

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: 5kV<sub>RMS</sub> (min)).

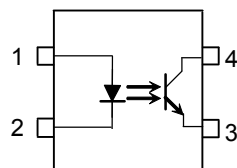
TLP785F is a lead forming type for the long creepage surface mounting of TLP785.

- TLP785: 7.62mm pitch type DIP4
- TLP785F: 10.16mm pitch type DIP4
- Collector-emitter voltage: 80V (min)
- Current transfer ratio: 50% (min)  
Rank GB: 100% (min)
- Isolation voltage: 5000V<sub>rms</sub> (min)
- UL approved: UL1577, file No. E67349
- BSI under application: BS EN60065:2002  
BS EN60950-1:2006
- SEMKO under application: EN60065:2002  
EN60950-1:2001, EN60335-1:2002
- Option(D4)type  
VDE approved: DIN EN60747-5-2  
(Note): When an EN60747-5-2 approved type is needed,  
Please designate "Option (D4)"

### Construction mechanical rating

|                         | 7.62mm Pitch<br>Standard Type | 10.16mm Pitch<br>TLPxxxF Type |
|-------------------------|-------------------------------|-------------------------------|
| Creepage distance       | 7.0mm(min)                    | 8.0mm(min)                    |
| Clearance               | 7.0mm(min)                    | 8.0mm(min)                    |
| Insulation thickness    | 0.4mm(min)                    | 0.4mm(min)                    |
| Inner creepage distance | 4.0mm(min)                    | 4.0mm(min)                    |

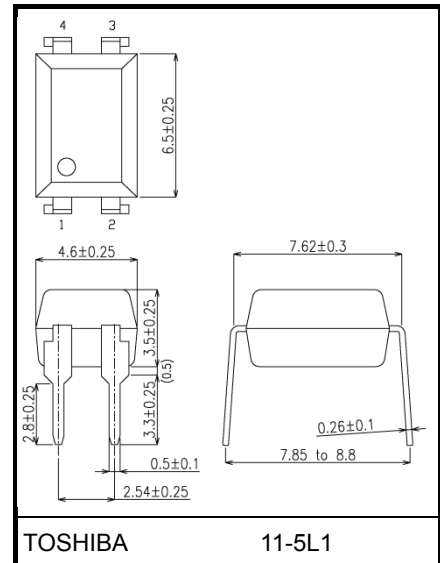
### Pin Configurations (top view)



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

TLP785

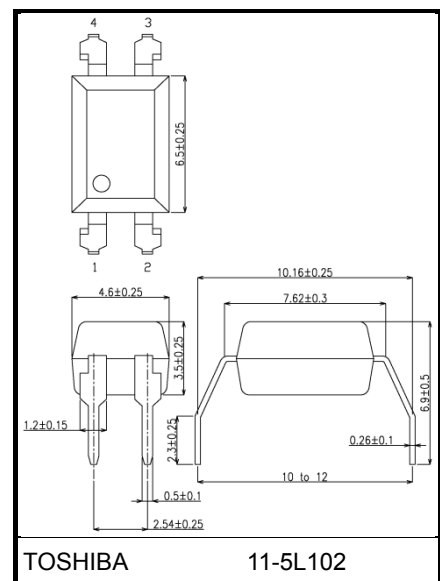
Unit: mm



Weight: 0.32 g (typ.)

TLP785F

Unit: mm



Weight: 0.32g (typ.)

Start of commercial production  
2010/11

## Current Transfer Ratio

| 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 2): Application type name for certification test, please use standard product type name, i. e.  
TLP785 (GB): TLP785

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

| 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 3)                             | $I_{FP}$                      | 1          | A                     |
|                                                                          | Power dissipation                                          | $P_D$                         | 90         | mW                    |
|                                                                          | Power dissipation derating                                 | $\Delta P_D / ^\circ\text{C}$ | -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 (10s)                                         |                                                            | $T_{sol}$                     | 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 4)                                               |                                                            | $BV_S$                        | 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 3): 100  $\mu\text{s}$  pulse, 100 Hz frequency

(Note 4): AC, 1 min., 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 ( $T_a = 25^\circ\text{C}$ )

| Characteristic |                                     | Symbol                             | Test Condition                                | Min | Typ. | Max | Unit |
|----------------|-------------------------------------|------------------------------------|-----------------------------------------------|-----|------|-----|------|
| LED            | Forward voltage                     | V <sub>F</sub>                     | I <sub>F</sub> = 10 mA                        | 1.0 | 1.15 | 1.3 | V    |
|                | Reverse current                     | I <sub>R</sub>                     | V <sub>R</sub> = 5 V                          | —   | —    | 10  | μA   |
|                | Capacitance                         | C <sub>T</sub>                     | V = 0V, f = 1 MHz                             | —   | 30   | —   | pF   |
| Detector       | Collector-emitter breakdown voltage | V <sub>(BR)</sub> CEO              | I <sub>C</sub> = 0.5 mA                       | 80  | —    | —   | V    |
|                | Emitter-collector breakdown voltage | V <sub>(BR)</sub> ECO              | I <sub>E</sub> = 0.1 mA                       | 7   | —    | —   | V    |
|                | Collector dark current              | I <sub>D</sub> (I <sub>CEO</sub> ) | V <sub>CE</sub> = 24 V                        | —   | 0.01 | 0.1 | μA   |
|                |                                     |                                    | V <sub>CE</sub> = 24 V, T <sub>a</sub> = 85°C | —   | 0.6  | 50  | μA   |
|                | Capacitance (collector to emitter)  | C <sub>CE</sub>                    | V = 0V, f = 1 MHz                             | —   | 6    | —   | pF   |

