation voltage | TLPxxx type | $V_{IORM}$ | 890 | Vpk |
| | TLPxxxF type | | 1140 | |
| Input to output test voltage, Method A<br>$V_{pr}$ = 1.6 × $V_{IORM}$, type and sample test<br>tp = 10 s, partial discharge < 5 pC | TLPxxx type | $V_{pr}$ | 1424 | Vpk |
| | TLPxxxF type | | 1824 | |
| Input to output test voltage, Method B<br>$V_{pr}$ = 1.875 × $V_{IORM}$, 100% production test<br>tp = 1 s, partial discharge < 5 pC | TLPxxx type | $V_{pr}$ | 1670 | Vpk |
| | TLPxxxF type | | 2140 | |
| Highest permissible Overvoltage<br>(transient overvoltage, tpr = 60 s) | TLPxxx type | $V_{TR}$ | 6000 | Vpk |
| | TLPxxxF type | | | |
| Safety limiting values (max. permissible ratings in case of fault, also refer to thermal derating curve)<br>current (input current $I_F$, Pso = 0)<br>power (output or total power dissipation)<br>temperature | | <br>$I_{si}$<br>$P_{so}$<br>$T_s$ | <br>400<br>700<br>150 | <br>mA<br>mW<br>°C |
| Insulation resistance | $V_{IO}$ = 500 V, Ta = 25 °C<br>$V_{IO}$ = 500 V, Ta = 100 °C<br>$V_{IO}$ = 500 V, Ta = Ts | $R_{si}$ | ≥ $10^{12}$<br>≥ $10^{11}$<br>≥ $10^{9}$ | Ω |

**Fig. 20.1 EN 60747 Insulation Characteristics**

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**Table Insulation Related Specifications (Note)**

| Insulation Related Parameters | Symbol | TLP3547 | TLP3547F |
|---|---|---|---|
| Minimum creepage distance | Cr | 7.0 mm | 8.0 mm |
| Minimum clearance | Cl | 7.0 mm | 8.0 mm |
| Minimum insulation thickness | ti | 0.4 mm | 0.4 mm |
| Comparative tracking index | CTI | 175 | 175 |

Note: If a printed circuit is incorporated, the creepage distance and clearance may be reduced below this value. (e.g., at a standard distance between soldering eye centers of 7.5 mm). If this is not permissible, the user shall take suitable measures.

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. 20.2 Marking on Packing**

TLP3547

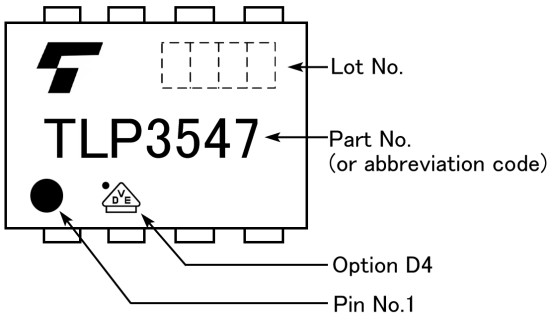



**Fig. 20.3 Marking Example (Note)**

TLP3547F

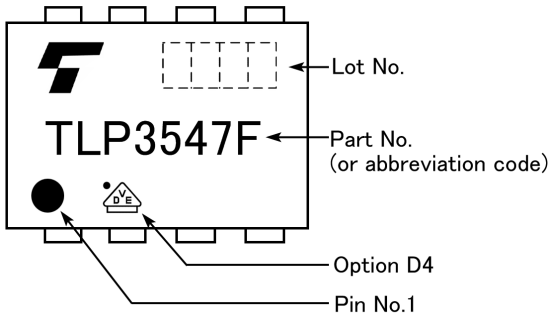



**Fig. 20.4 Marking Example (Note)**

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



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Figure 1 Partial discharge measurement procedure according to EN 60747
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 |

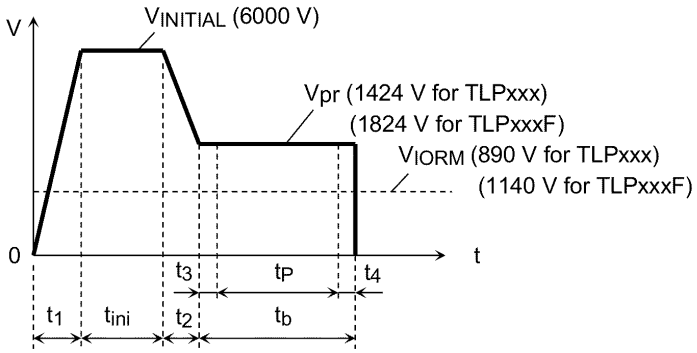



Figure 2 Partial discharge measurement procedure according to EN 60747
Non-destructive test for100% inspection.

