

Photocouplers Photorelay

TLP240D, TLP240DF

1. Applications

- Mechanical relay replacements
- Security Systems
- Measuring Instruments
- Factory Automation (FA)
- Amusement Equipment
- Smart Meters
- Electricity Meters

2. General

The TLP240D and TLP240DF photorelay consist of a photo MOSFET optically coupled to an infrared LED. They are housed in a 4-pin DIP package. They provide an isolation voltage of 5000 Vrms, making them suitable for applications that require reinforced insulation.

3. Features

- (1) Halogen-free
For details, see "Devices in Halogen-Free Resin Packages" at the end of this datasheet.
- (2) Normally opened (1-Form-A)
- (3) OFF-state output terminal voltage: 200 V (min)
- (4) Trigger LED current: 3 mA (max)
- (5) ON-state current: 250 mA (max)
- (6) ON-state resistance: 8 Ω (max)
- (7) Isolation voltage: 5000 Vrms (min)
- (8) 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**)
CQC-approved: GB4943.1, GB8898 Japan Factory
VDE-approved: EN 60747-5-5, EN 62368-1 (**Note 2**)

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

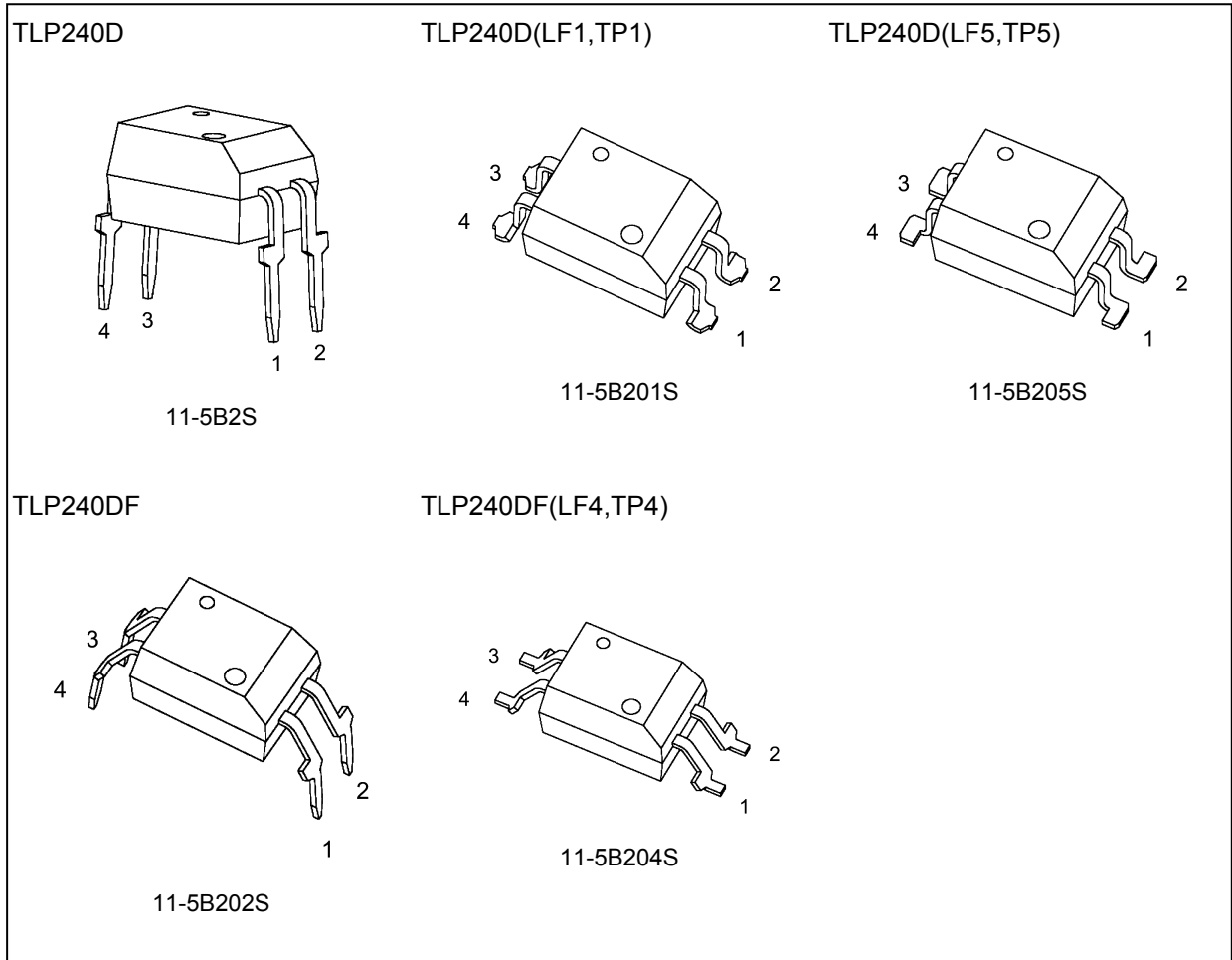
Note 2: When a VDE approved type is needed, please designate the **Option (D4)**.

4. Mechanical Parameters

| Characteristics | 7.62-mm Pitch TLP240D | 10.16-mm Pitch TLP240DF | 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) | |

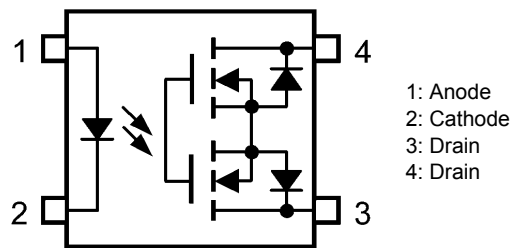
Start of commercial production
2013-03

5. Packaging (Note)

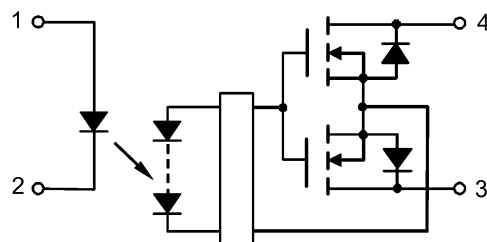


Note: Through-hole type: TLP240D, TLP240DF
 Lead forming option: (LF1), (LF4), (LF5)
 Taping option: (TP1), (TP4), (TP5)

6. Pin Assignment



7. Internal Circuit



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

| | Characteristics | Symbol | Note | Rating | Unit |
|----------|---|------------------------------|----------|------------|-------|
| LED | Input forward current | I_F | | 30 | mA |
| | Input forward current derating ($T_a \geq 25\text{ °C}$) | $\Delta I_F / \Delta T_a$ | | -0.3 | mA/°C |
| | Input forward current (pulsed) (100 μ s 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 ($T_a \geq 25\text{ °C}$) | $\Delta P_D / \Delta T_a$ | | -0.5 | mW/°C |
| | Junction temperature | T_j | | 125 | °C |
| Detector | OFF-state output terminal voltage | V_{OFF} | | 200 | V |
| | ON-state current | I_{ON} | | 250 | mA |
| | ON-state current derating ($T_a \geq 25\text{ °C}$) | $\Delta I_{ON} / \Delta T_a$ | | -2.5 | mA/°C |
| | ON-state current (pulsed) (t = 100 ms, Duty = 1/10) | I_{ONP} | | 750 | mA |
| | Output power dissipation | P_O | | 500 | mW |
| | Output power dissipation derating ($T_a \geq 25\text{ °C}$) | $\Delta P_O / \Delta T_a$ | | -5.0 | mW/°C |
| | Junction temperature | T_j | | 125 | °C |
| Common | Storage temperature | T_{stg} | | -55 to 125 | °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. \leq 60 %) | BV_S | (Note 1) | 5000 | 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.