Coupled Electrical Characteristics ( $T_a = 25^\circ\text{C}$ )

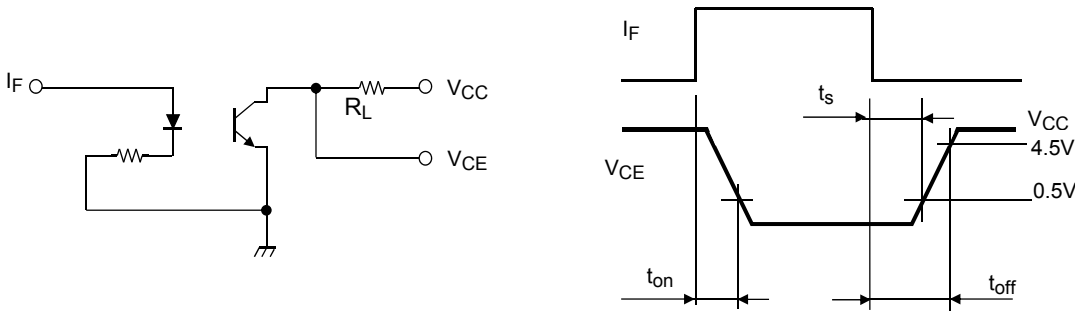
| Characteristic                       | Symbol                  | Test Condition                                        | Min | Typ. | Max | Unit |
|--------------------------------------|-------------------------|-------------------------------------------------------|-----|------|-----|------|
| Current 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 | $V_{CE(\text{sat})}$    | $I_C = 2.4\text{ mA}, I_F = 8\text{ mA}$              | —   | —    | 0.4 | V    |
|                                      |                         | $I_C = 0.2\text{ mA}, I_F = 1\text{ mA}$<br>Rank GB   | —   | 0.2  | —   |      |
|                                      |                         |                                                       | —   | —    | 0.4 |      |

Isolation Characteristics ( $T_a = 25^\circ\text{C}$ )

| 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, 1 minute                         | 5000               | —         | —   | $V_{rms}$ |
|                               |        | AC, 1 second, in oil                 | —                  | 10000     | —   |           |
|                               |        | DC, 1 minute, in oil                 | —                  | 10000     | —   | Vdc       |

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    | $t_{on}$  | $R_L = 1.9\text{ k}\Omega$<br>$V_{CC} = 5\text{ V}, I_F = 16\text{ mA}$<br>(fig. 1) | —   | 1.5  | —   | $\mu\text{s}$ |
| Storage time    | $t_s$     |                                                                                     | —   | 25   | —   |               |
| Turn-off time   | $t_{off}$ |                                                                                     | —   | 50   | —   |               |

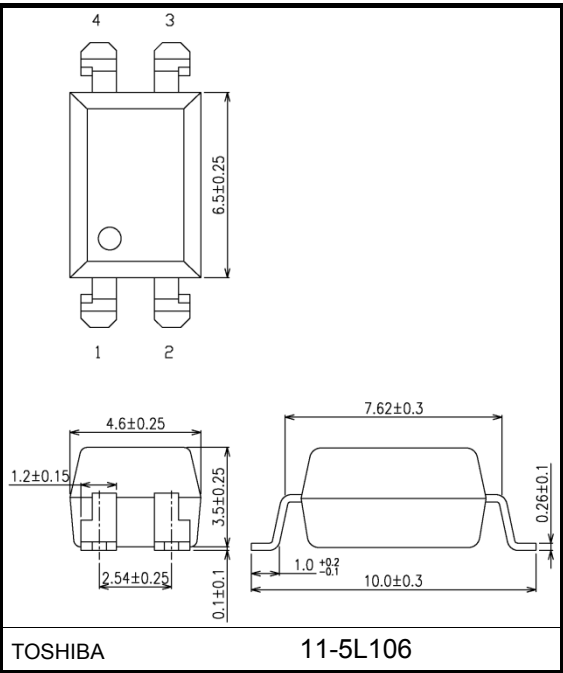


(fig. 1): Switching time test circuit

Surface-Mount Lead Form Option

TLP785(LF6)

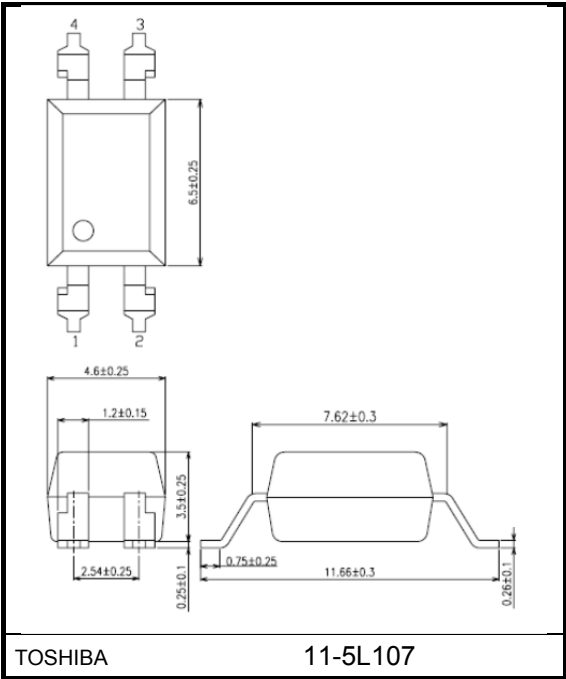
Unit: mm



Weight: 0.31g (typ.)

