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TOSHIBA Photocoupler GaAs IRED & Photo-Transistor

# TLP785, TLP785F

Office Equipment  
 Household Appliances  
 Solid State Relays  
 Switching Power Supplies  
 Various Controllers  
 Signal Transmission between Different Voltage Circuits

The TOSHIBA TLP785 consists of a silicone phototransistor optically coupled to a gallium arsenide (GaAs) infrared emitting diode in a four lead plastic DIP (DIP4) with having high isolation voltage (AC: 5 kVRMS (min)).  
 TLP785F is a lead forming type for the long creepage surface mounting of TLP785.

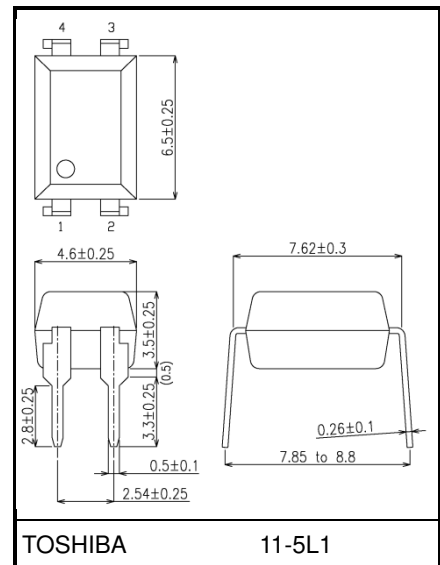
- TLP785: 7.62 mm pitch type DIP4
- TLP785F: 10.16 mm pitch type DIP4
- Collector-emitter voltage: 80 V (min)
- Current transfer ratio: 50% (min)  
 Rank GB: 100% (min)
- Isolation voltage: 5000 Vrms (min)
- UL approved : UL1577, File No.E67349
- c-UL approved :CSA Component Acceptance Service No. 5A, File No.E67349
- Option (D4) VDE approved : DIN EN60747-5-5(Note 1)
- CQC-approved: GB4943.1, GB8898 China Factory
- SEMKO approved: EN60065:2002  
 EN60950-1:2001, EN60335-1:2002

**Note 1 : When a EN60747-5-5 approved type is needed, please designate "Option(D4)"**

- Construction mechanical rating

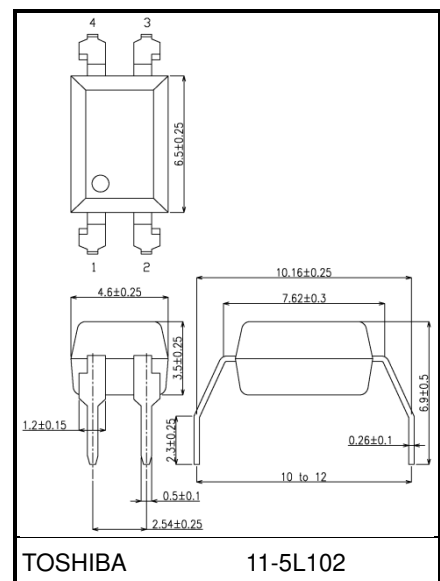
|                         | 7.62 mm Pitch Standard Type | 10.16 mm Pitch TLPxxx F Type |
|-------------------------|-----------------------------|------------------------------|
| Creepage distance       | 7.0 mm (min)                | 8.0 mm (min)                 |
| Clearance               | 7.0 mm (min)                | 8.0 mm (min)                 |
| Insulation thickness    | 0.4 mm (min)                | 0.4 mm (min)                 |
| Inner creepage distance | 4.0 mm (min)                | 4.0 mm (min)                 |

TLP785 Unit: mm



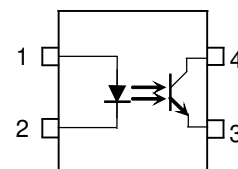
Weight: 0.25 g (typ.)

TLP785F Unit: mm



Weight: 0.25 g (typ.)

**Pin Configurations (top view)**



- 1 : Anode
- 2 : Cathode
- 3 : Emitter
- 4 : Collector

Start of commercial production  
 2010-11

## Current Transfer Ratio (Note)

| Type   | Classification<br>(Note 1) | Current Transfer Ratio (%)<br>( $I_C / I_F$ )                  |     | Marking of Classification |
|--------|----------------------------|--|-----|---------------------------|
|        |                            | $I_F = 5\text{mA}, V_{CE} = 5\text{V}, T_a = 25^\circ\text{C}$ |     |                           |
|        |                            | Min  | Max |                           |
| TLP785 | None                       | 50   | 600 | Blank                     |
|        | Rank Y                     | 50   | 150 | YE                        |
|        | Rank GR                    | 100  | 300 | GR                        |
|        | Rank BL                    | 200  | 600 | BL                        |
|        | Rank GB                    | 100  | 600 | GB                        |
|        | Rank YH                    | 75   | 150 | Y+                        |
|        | Rank GRL                   | 100  | 200 | G                         |
|        | Rank GRH                   | 150  | 300 | G+                        |
|        | Rank BLL                   | 200  | 400 | B                         |

Note 1: Ex. rank GB: TLP785 (GB)

Note : Application type name for certification test, please use standard product type name, i. e. TLP785 (GB): TLP785