9. Recommended Operating Conditions (Note)

| Characteristics | Symbol | Note | Min | Typ. | Max | Unit |
|-----------------------|-----------|------|-----|------|-----|------|
| Supply voltage | V_{DD} | | — | — | 160 | V |
| Input forward current | I_F | | 5 | 7.5 | 25 | mA |
| ON-state current | I_{ON} | | — | — | 250 | mA |
| Operating temperature | T_{opr} | | -20 | — | 65 | °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, $T_a = 25\text{ °C}$)

| | Characteristics | Symbol | Note | Rating | Unit |
|----------|---|------------------------------|----------|------------|-------|
| LED | Input forward current | I_F | | 30 | mA |
| | Input forward current derating ($T_a \geq 25\text{ °C}$) | $\Delta I_F / \Delta T_a$ | | -0.3 | mA/°C |
| | Input forward current (pulsed) (100 μ s 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 ($T_a \geq 25\text{ °C}$) | $\Delta P_D / \Delta T_a$ | | -0.5 | mW/°C |
| | Junction temperature | T_j | | 105 | °C |
| Detector | OFF-state output terminal voltage | V_{OFF} | | 200 | V |
| | ON-state current | I_{ON} | | 250 | mA |
| | ON-state current derating ($T_a \geq 25\text{ °C}$) | $\Delta I_{ON} / \Delta T_a$ | | -2.5 | mA/°C |
| | ON-state current (pulsed) ($t = 100\text{ ms}$, duty = 1/10) | I_{ONP} | | 750 | mA |
| | Output power dissipation | P_O | | 500 | mW |
| | Output power dissipation derating ($T_a \geq 25\text{ °C}$) | $\Delta P_O / \Delta T_a$ | | -5.0 | 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. $\leq 60\%$) | BV_S | (Note 1) | 5000 | 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.

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

| Characteristics | Symbol | Note | Min | Typ. | Max | Unit |
|-----------------------|-----------|----------|-----|------|-------|------|
| Supply voltage | V_{DD} | | — | — | 160 | V |
| Input forward current | I_F | (Note 1) | 5 | 7.5 | 19.5 | mA |
| ON-state current | I_{ON} | (Note 1) | — | — | 162.5 | mA |
| Operating temperature | T_{opr} | | -20 | — | 65 | °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 $T_a = 60\text{ °C}$.

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, $T_a = 25\text{ }^\circ\text{C}$)

| | 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 | μA |
| | Input capacitance | C_t | | $V = 0\text{ V}, f = 1\text{ MHz}$ | — | 50 | — | pF |
| Detector | OFF-state current | I_{OFF} | | $V_{OFF} = 200\text{ V}$ | — | — | 1000 | nA |
| | Output capacitance | C_{OFF} | | $V = 0\text{ V}, f = 1\text{ MHz}$ | — | 80 | — | 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} | | $I_{ON} = 250\text{ mA}$ | — | 0.6 | 3 | mA |
| Return LED current | I_{FC} | | $I_{OFF} = 10\text{ }\mu\text{A}$ | 0.1 | — | — | |
| ON-state resistance | R_{ON} | (Note 1) | $I_{ON} = 250\text{ mA}, I_F = 5\text{ mA}, \text{Continuous}$ | — | 5 | 8 | Ω |

Note 1: Thermally saturated state.

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) | $V_S = 500\text{ V}, \text{R.H.} \leq 60\%$ | 10^{12} | 10^{14} | — | Ω |
| Isolation voltage | BV_S | (Note 1) | AC, 60 s | 5000 | — | — | 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.

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. $R_L = 200\text{ }\Omega, V_{DD} = 20\text{ V}, I_F = 5\text{ mA}$ | — | 1 | 3 | ms |
| Turn-off time | t_{OFF} | | | — | 0.1 | 1 | |