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 |

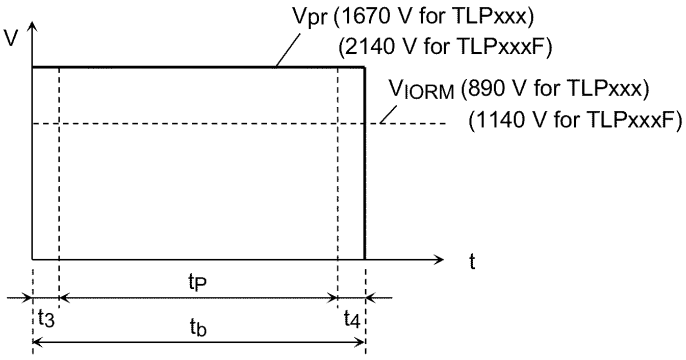



Figure 3 Dependency of maximum safety ratings on ambient temperature

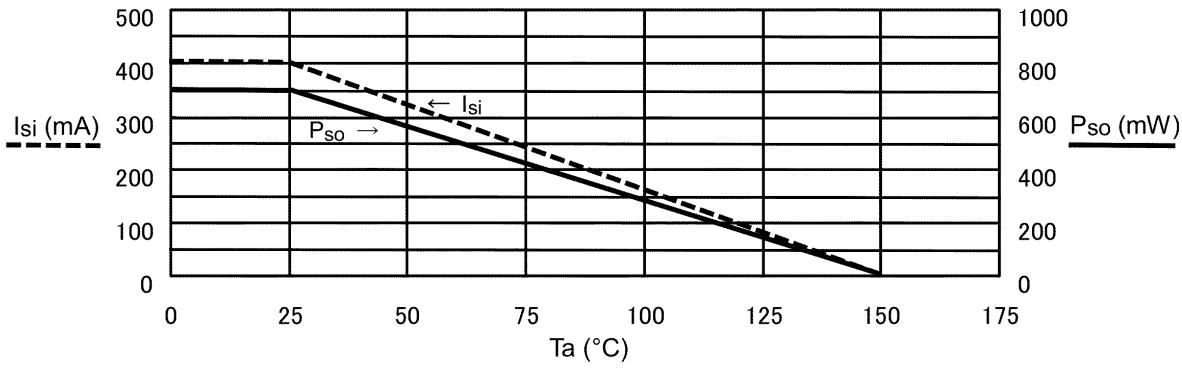



**Fig. 20.5 Measurement Procedure**



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

| Item Name | Packaging (Note 1) | VDE Option | Packing (MOQ) |
|---|---|---|---|
| TLP3547(F | TH | | Magazine (50 pcs) |
| TLP3547(LF1,F | LF1 | | Magazine (50 pcs) |
| TLP3547(LF5,F | LF5 | | Magazine (50 pcs) |
| TLP3547(TP1,F | LF1 | | Tape and reel (1500 pcs) |
| TLP3547(TP5,F | LF5 | | Tape and reel (1500 pcs) |
| TLP3547F(F | TH, Wide forming | | Magazine (50 pcs) |
| TLP3547F(LF4,F | LF4, Wide forming | | Magazine (50 pcs) |
| TLP3547F(TP4,F | LF4, Wide forming | | Tape and reel (1000 pcs) |
| TLP3547(D4,F | TH | EN 60747-5-5 | Magazine (50 pcs) |
| TLP3547(D4,LF1,F | LF1 | EN 60747-5-5 | Magazine (50 pcs) |
| TLP3547(D4,LF5,F | LF5 | EN 60747-5-5 | Magazine (50 pcs) |
| TLP3547(D4,TP1,F | LF1 | EN 60747-5-5 | Tape and reel (1500 pcs) |
| TLP3547(D4,TP5,F | LF5 | EN 60747-5-5 | Tape and reel (1500 pcs) |
| TLP3547F(D4,F | TH, Wide forming | EN 60747-5-5 | Magazine (50 pcs) |
| TLP3547F(D4LF4,F | LF4, Wide forming | EN 60747-5-5 | Magazine (50 pcs) |
| TLP3547F(D4TP4,F | LF4, Wide forming | EN 60747-5-5 | Tape and reel (1000 pcs) |