## Absolute Maximum Ratings (Note) ( $T_a = 25^\circ\text{C}$ )

| Characteristic   |  | Symbol                        | Rating     | Unit                  |
|--|--|-------------------------------|------------|-----------------------|
| LED  | Forward current  | $I_F$                         | 60         | mA                    |
|  | Forward current derating ( $T_a \geq 39^\circ\text{C}$ )   | $\Delta I_F / ^\circ\text{C}$ | -0.7       | mA / $^\circ\text{C}$ |
|  | Pulse forward current (Note 2)                             | $I_{FP}$                      | 1          | A                     |
|  | Power dissipation  | $P_D$                         | 90         | mW                    |
|  | Power dissipation derating ( $T_a \geq 39^\circ\text{C}$ ) | $\Delta P_D / ^\circ\text{C}$ | -0.9       | mW / $^\circ\text{C}$ |
|  | Reverse voltage  | $V_R$                         | 5          | V                     |
|  | Junction temperature                                       | $T_j$                         | 125        | $^\circ\text{C}$      |
| Detector   | Collector-emitter voltage                                  | $V_{CEO}$                     | 80         | V                     |
|  | Emitter-collector voltage                                  | $V_{ECO}$                     | 7          | V                     |
|  | Collector current  | $I_C$                         | 50         | mA                    |
|  | Power dissipation (single circuit)                         | $P_C$                         | 150        | mW                    |
|  | Power dissipation derating ( $T_a \geq 25^\circ\text{C}$ ) | $\Delta P_C / ^\circ\text{C}$ | -1.5       | mW / $^\circ\text{C}$ |
|  | Junction temperature                                       | $T_j$                         | 125        | $^\circ\text{C}$      |
| Operating temperature range  |  | $T_{opr}$                     | -55 to 110 | $^\circ\text{C}$      |
| Storage temperature range  |  | $T_{stg}$                     | -55 to 125 | $^\circ\text{C}$      |
| Lead soldering temperature (10 s)  |  | $T_{sol}$                     | 260        | $^\circ\text{C}$      |
| Total package power dissipation  |  | $P_T$                         | 240        | mW                    |
| Total package power dissipation derating ( $T_a \geq 25^\circ\text{C}$ ) |  | $\Delta P_T / ^\circ\text{C}$ | -2.4       | mW / $^\circ\text{C}$ |
| Isolation voltage (Note 3)   |  | $BV_S$                        | 5000       | $V_{rms}$             |

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 2: 100  $\mu\text{s}$  pulse, 100 Hz frequency

Note 3: AC, 60 s., R.H.  $\leq$  60%. Apply voltage to LED pin and detector pin together.

## Recommended Operating Conditions (Note)

| Characteristic        | Symbol    | Min | Typ. | Max | Unit |
|-----------------------|-----------|-----|------|-----|------|
| Supply voltage        | $V_{CC}$  | —   | 5    | 24  | V    |
| Forward current       | $I_F$     | —   | 16   | 25  | mA   |
| Collector current     | $I_C$     | —   | 1    | 10  | mA   |
| Operating temperature | $T_{opr}$ | -25 | —    | 85  | °C   |

Note: Recommended operating conditions are given as a design guideline to obtain expected performance of the device. Additionally, each item is an independent guideline respectively. In developing designs using this product, please confirm specified characteristics shown in this document.

## Individual Electrical Characteristics (Ta = 25°C)

| Characteristic                     |                                     | Symbol                               | Test Condition                                  | Min | Typ. | Max | Unit          |
|------------------------------------|-------------------------------------|--------------------------------------|---|-----|------|-----|---------------|
| LED                                | Forward voltage                     | $V_F$                                | $I_F = 10 \text{ mA}$                           | 1.0 | 1.15 | 1.3 | V             |
|                                    | Reverse current                     | $I_R$                                | $V_R = 5 \text{ V}$                             | —   | —    | 10  | $\mu\text{A}$ |
|                                    | Capacitance                         | $C_T$                                | $V = 0 \text{ V}, f = 1 \text{ MHz}$            | —   | 30   | —   | pF            |
| Detector                           | Collector-emitter breakdown voltage | $V_{(BR) CEO}$                       | $I_C = 0.5 \text{ mA}$                          | 80  | —    | —   | V             |
|                                    | Emitter-collector breakdown voltage | $V_{(BR) ECO}$                       | $I_E = 0.1 \text{ mA}$                          | 7   | —    | —   | V             |
|                                    | Collector dark current              | $I_D(I_{CEO})$                       | $V_{CE} = 24 \text{ V}$                         | —   | 0.01 | 0.1 | $\mu\text{A}$ |
|                                    |                                     |                                      | $V_{CE} = 24 \text{ V}, T_a = 85^\circ\text{C}$ | —   | 0.6  | 50  | $\mu\text{A}$ |
| Capacitance (collector to emitter) | $C_{CE}$                            | $V = 0 \text{ V}, f = 1 \text{ MHz}$ | —   | 6   | —    | pF  |               |

## Coupled Electrical Characteristics (Ta = 25°C)

| Characteristic                       | Symbol                  | Test Condition  | Min | Typ. | Max | Unit |
|--------------------------------------|-------------------------|---|-----|------|-----|------|
| Current transfer ratio               | $I_C / I_F$             | $I_F = 5 \text{ mA}, V_{CE} = 5 \text{ V}$<br>Rank GB   | 50  | —    | 600 | %    |
|                                      |                         |   | 100 | —    | 600 |      |
| Saturated CTR                        | $I_C / I_F(\text{sat})$ | $I_F = 1 \text{ mA}, V_{CE} = 0.4 \text{ V}$<br>Rank GB   | —   | 60   | —   | %    |
|                                      |                         |   | 30  | —    | —   |      |
| Collector-emitter saturation voltage | $V_{CE(\text{sat})}$    | $I_C = 2.4 \text{ mA}, I_F = 8 \text{ mA}$<br>$I_C = 0.2 \text{ mA}, I_F = 1 \text{ mA}$<br>Rank GB | —   | —    | 0.4 | V    |
|                                      |                         |   | —   | 0.2  | —   |      |
|                                      |                         | —   | —   | 0.4  |     |      |