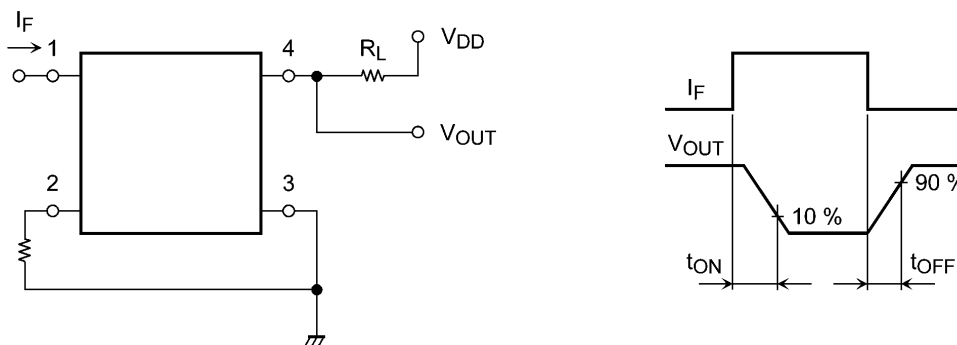


Fig. 15.1 Switching Time Test Circuit and Waveform

16. Characteristics Curves (Note)

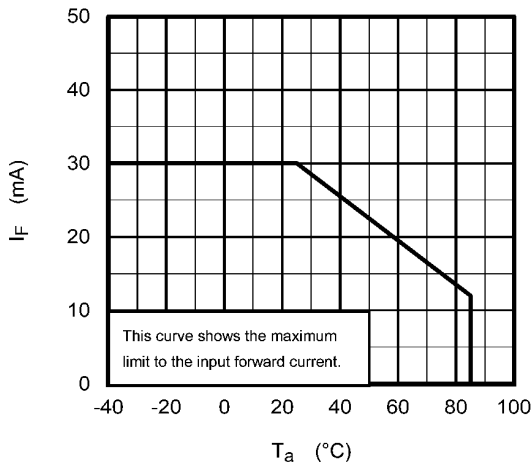


Fig. 16.1 I_F - T_a

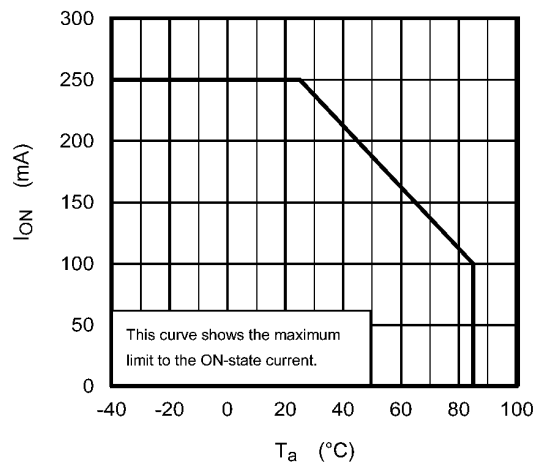


Fig. 16.2 I_{ON} - T_a

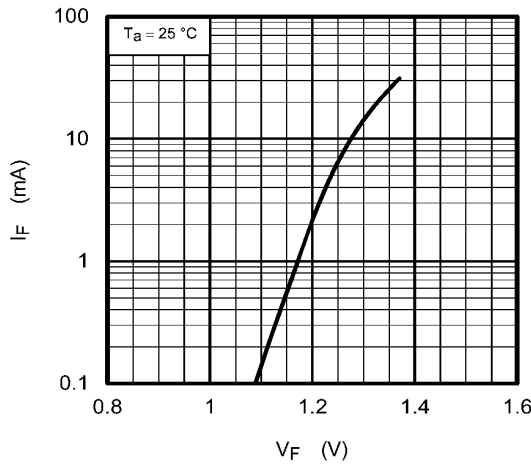


Fig. 16.3 I_F - V_F

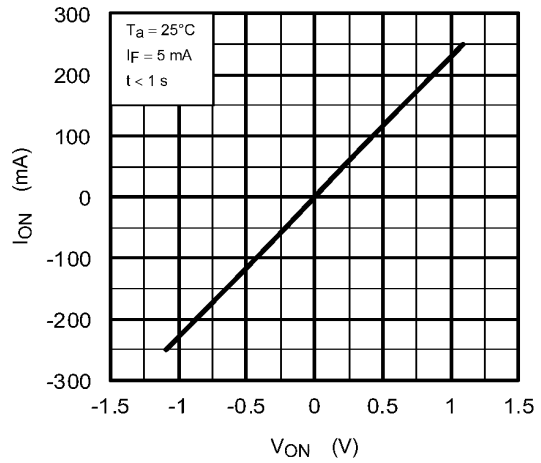


Fig. 16.4 I_{ON} - V_{ON}

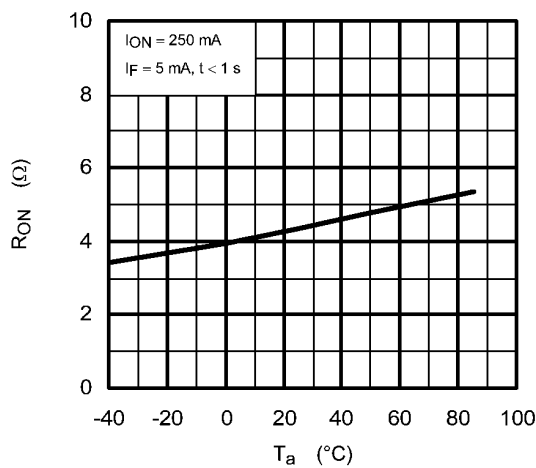


Fig. 16.5 R_{ON} - T_a

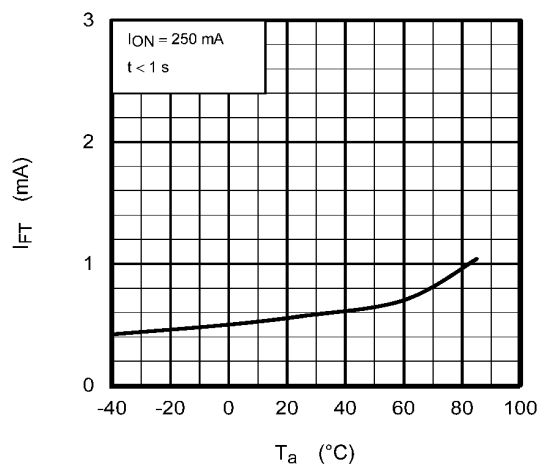


Fig. 16.6 I_{FT} - T_a

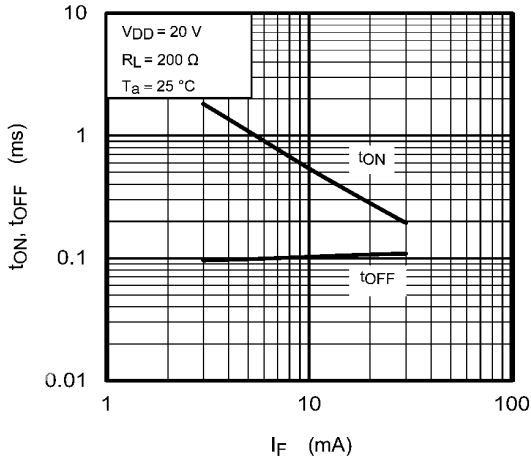


Fig. 16.7 t_{ON} , t_{OFF} - I_F

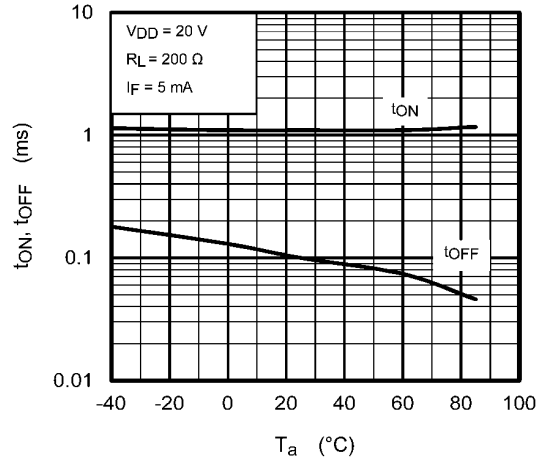


Fig. 16.8 t_{ON} , t_{OFF} - T_a

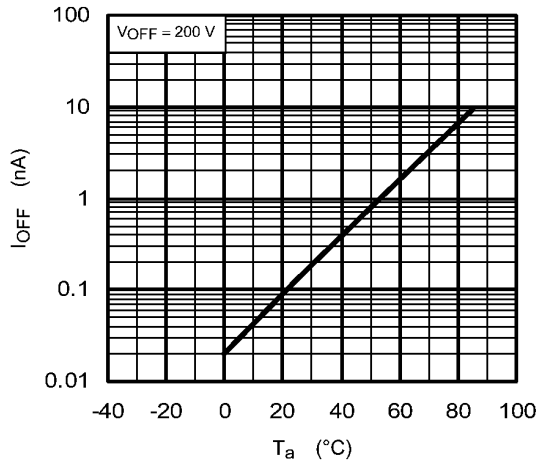


Fig. 16.9 I_{OFF} - T_a

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

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.