TLP785F(LF7)

Unit: mm



Weight: 0.31g (typ.)

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

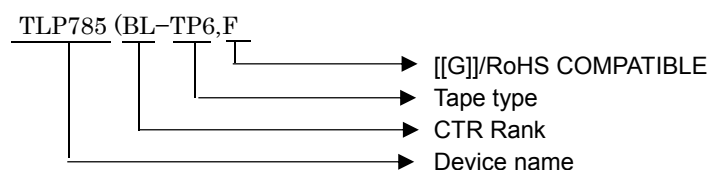
### 1. Applicable Package

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

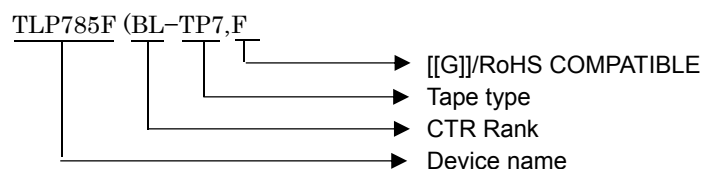
### 2. Product Naming System

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)



### 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.

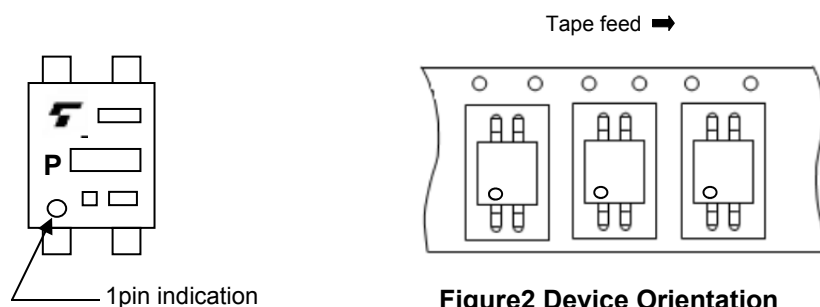


Figure2 Device Orientation

#### 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)

(1) Tape material: Plastic

(2) Dimensions: The tape dimensions are as shown in Figure 3.

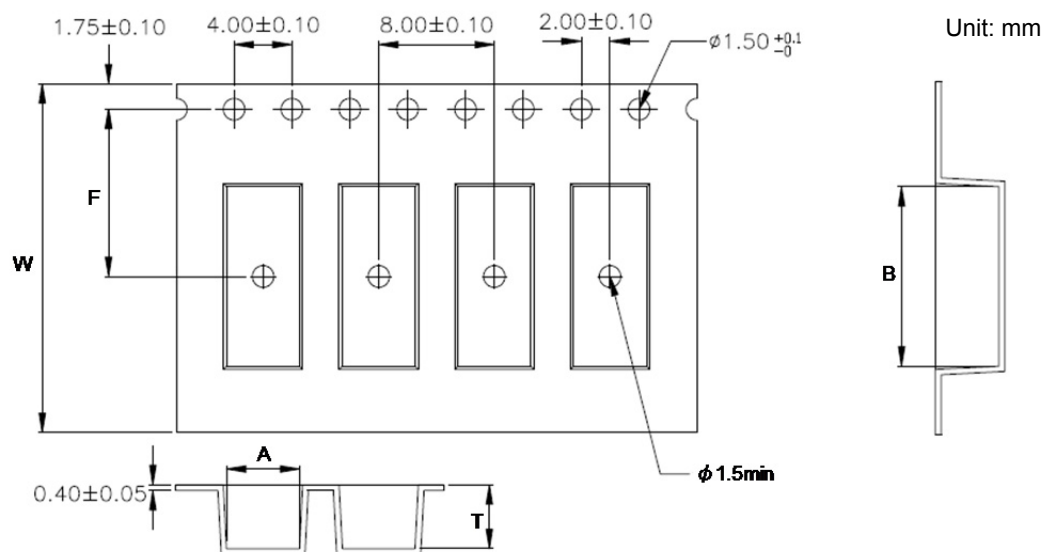


Figure 3 Tape Forms

|   | 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   |

3.6 Reel Specification

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

- (1)Material: Plastic
- (2)Dimensions: The reel dimensions are as shown in Figure 4.