## Isolation Characteristics (Ta = 25°C)

| Characteristic                | Symbol | Test Condition                         | Min                | Typ.      | Max | Unit      |
|-------------------------------|--------|--|--------------------|-----------|-----|-----------|
| Capacitance (input to output) | $C_S$  | $V_S = 0 \text{ V}, f = 1 \text{ MHz}$ | —                  | 0.8       | —   | pF        |
| Isolation resistance          | $R_S$  | $V_S = 500 \text{ V}$                  | $1 \times 10^{12}$ | $10^{14}$ | —   | $\Omega$  |
| Isolation voltage             | $BV_S$ | AC, 60 s                               | 5000               | —         | —   | $V_{rms}$ |
|                               |        | AC, 1 s, in oil                        | —                  | 10000     | —   |           |
|                               |        | DC, 60 s, in oil                       | —                  | 10000     | —   | $V_{dc}$  |

## Switching Characteristics (Ta = 25°C)

| Characteristics | Symbol    | Test Condition  | Min | Typ. | Max | Unit          |
|-----------------|-----------|---|-----|------|-----|---------------|
| Rise time       | $t_r$     | $V_{CC} = 10\text{ V}$ , $I_C = 2\text{ mA}$<br>$R_L = 100\ \Omega$                 | —   | 2    | —   | $\mu\text{s}$ |
| Fall time       | $t_f$     |   | —   | 3    | —   |               |
| Turn-on time    | $t_{on}$  |   | —   | 3    | —   |               |
| Turn-off time   | $t_{off}$ |   | —   | 3    | —   |               |
| Turn-on time    | $t_{on}$  | $R_L = 1.9\text{ k}\Omega$ (fig. 1)<br>$V_{CC} = 5\text{ V}$ , $I_F = 16\text{ mA}$ | —   | 1.5  | —   | $\mu\text{s}$ |
| Storage time    | $t_s$     |   | —   | 25   | —   |               |
| Turn-off time   | $t_{off}$ |   | —   | 50   | —   |               |

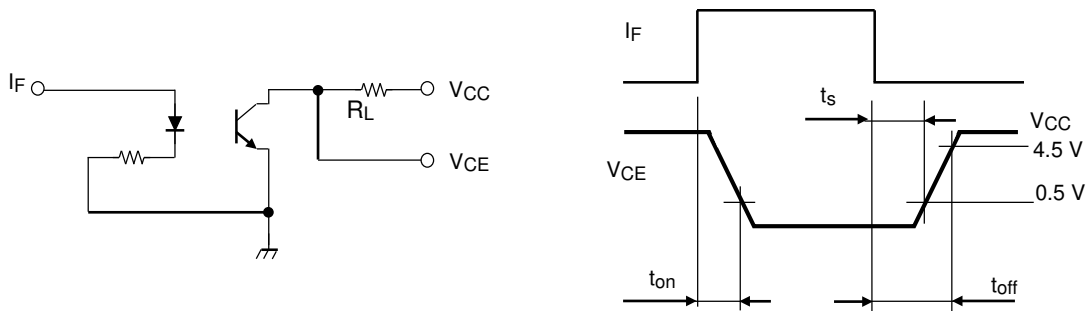
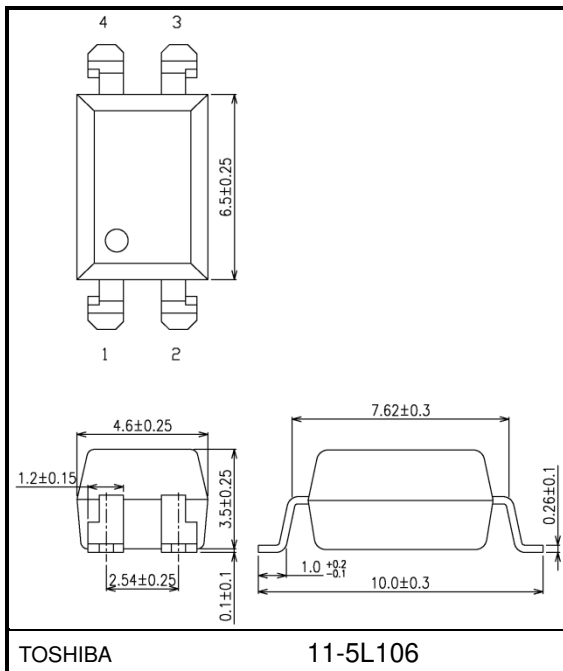


fig. 1: Switching time test circuit

## Surface-Mount Lead Form Option

TLP785(LF6)

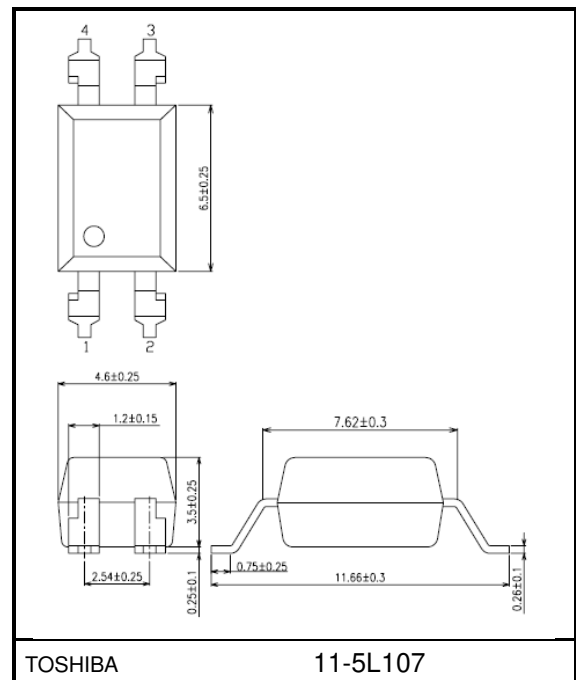
Unit: mm



Weight: 0.24 g (typ.)