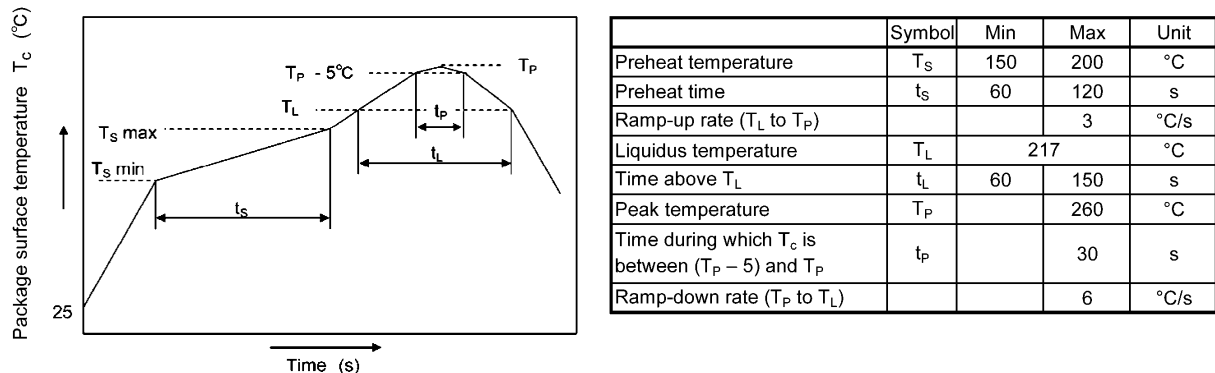


Fig. 17.1.1 An Example of a Temperature Profile When Lead(Pb)-Free Solder Is Used

- 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.

18. Land Pattern Dimensions (for reference only)

Unit: mm

TLP240D

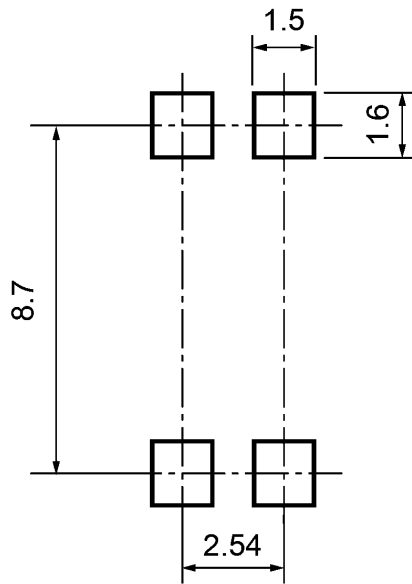


Fig. 18.1 Lead forming and taping option
(LF1), (TP1), (LF5), (TP5)

TLP240DF

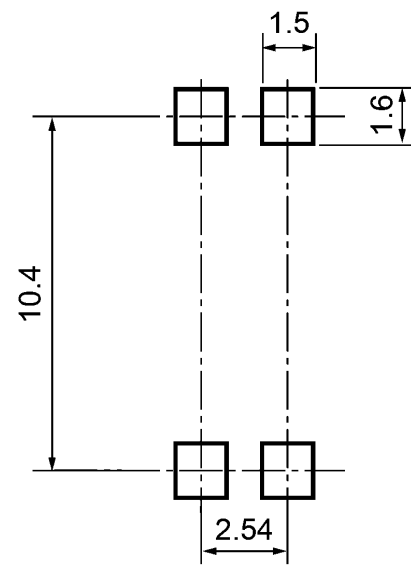


Fig. 18.2 Lead forming and taping option
(LF4), (TP4)

19. EN 60747-5-5 Option (D4) Specification

- Part number: TLP240D (**Note 1**)
- The following part naming conventions are used for the devices that have been qualified according to option (D4) of EN 60747.

Example: TLP240D(D4-TP1,F)

D4: EN 60747 option

TP1: Tape type

F: [[G]]/RoHS COMPATIBLE (**Note 2**)

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

e.g., TLP240D(D4-TP1,F → TLP240D

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 ≤ 300 Vrms | | | I-IV | — |
| for rated mains voltage ≤ 600 Vrms | | | I-III | — |
| Climatic classification | | | 40 / 085 / 21 | — |
| Pollution degree | | | 2 | — |
| Maximum operating insulation voltage | TLPxxxx type | V_{IORM} | 890 | V_{peak} |
| | TLPxxxxF type | | 1130 | |
| Input to output test voltage, Method A $V_{pr} = 1.6 \times V_{IORM}$, type and sample test $t_p = 10$ s, partial discharge < 5 pC | TLPxxxx type | V_{pr} | 1424 | V_{peak} |
| | TLPxxxxF type | | 1808 | |
| Input to output test voltage, Method B $V_{pr} = 1.875 \times V_{IORM}$, 100 % production test $t_p = 1$ s, partial discharge < 5 pC | TLPxxxx type | V_{pr} | 1670 | V_{peak} |
| | TLPxxxxF type | | 2120 | |
| Highest permissible overvoltage (transient overvoltage, $t_{pr} = 60$ s) | | V_{TR} | 8000 | V_{peak} |
| Safety limiting values (max. permissible ratings in case of fault, also refer to thermal derating curve) | | | | |
| current (input current I_F , $P_{SO} = 0$) | | I_{Si} | 400 | mA |
| power (output or total power dissipation) | | P_{SO} | 700 | mW |
| temperature | | T_s | 150 | °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. 19.1 EN 60747 Insulation Characteristics

Table Insulation Related Specifications (Note)

| Insulation Related Parameters | Symbol | TLP240D | TLP240DF |
|-------------------------------|--------|---------|----------|
| 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. 19.2 Marking on Packing