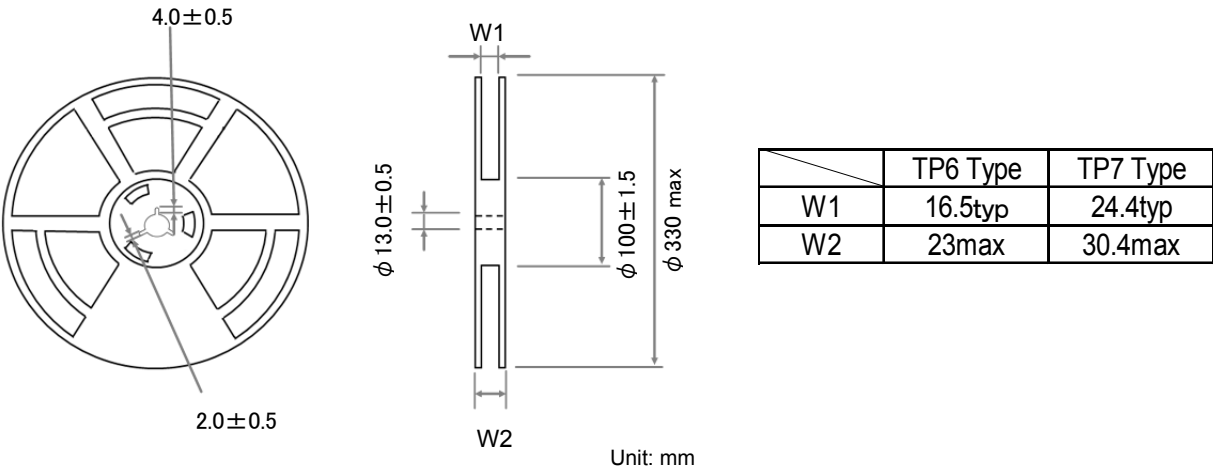


Figure 4 Reel Forms

4. Packing

Two reels of photocouplers are packed in a shipping carton.

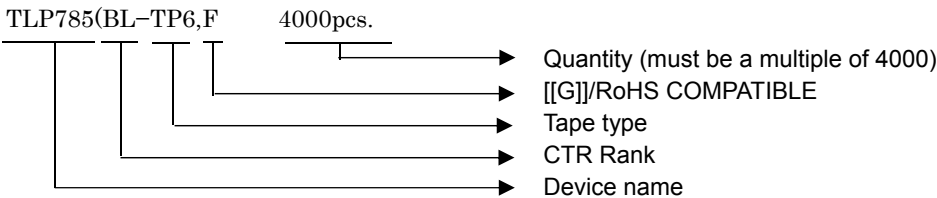
5. Label Indication

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.

## Soldering and Storage

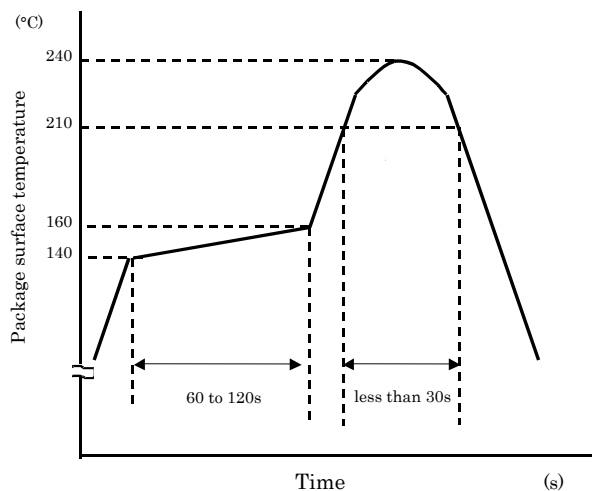
### 1. Soldering

#### 1.1 Soldering

When using a soldering iron or medium infrared ray/hot air reflow, avoid a rise in device temperature as much as possible by observing the following conditions.

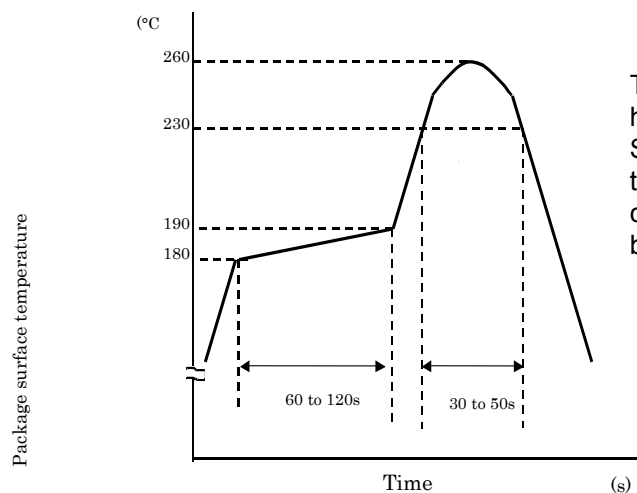
##### 1) Using solder reflow

·Temperature profile example of lead (Pb) solders



This profile is based on the devices maximum heat resistance guaranteed value. Set the preheat temperature/heating temperature to the optimum temperature corresponding to the solder paste type used by the customer within the described profile.

Temperature profile example of using lead (Pb)-free solders



This profile is based on the devices maximum heat resistance guaranteed value. Set the preheat temperature/heating temperature to the optimum temperature corresponding to the solder paste type used by the customer within the described profile.

##### 2) Using solder flow (for lead (Pb) solder, or lead (Pb)-free solder)

Please preheat it at 150°C between 60 and 120 seconds.

Complete soldering within 10 seconds below 260°C. Each pin may be heated at most once.

##### 3) Using a soldering iron

Complete soldering within 10 seconds below 260°C, or within 3 seconds at 350°C. Each pin may be heated at most once.



**2. Storage**

- 1) Avoid storage locations where devices may be exposed to moisture or direct sunlight.
- 2) Follow the precautions printed on the packing label of the device for transportation and storage.
- 3) Keep the storage location temperature and humidity within a range of 5°C to 35°C and 45% to 75%, respectively.
- 4) Do not store the products in locations with poisonous gases (especially corrosive gases) or in dusty conditions.
- 5) 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.
- 6) When restoring devices after removal from their packing, use anti-static containers.
- 7) Do not allow loads to be applied directly to devices while they are in storage.
- 8) 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.