TLP785F(LF7)

Unit: mm



Weight: 0.25 g (typ.)

**Option: Specifications for Embossed-Tape Packing; (TP6)/(TP7)**

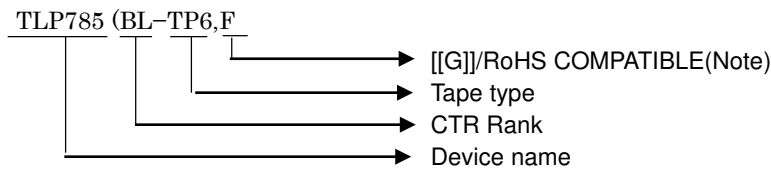
**1. Applicable Package**

| Package Name | Product Type |
|--------------|--------------|
| DIP4LF6      | TLP785       |
| DIP4LF7      | TLP785F      |

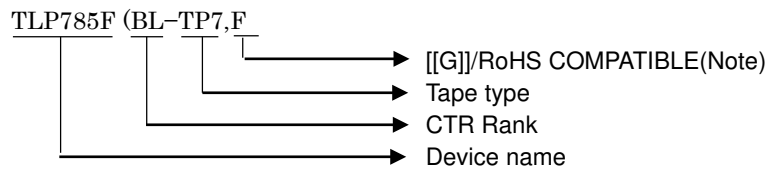
**2. Product Naming System**

Type of package used for shipment is denoted by a symbol suffix after a product number. The method of classification is as below.

(Example)



(Example2)

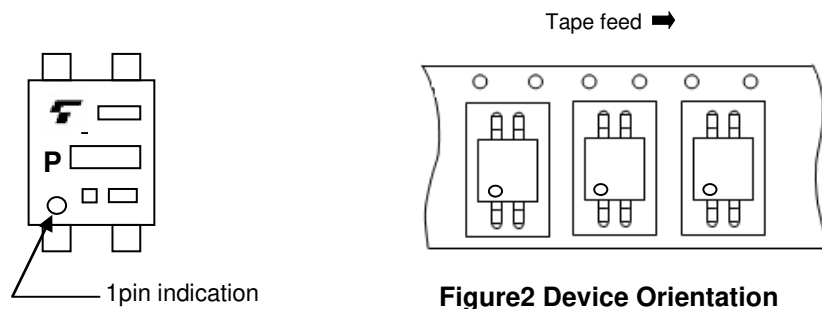


Note: Please contact your Toshiba sales representative for details on environmental information such as the product's RoHS compatibility.  
RoHS is the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronics equipment.

**3. Tape Dimensions**

**3.1 Orientation of Device in Relation to Direction of Tape Movement**

Device orientation in the recesses is as shown in Figure 2.



**3.2 Tape Packing Quantity:2000 devices per reel**

**3.3 Empty Device Recesses Are as Shown in Table 1.**

**Table1 Empty Device Recesses**

|   | Standard                 | Remarks  |
|---|--------------------------|--|
| Occurrences of 2 or more successive empty device recesses | 0                        | Within any given 40-mm section of tape, not including leader and trailer |
| Single empty device recesses                              | 6 devices (max) per reel | Not including leader and trailer   |

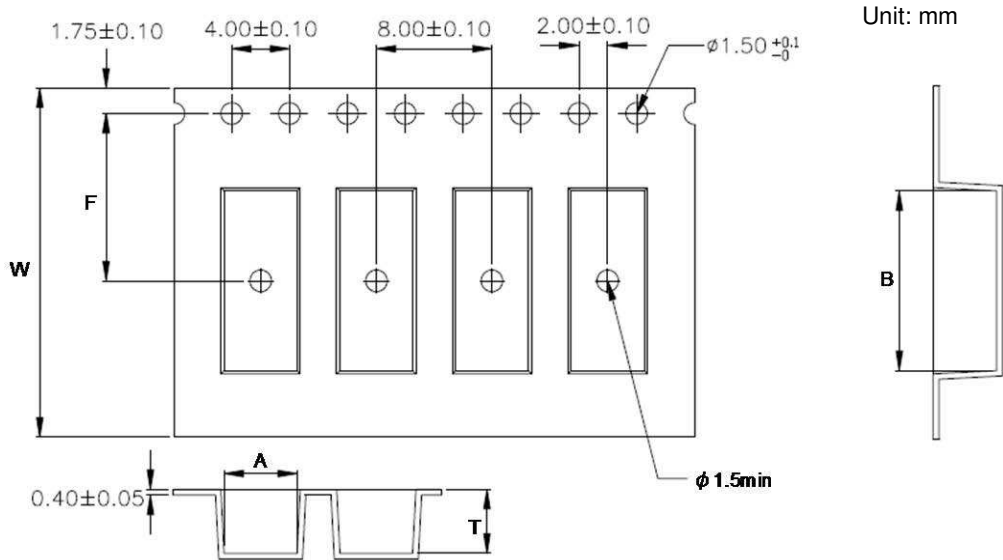
**3.4 Start and End of Tape**

The start of the tape has 30 or more empty holes. The end of the tape has 50 or more empty holes.

**3.5 Tape Specification**

[1] TLP785(TP6) / TLP785F(TP7)

- Tape material: Plastic
- Dimensions: The tape dimensions are as shown in Figure 3.