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

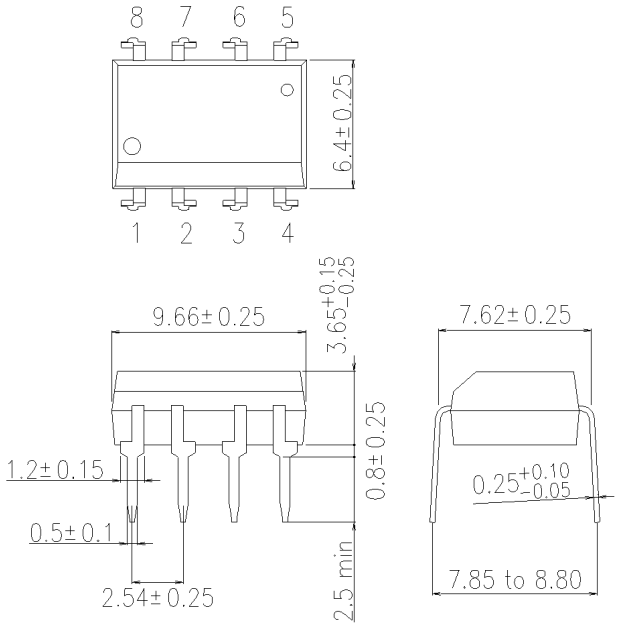
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## Package Dimensions

Unit: mm

TLP3547




Weight: 0.54 g (typ.)

| Package Name(s) |
| --- |
| TOSHIBA: 11-10C4S |

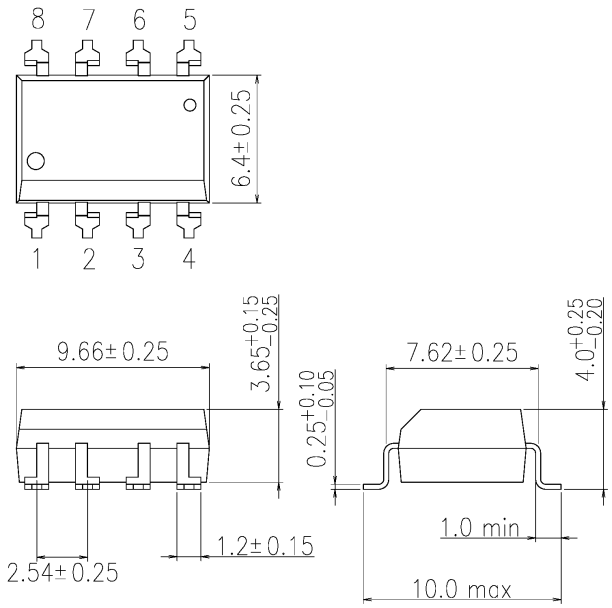


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## Package Dimensions

Unit: mm

TLP3547(LF1,TP1)




Weight: 0.53 g (typ.)