## EN60747-5-2 'Option: (D4)'

Attachment: Specification for EN60747-5-2 option: (D4)

Types: TLP785, TLP785F

Type designations for 'option: (D4)', which are tested under EN60747 requirements.

Ex.: TLP785(D4-GR-LF6,F)      D4: EN60747 option  
                                          GR: CTR rank name  
                                          LF6: standard lead bend name  
                                          F: [[G]]/RoHS COMPATIBLE

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

Ex. TLP785(D4-GR-LF6,F → TLP785

## EN60747 Isolation Characteristics

| Description                                                                                                                                                              |         | Symbol                           | Rating            | Unit           |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|----------------------------------|-------------------|----------------|
| Application classification<br>for rated mains voltage $\leq 300 V_{rms}$<br>for rated mains voltage $\leq 600 V_{rms}$                                                   |         |                                  | I-IV<br>I-III     | —              |
| Climatic classification                                                                                                                                                  |         |                                  | 55 / 115 / 21     | —              |
| Pollution degree                                                                                                                                                         |         |                                  | 2                 | —              |
| Maximum operating insulation voltage                                                                                                                                     | TLP785  | $V_{IORM}$                       | 890               | Vpk            |
|                                                                                                                                                                          | TLP785F |                                  | 1140              |                |
| Input to output test voltage,<br>$V_{pr} = 1.5 \times V_{IORM}$ , type and sample test<br>$t_p = 10s$ , partial discharge $< 5pC$                                        | TLP785  | $V_{pr}$                         | 1335              | Vpk            |
|                                                                                                                                                                          | TLP785F |                                  | 1710              |                |
| Input to output test voltage,<br>$V_{pr} = 1.875 \times V_{IORM}$ , 100% production test<br>$t_p = 1s$ , partial discharge $< 5pC$                                       | TLP785  | $V_{pr}$                         | 1670              | Vpk            |
|                                                                                                                                                                          | TLP785F |                                  | 2140              |                |
| Highest permissible overvoltage<br>(transient overvoltage, $t_{pr} = 60s$ )                                                                                              |         | $V_{TR}$                         | 8000              | Vpk            |
| Safety limiting values (max. permissible ratings in case of fault)<br>current (input current) $P_{si} = 0mW$<br>power (output or total power dissipation)<br>temperature |         | $I_{si}$<br>$P_{si}$<br>$T_{si}$ | 400<br>700<br>175 | mA<br>mW<br>°C |
| Insulation resistance, $V_{IO} = 500V$ , $T_a = 25^\circ C$                                                                                                              |         | $R_{si}$                         | $\geq 10^{12}$    | $\Omega$       |

Insulation Related Specifications

|                              |     | <br>7.62mm pitch<br>TLPxxx type | <br>10.16mm pitch<br>TLPxxxF type |
|------------------------------|-----|------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|
| Minimum creepage distance    | Cr  | 7.0mm                                                                                                            | 8.0mm                                                                                                                |
| Minimum clearance            | Cl  | 7.0mm                                                                                                            | 8.0mm                                                                                                                |
| 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

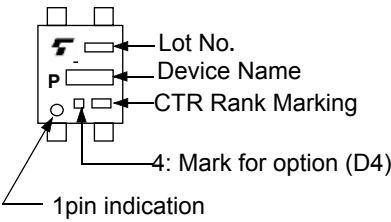


Figure 1 Partial discharge measurement procedure according to EN60747  
Destructive test for qualification and sampling tests.

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<br>partial discharge) | = 10 s      |
| $t_b$                                           | = 12 s      |
| $t_{ini}$                                       | = 60 s      |

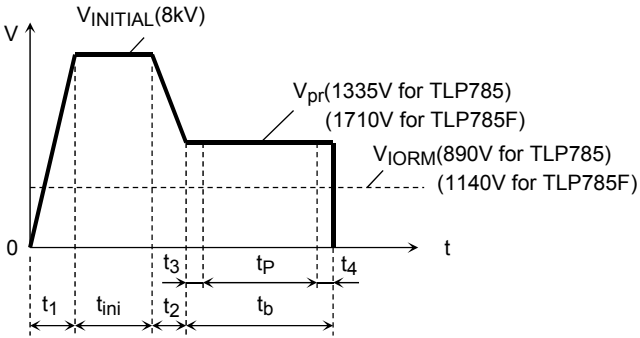


Figure 2 Partial discharge measurement procedure according to EN60747  
Non-destructive test for 100% inspection.