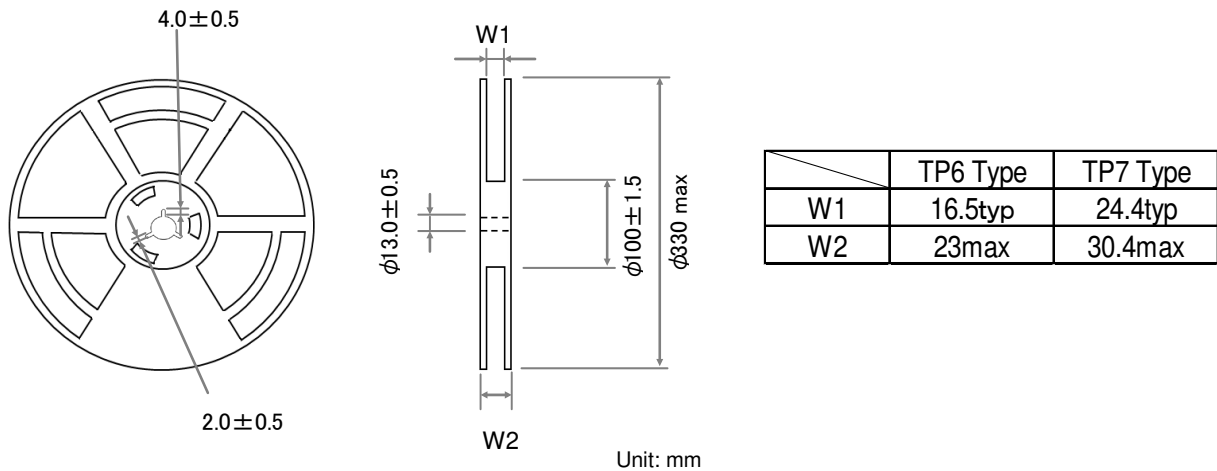
|   | TP6 Type | TP7 Type  |
|---|----------|-----------|
| A | 5.1±0.1  | 5.05±0.1  |
| B | 10.6±0.1 | 12.35±0.1 |
| W | 16.0±0.3 | 24.0±0.3  |
| F | 7.5±0.1  | 11.5±0.1  |
| T | 4.2±0.15 | 4.4±0.1   |

**Figure 3 Tape Forms**

### 3.6 Reel Specification

[1] TLP785(TP6) / TLP785F(TP7)

- Material: Plastic
- Dimensions: The reel dimensions are as shown in Figure 4.



**Figure 4 Reel Forms**

### 4. Packing

Two reels of photocouplers are packed in a shipping carton.

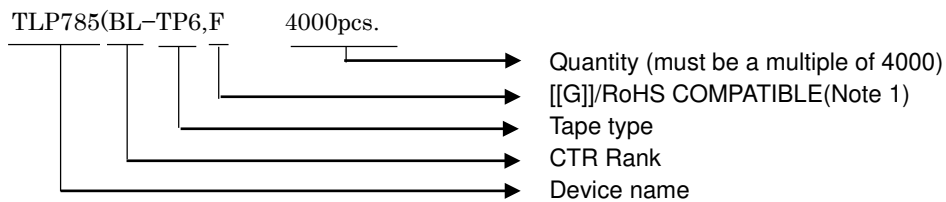
### 5. Label Indication

The carton bears a label indicating the product number, the symbol representing classification of standard, the quantity, the lot number and the Toshiba company name.

### 6. Ordering Information

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

(Example)



Note: The order code may be suffixed with a letter or a digit.

Please contact your nearest Toshiba sales representative for more details.

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 electronics equipment.



## Soldering and Storage

### (1) Precautions for Soldering

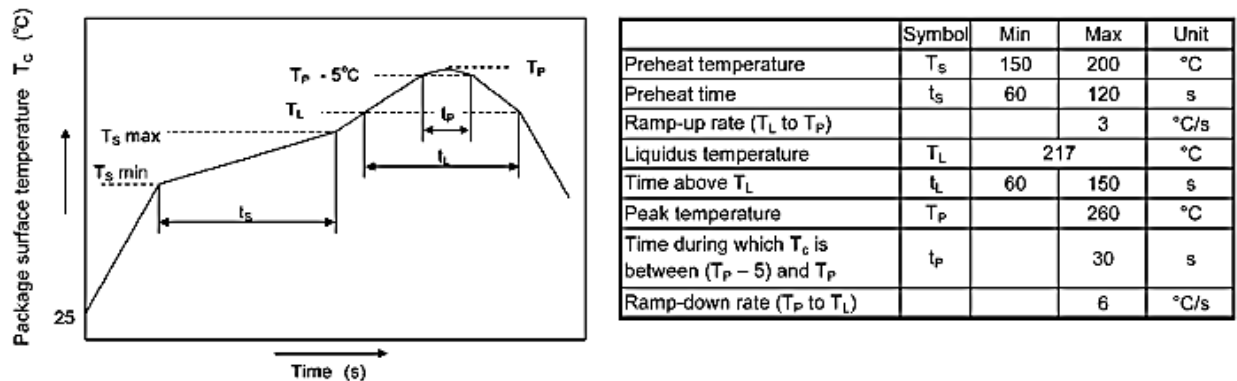
The soldering temperature should be controlled as closely as possible to the conditions shown below, irrespective of whether a soldering iron or a reflow soldering method is used.

#### 1) 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.)

**Fig. An example of a temperature profile when lead(Pb)-free solder is used**



- 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.

#### 2) 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.

#### 3) 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.

## 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.



## Insulation Related Specifications

|                              |     | <br>7.62 mm pitch<br>TLPxxx type | <br>10.16 mm pitch<br>TLPxxx F type |
|------------------------------|-----|---|--|
| 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  |  |
| Comparative tracking index   | CTI | 175   |  |

- (1) 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 centres of 7.5mm). If this is not permissible, the user shall take suitable measures.
- (2) 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.

VDE test sign: Marking on product  
for EN60747

4

Marking on packing  
for EN60747



Marking Example: TLP785, TLP785F

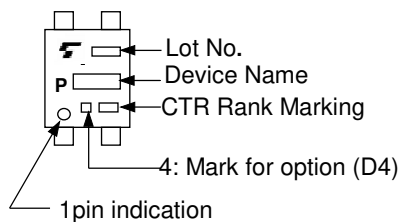


Figure 1 Partial discharge measurement procedure according to EN60747  
Destructive test for qualification and sampling tests.