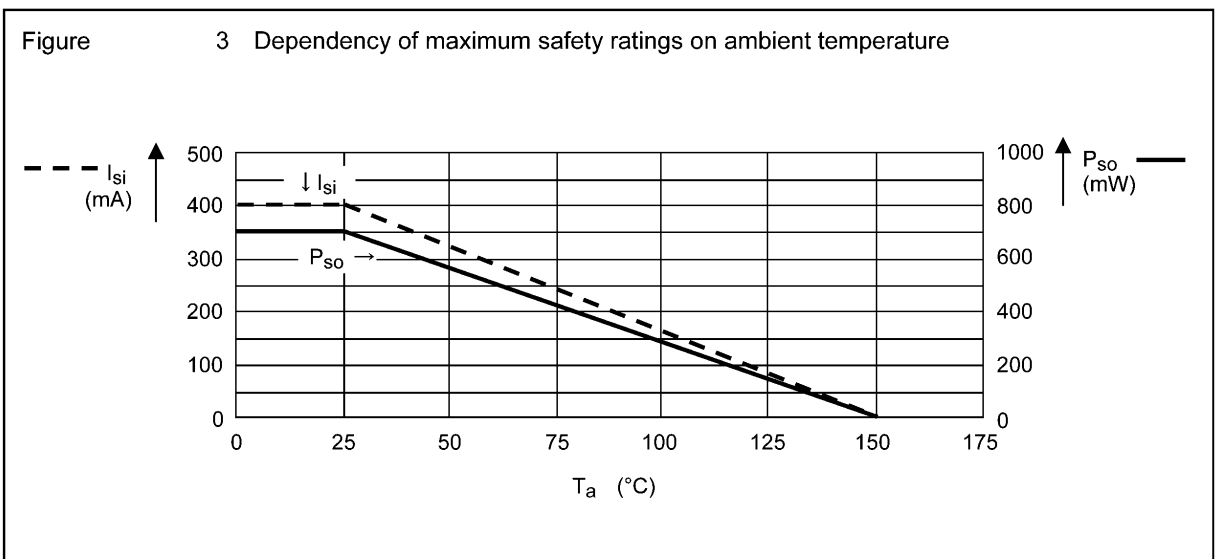
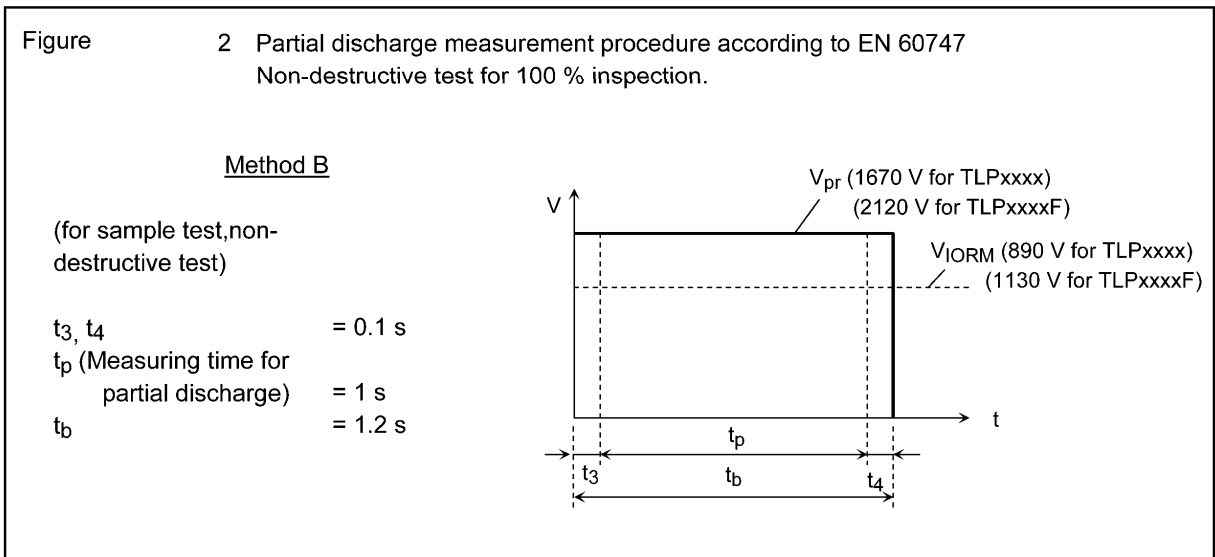
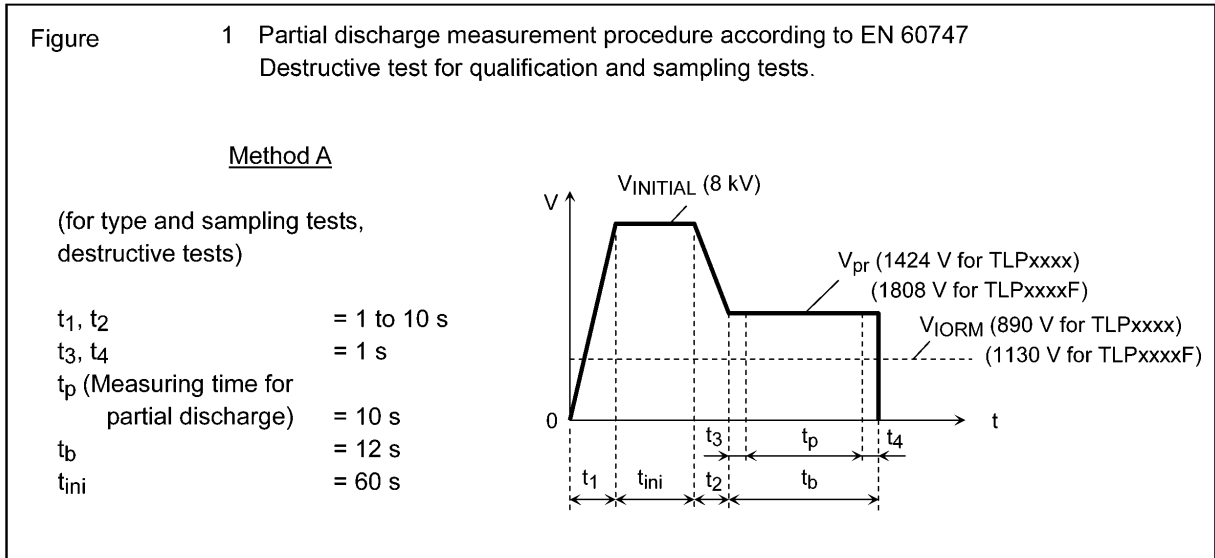


Fig. 19.3 Measurement Procedure

20. Ordering Information (Example of Item Name)

| Item Name | Packaging (Note 1) | VDE Option | Packing (MOQ) |
|-------------------|--------------------|--------------|--------------------------|
| TLP240D(F) | TH | | Magazine (100 pcs) |
| TLP240D(LF1,F) | LF1 | | Magazine (100 pcs) |
| TLP240D(LF5,F) | LF5 | | Magazine (100 pcs) |
| TLP240D(TP1,F) | LF1 | | Tape and reel (1500 pcs) |
| TLP240D(TP5,F) | LF5 | | Tape and reel (1500 pcs) |
| TLP240D(D4,F) | TH | EN 60747-5-5 | Magazine (100 pcs) |
| TLP240D(D4,LF1,F) | LF1 | EN 60747-5-5 | Magazine (100 pcs) |
| TLP240D(D4,LF5,F) | LF5 | EN 60747-5-5 | Magazine (100 pcs) |
| TLP240D(D4,TP1,F) | LF1 | EN 60747-5-5 | Tape and reel (1500 pcs) |
| TLP240D(D4,TP5,F) | LF5 | EN 60747-5-5 | Tape and reel (1500 pcs) |
| TLP240DF(F) | TH, Wide forming | | Magazine (100 pcs) |
| TLP240DF(LF4,F) | LF4, Wide forming | | Magazine (100 pcs) |
| TLP240DF(TP4,F) | LF4, Wide forming | | Tape and reel (1000 pcs) |
| TLP240DF(D4,F) | TH, Wide forming | EN 60747-5-5 | Magazine (100 pcs) |
| TLP240DF(D4LF4,F) | LF4, Wide forming | EN 60747-5-5 | Magazine (100 pcs) |
| TLP240DF(D4TP4,F) | LF4, Wide forming | EN 60747-5-5 | Tape and reel (1000 pcs) |

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

21. Devices in Halogen-Free Resin Packages

- This product is Halogen-Free

Toshiba Electronic Devices & Storage Corporation ("Toshiba") defines a "Halogen-Free resin semiconductor product" as a semiconductor product in which:

- (1) the encapsulating resins do not contain any of the following elements: bromine (Br), chlorine (Cl) and antimony (Sb), respectively, in an amount exceeding 0.09 weight percent, and do not contain chlorine and bromine in an aggregate amount exceeding 0.15 weight percent of the encapsulating resins, and/or
- (2) the resin portion(s) in printed circuit boards do not contain any of the following elements: bromine, chlorine and antimony, respectively, in an amount exceeding 0.09 weight percent, and do not contain chlorine and bromine in an aggregate amount exceeding 0.15 weight percent of the each resin portion(s) in printed circuit boards.