Method B

(for sample test, non-  
destructive test)

|                                                 |         |
|-------------------------------------------------|---------|
| $t_3, t_4$                                      | = 0.1 s |
| $t_p$ (Measuring time for<br>partial discharge) | = 1 s   |
| $t_b$                                           | = 1.2 s |

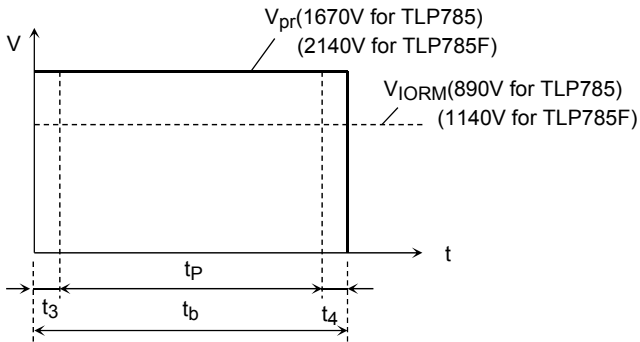
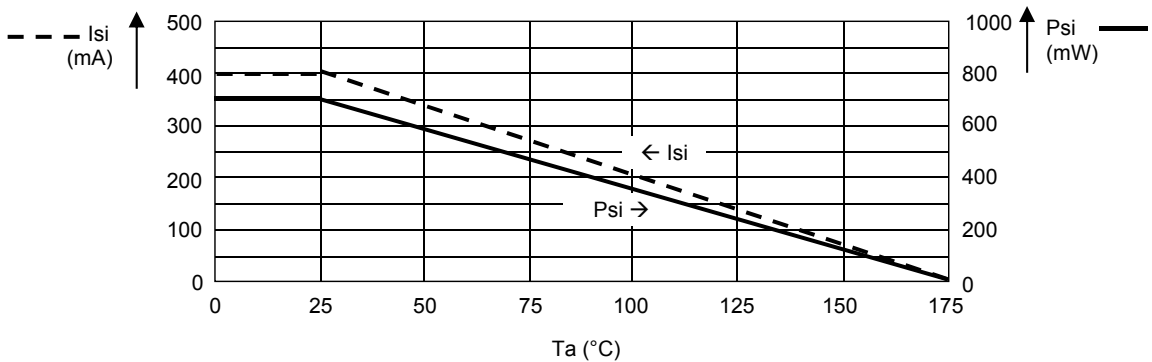