| Package Name(s) |
| --- |
| TOSHIBA: 11-10C401S |

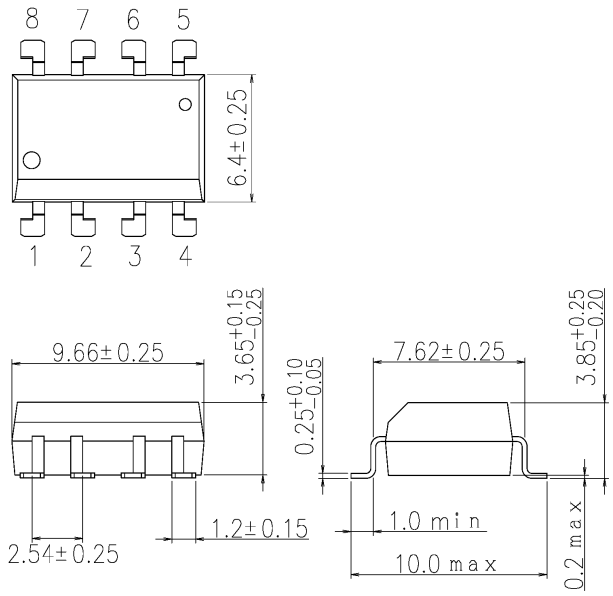


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## Package Dimensions

Unit: mm

TLP3547(LF5,TP5)




Weight: 0.53 g (typ.)

| Package Name(s) |
| --- |
| TOSHIBA: 11-10C405S |

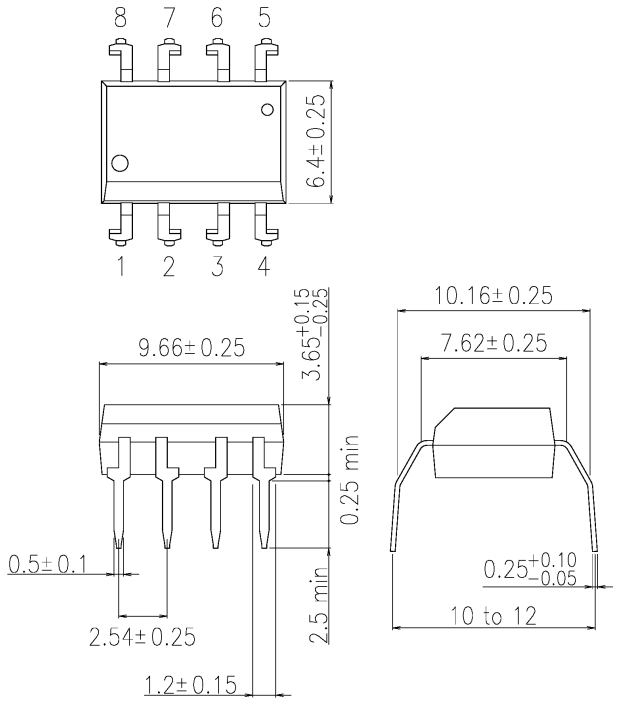


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## Package Dimensions

Unit: mm

TLP3547F




Weight: 0.54 g (typ.)

| Package Name(s) |
| --- |
| TOSHIBA: 11-10C402S |

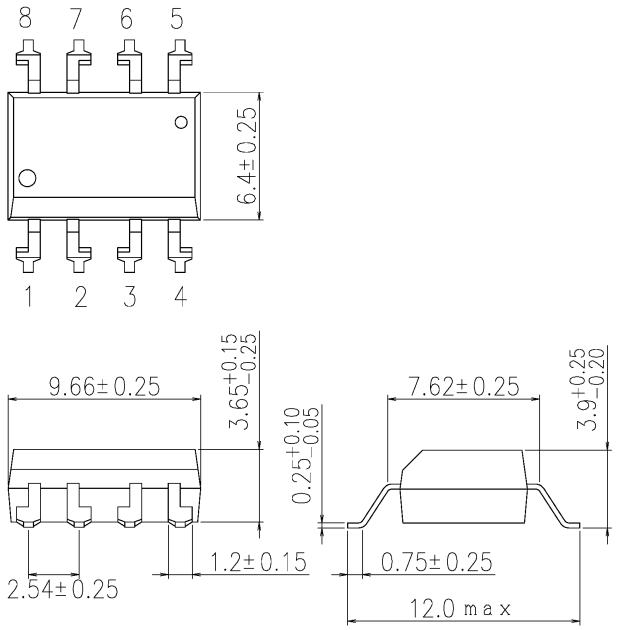


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## Package Dimensions

Unit: mm

TLP3547F(LF4,TP4)




Weight: 0.53 g (typ.)

| Package Name(s) |
|---|
| TOSHIBA: 11-10C404S |



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