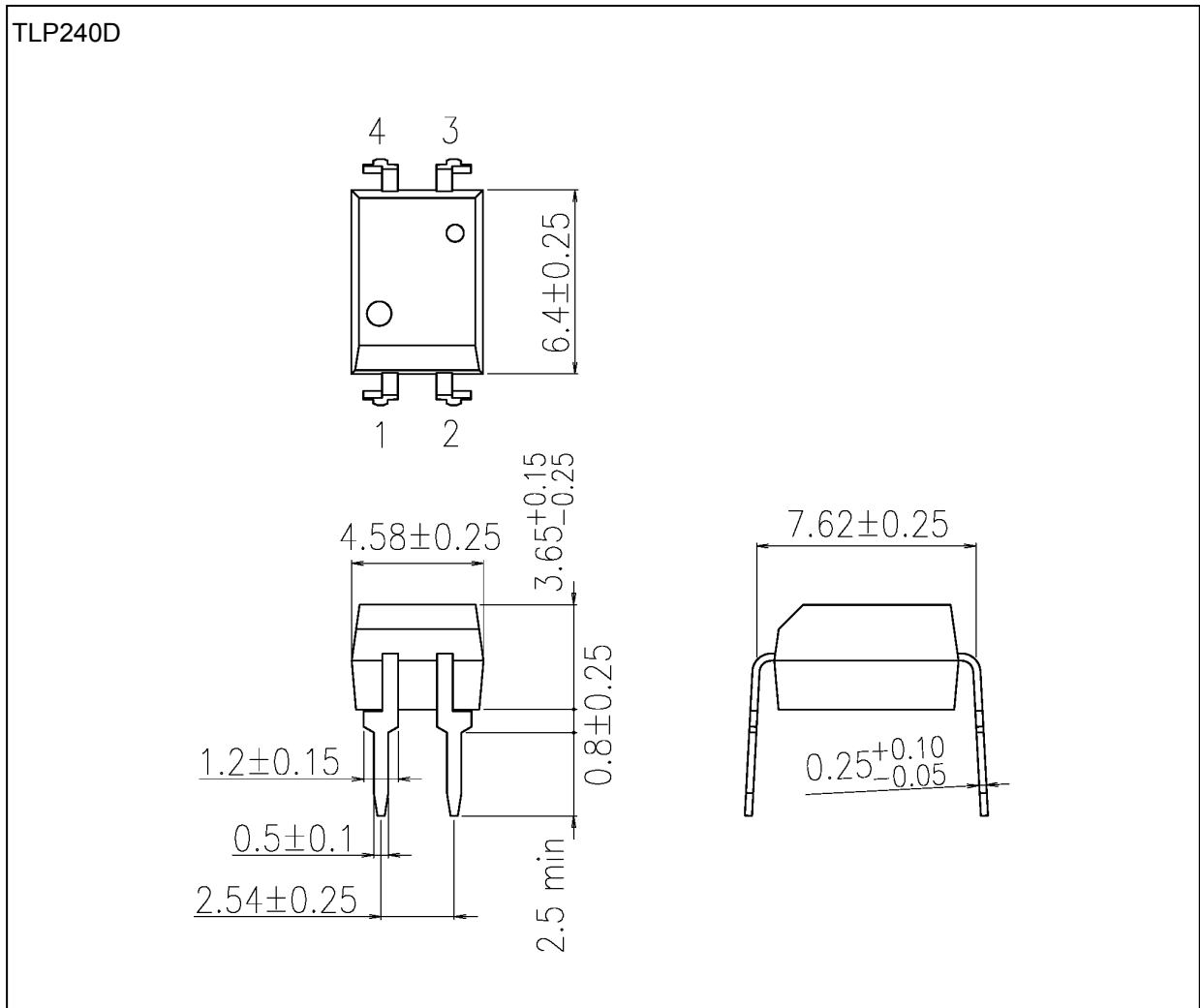
For avoidance of doubt, "Halogen-Free resin semiconductor product" does not mean, and Toshiba does not make any warranty of any kind, that said semiconductor product is entirely free of antimony or of any of the following elements of the halogen family: bromine, chlorine, iodine (I), fluorine (F) and astatine (At).

In addition, a Halogen-Free resin semiconductor product may contain antimony and/or any of the elements of the halogen family as mentioned in the above paragraph in one or more portion(s) of the semiconductor product other than the encapsulating resins and the resin portion(s) in printed circuit boards.

The information provided herein is accurate as of the date that it was provided, to the best of the knowledge and belief of the Toshiba Electronic Devices & Storage Corporation ("Toshiba"), Toshiba bases such knowledge and belief on information provided by third parties, and Toshiba makes no representation or warranty as to the accuracy of such third party information. Toshiba has taken and will continue to take, reasonable steps to provide accurate information to its customers, but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals.