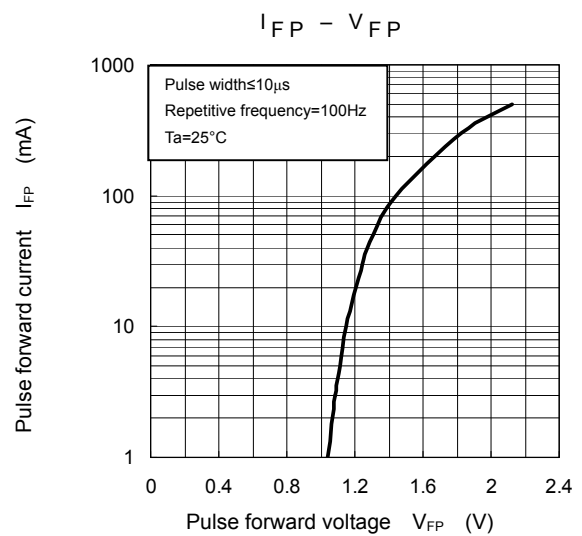
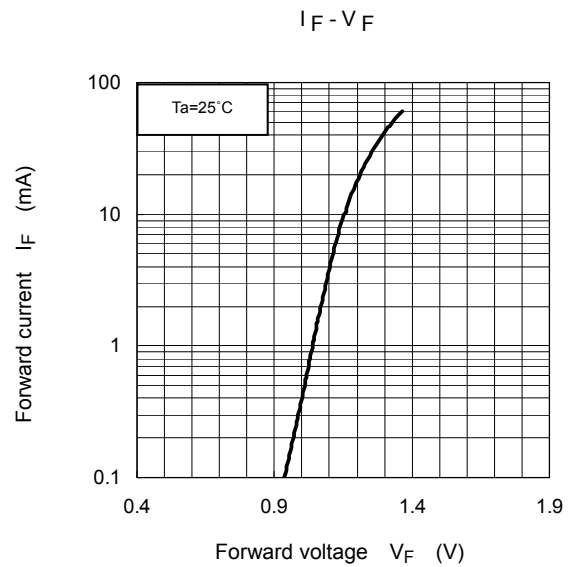
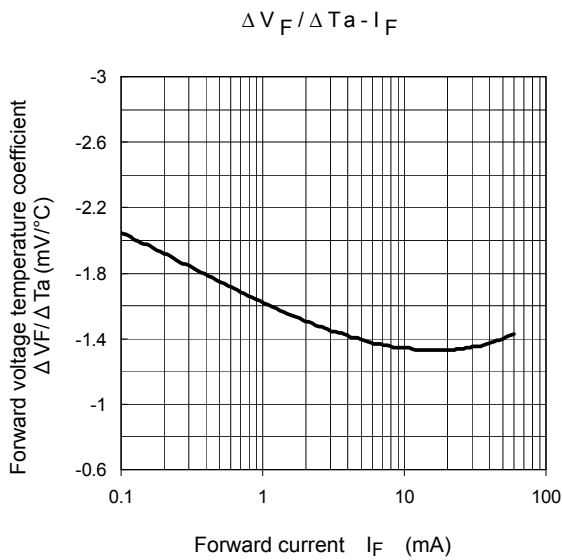
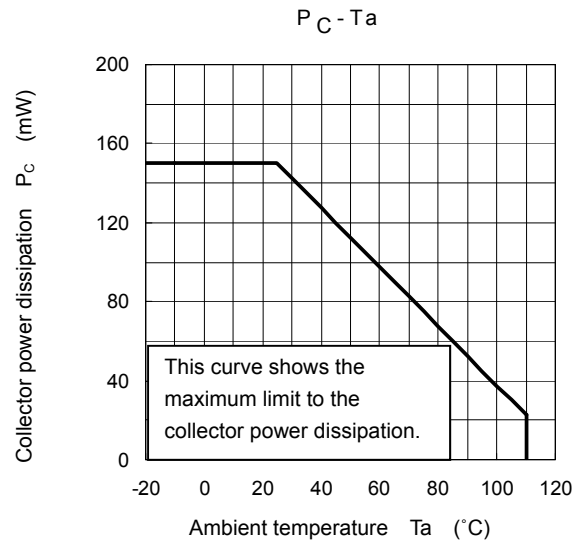
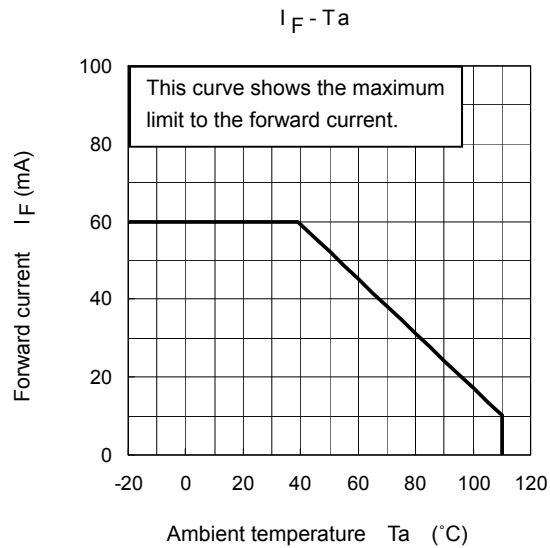
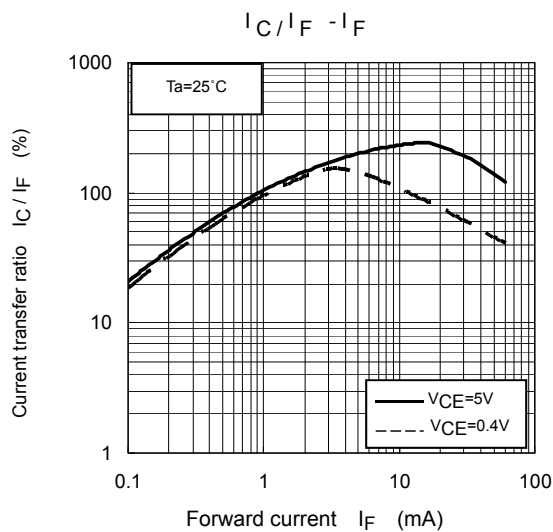
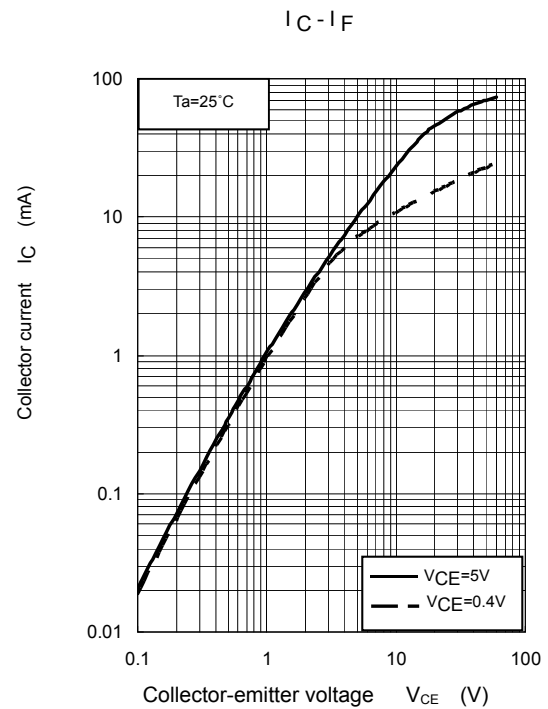
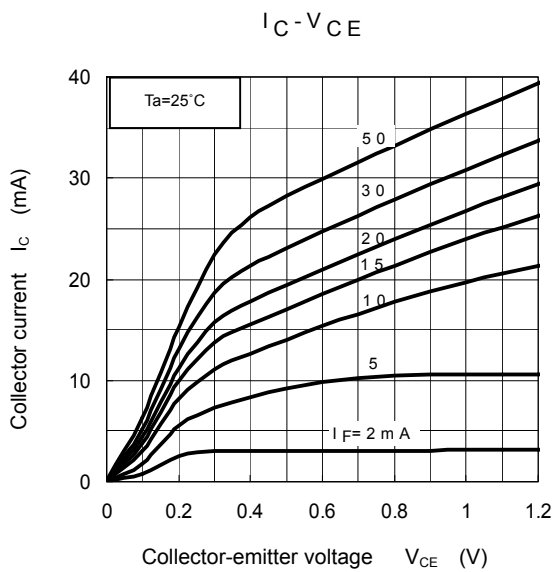
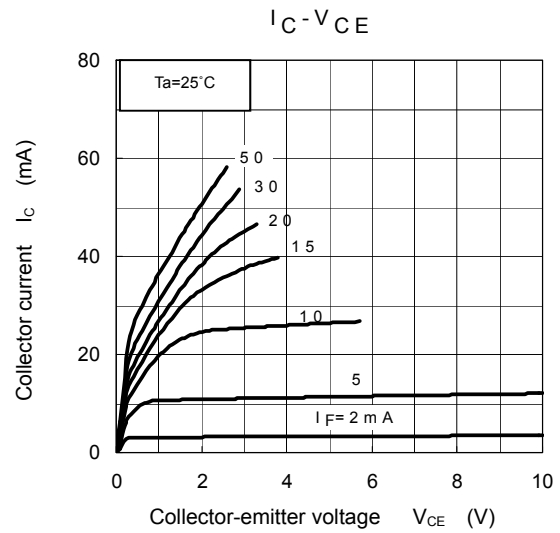
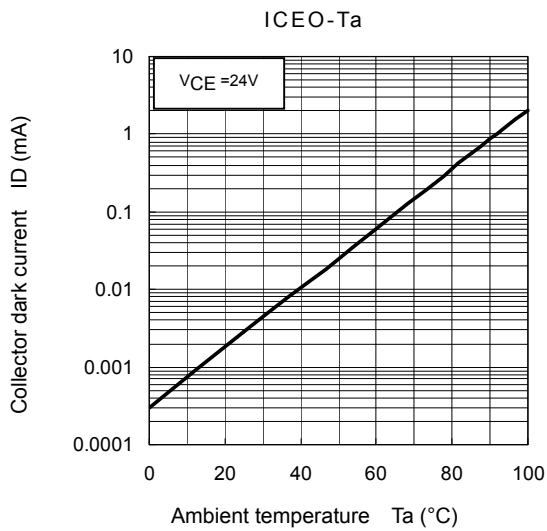