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
- $t_{inj}$  = 60 s

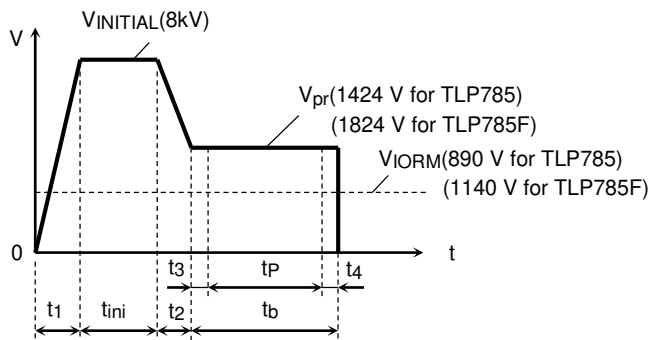


Figure 2 Partial discharge measurement procedure according to EN60747  
Non-destructive test for 100% inspection.

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

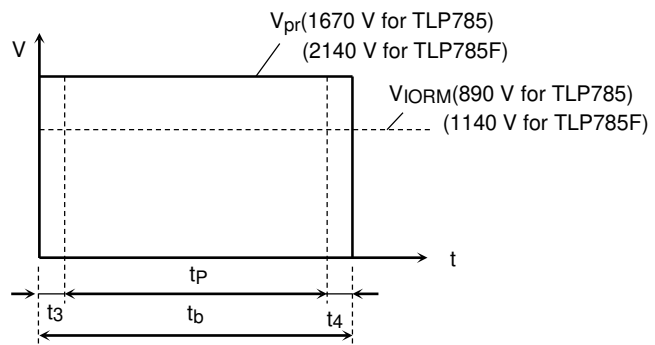
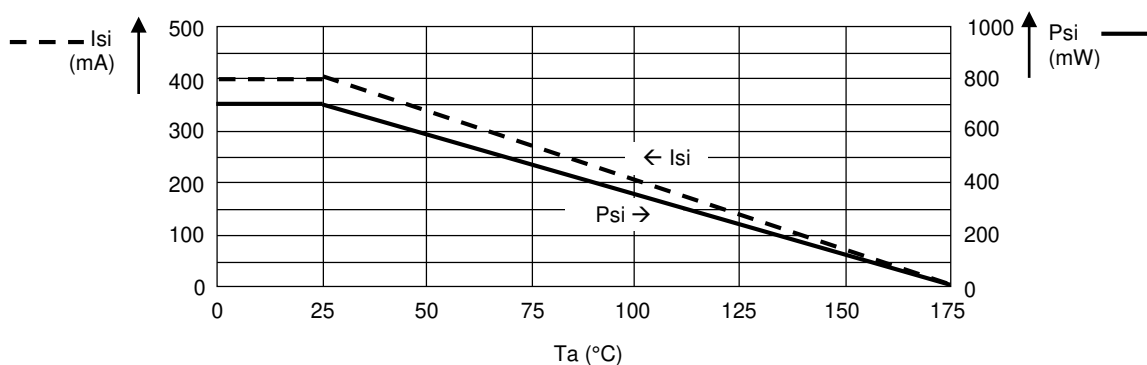
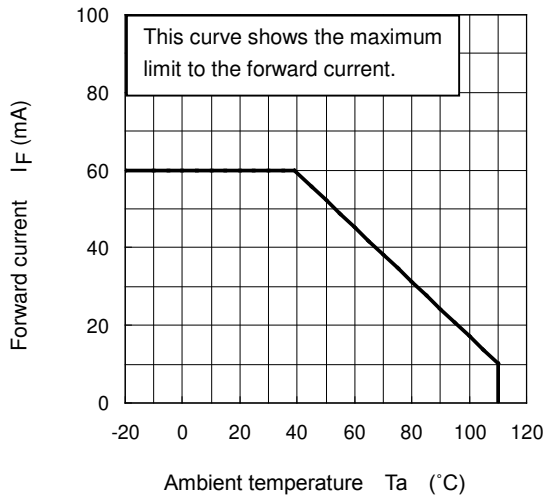


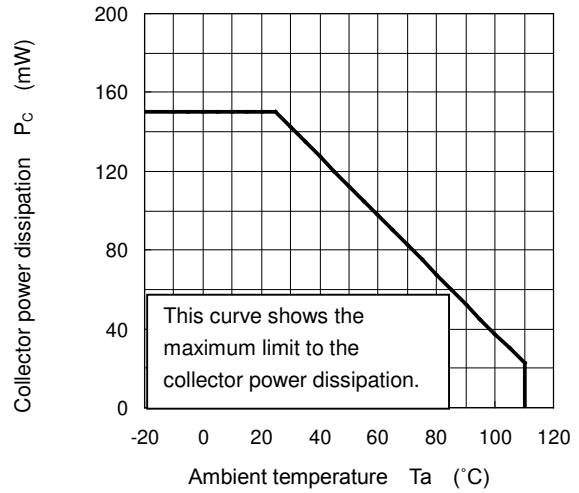
Figure 3 Dependency of maximum safety ratings on ambient temperature