Package Dimensions

Unit: mm

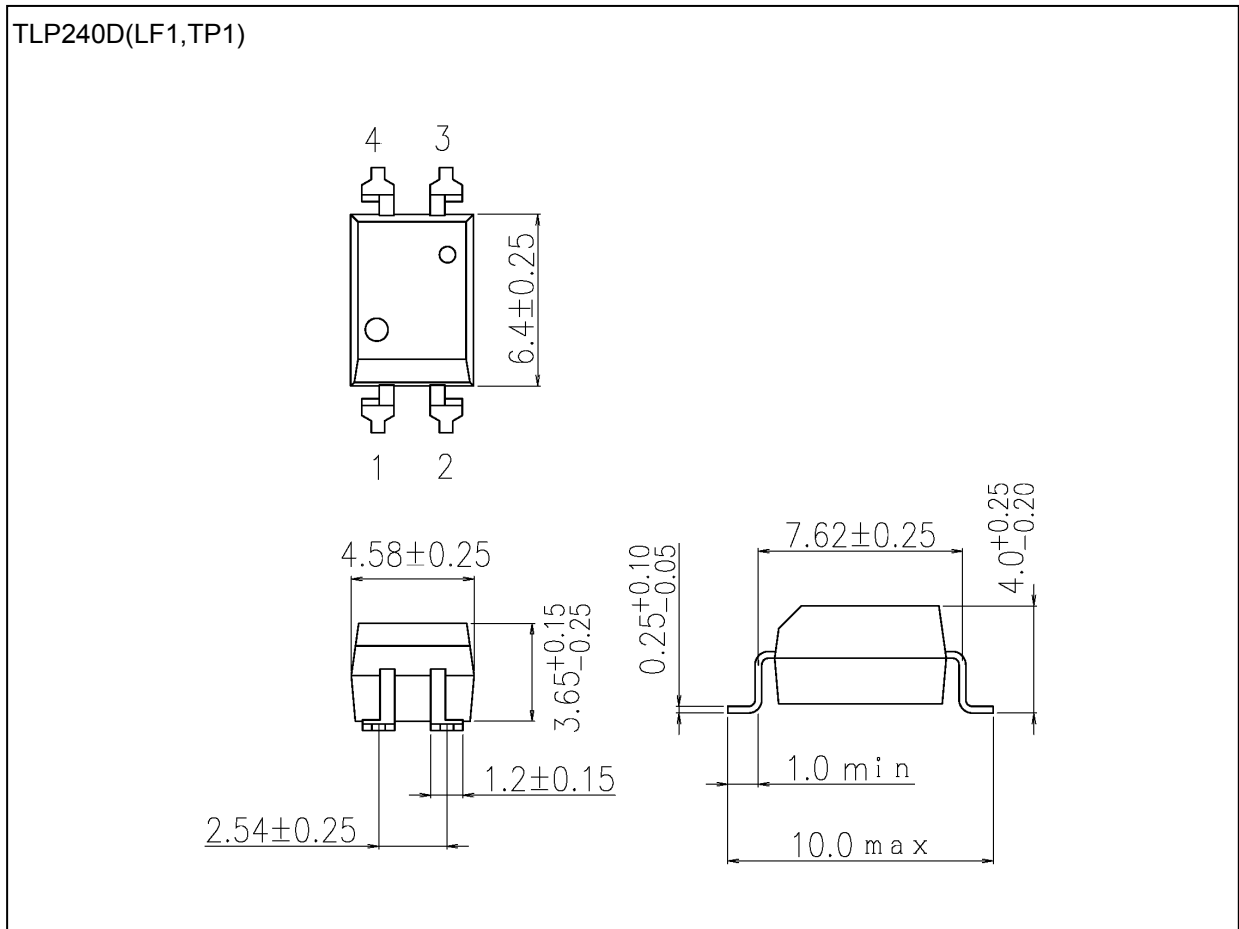


Weight: 0.26 g (typ.)

| Package Name(s) |
|------------------|
| TOSHIBA: 11-5B2S |

Package Dimensions

Unit: mm

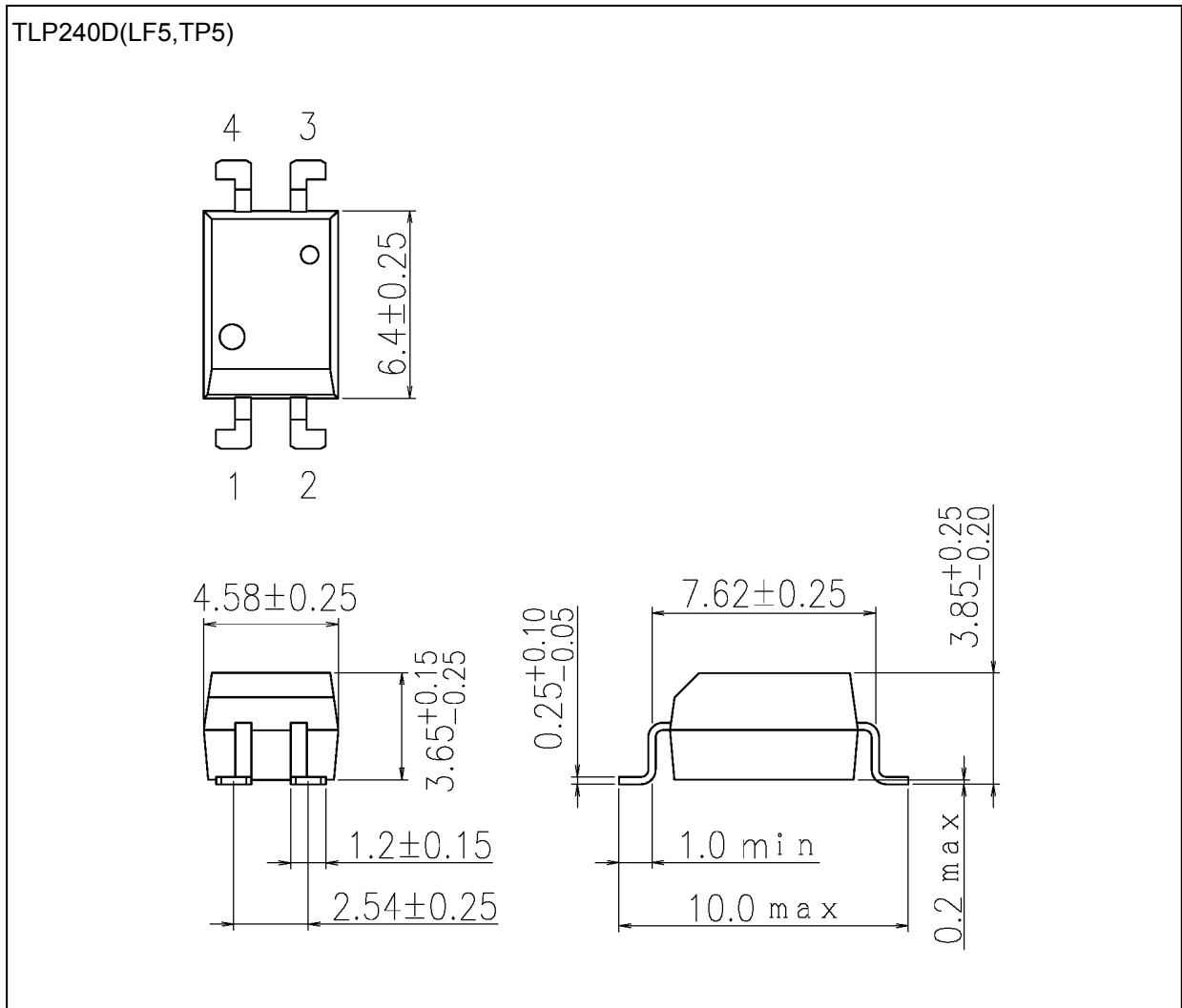


Weight: 0.25 g (typ.)