Figure 3 Dependency of maximum safety ratings on ambient temperature

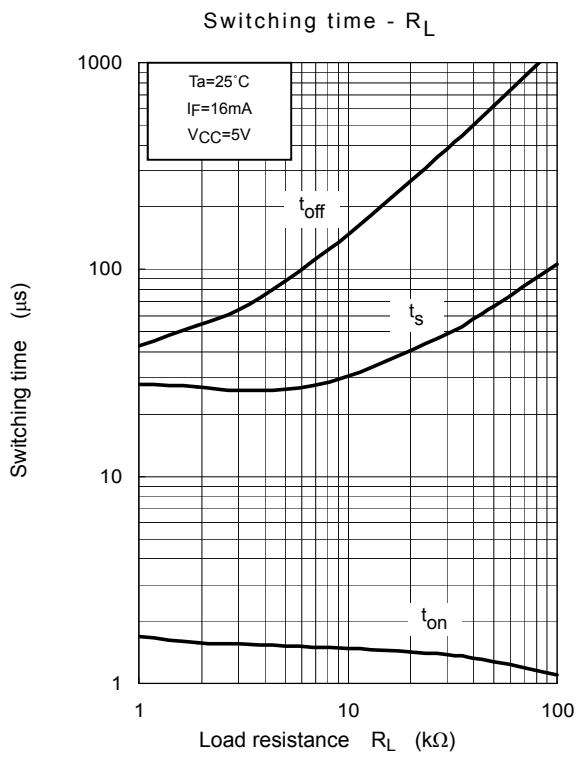
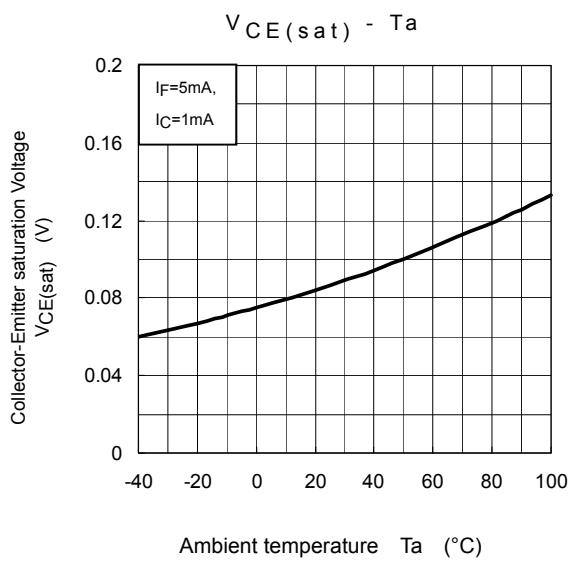
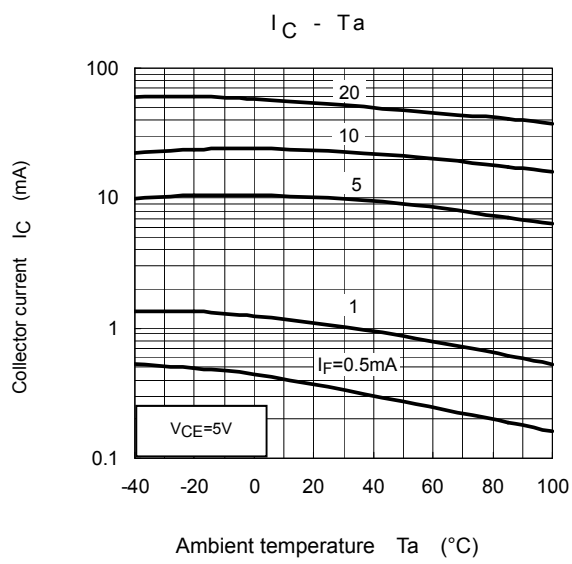




\*The above graphs show typical characteristic.



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