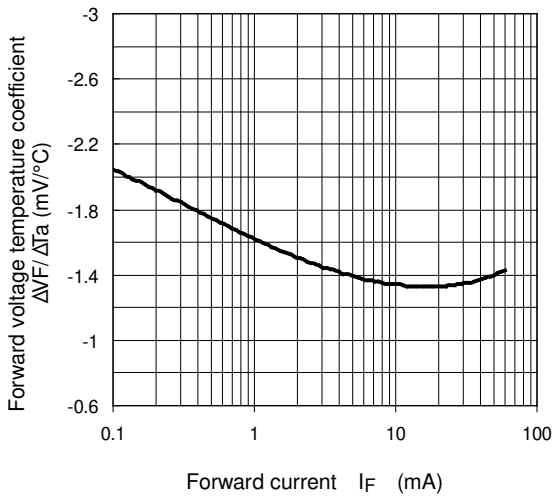
$I_F - T_a$



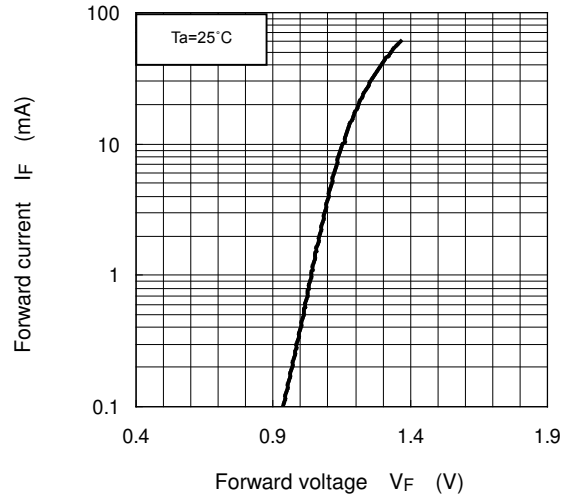
$P_C - T_a$



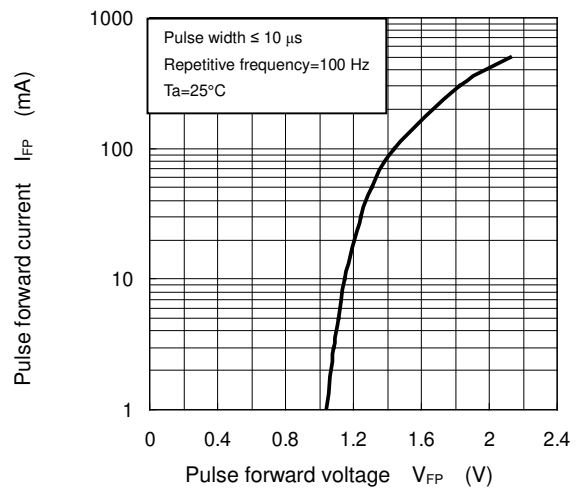
$\Delta V_F / \Delta T_a - I_F$



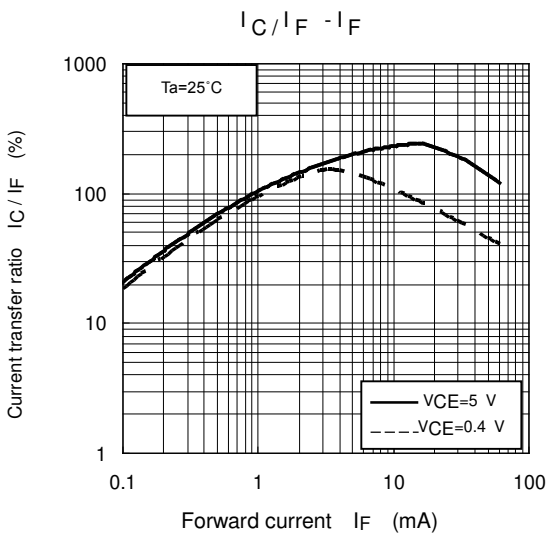
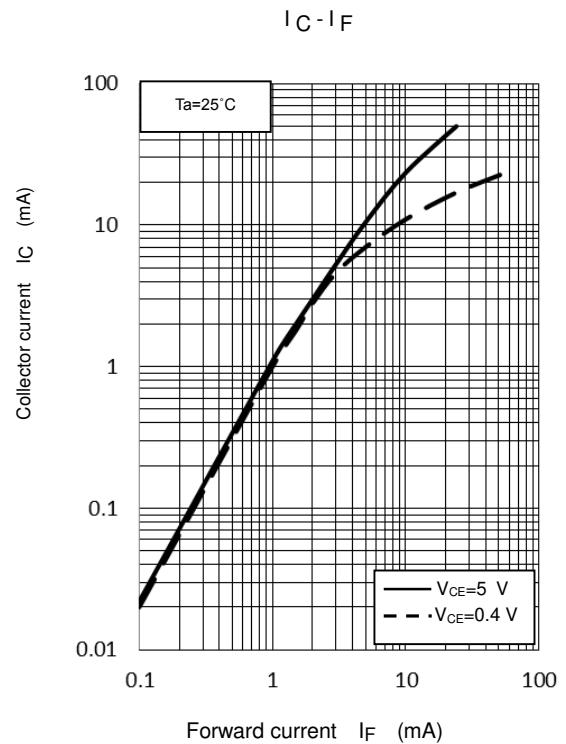
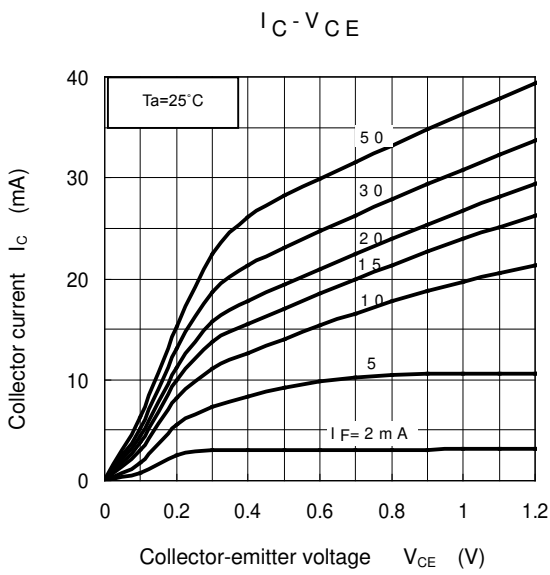
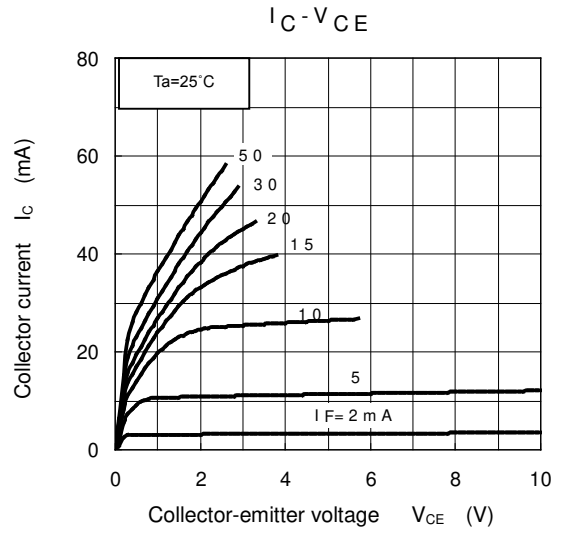
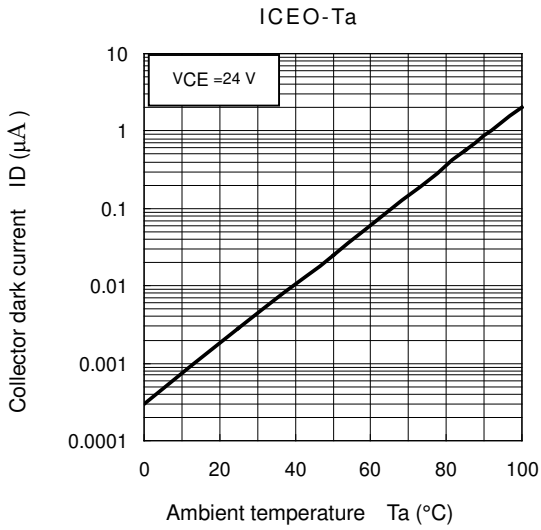
$I_F - V_F$