| Package Name(s) |
|--------------------|
| TOSHIBA: 11-5B201S |

Package Dimensions

Unit: mm

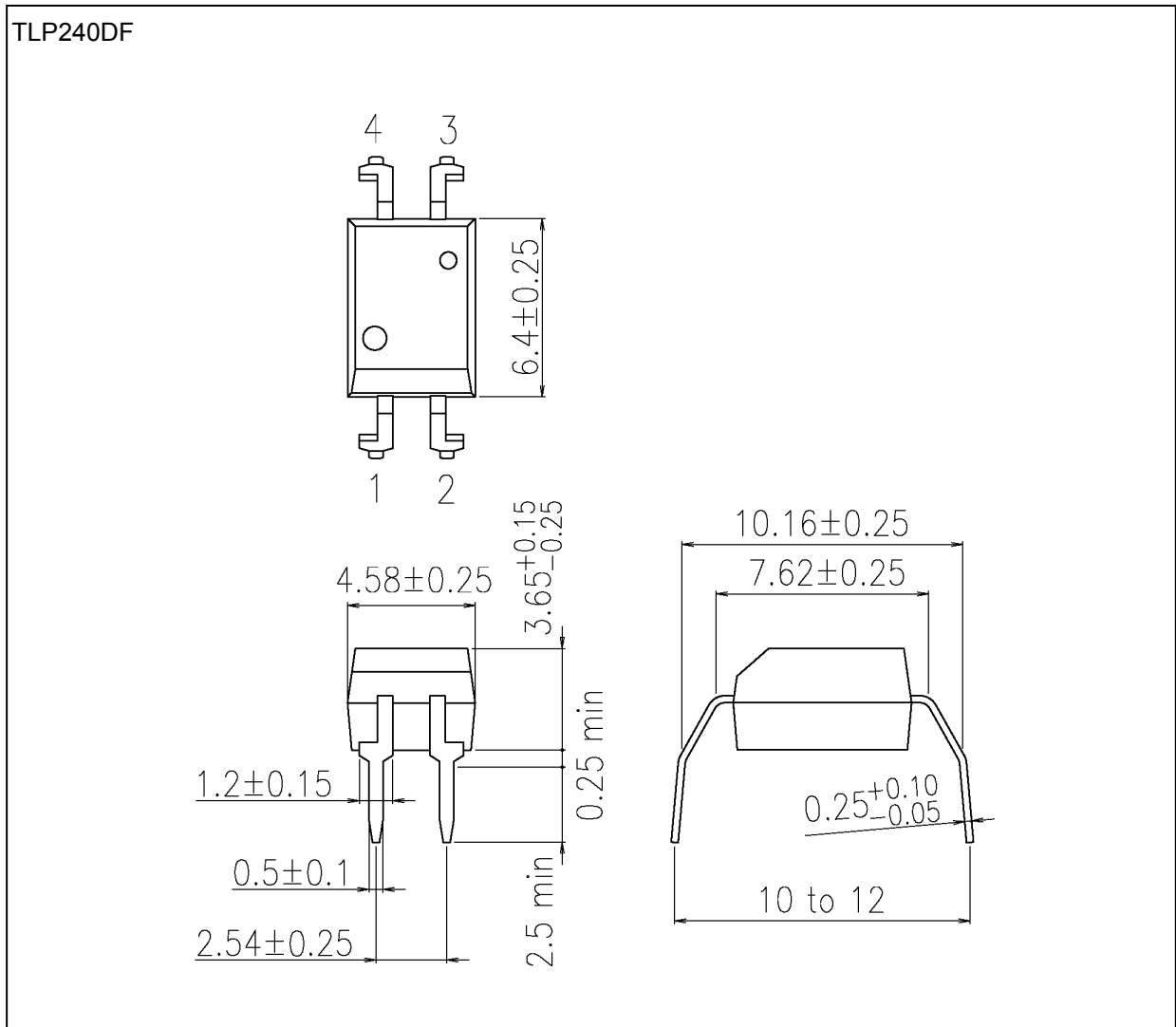


Weight: 0.25 g (typ.)

| Package Name(s) |
|--------------------|
| TOSHIBA: 11-5B205S |

Package Dimensions

Unit: mm

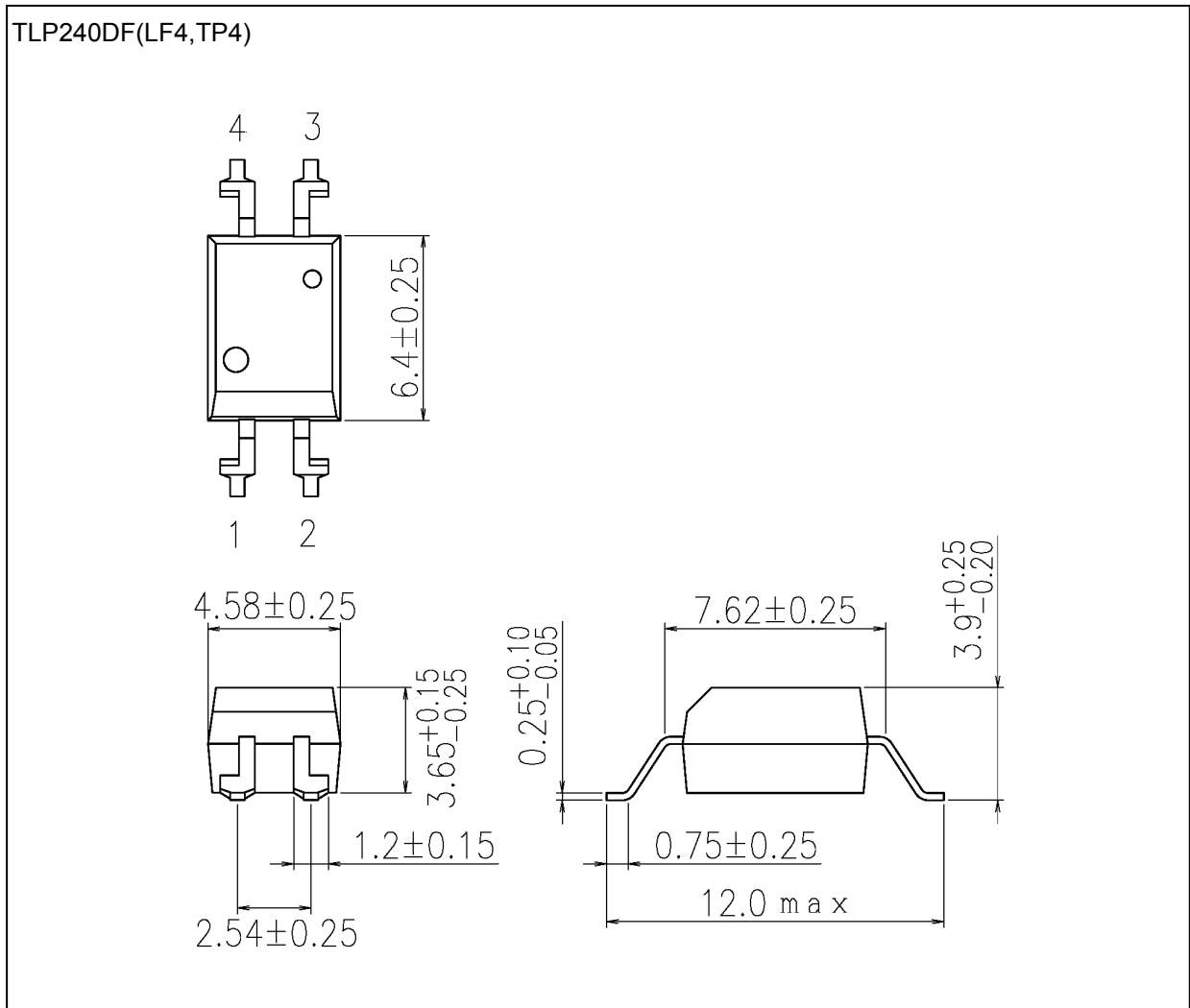


Weight: 0.26 g (typ.)

| Package Name(s) |
|--------------------|
| TOSHIBA: 11-5B202S |

Package Dimensions

Unit: mm



Weight: 0.25 g (typ.)

| Package Name(s) |
|--------------------|
| TOSHIBA: 11-5B204S |

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