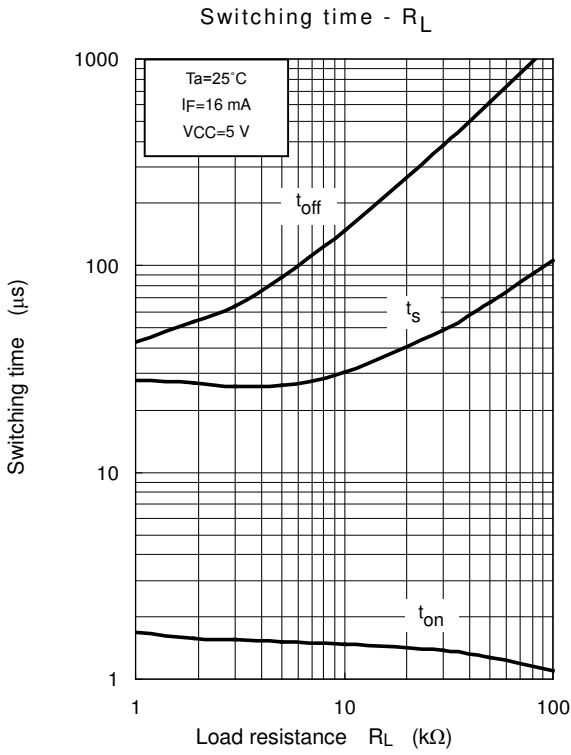
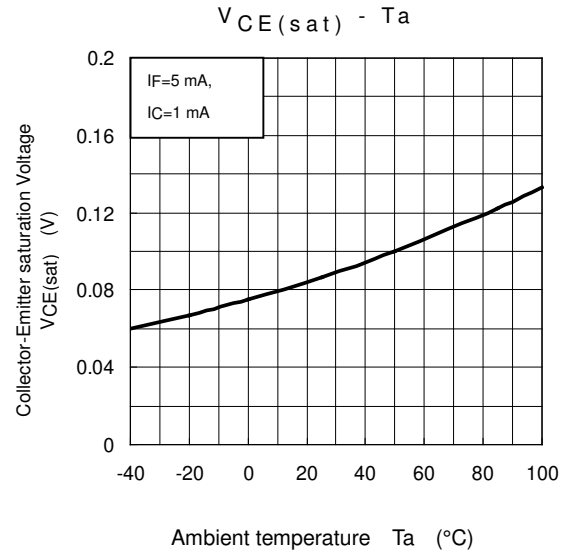
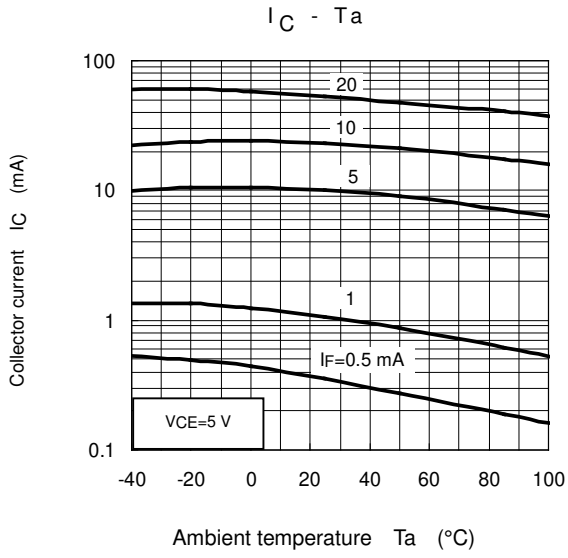
$I_{FP} - V_{FP}$



\*The above graphs show typical characteristic.



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