

# TLPN137,TLPN137(LF1)

## 1. Applications

- Factory Automation (FA)
- High-Speed Digital Interfacing
- Measuring Instruments

## 2. General

The Toshiba TLPN137 consists of a high-output GaAs light-emitting diode coupled with integrated high gain, high-speed photodetectors. It is housed in the DIP8 package. The TLPN137 succeeds the 6N137 which has been released. The characteristics of the TLPN137 are similar as the 6N137. The TLPN137 has an internal Faraday shield that provides a guaranteed common-mode transient immunity of  $\pm 10$  kV/ $\mu$ s.

## 3. Features

- (1) Inverter logic type (open collector output)
- (2) Package: DIP8
- (3) Operating temperature: -40 to 85 °C
- (4) Supply voltage: 4.5 to 5.5 V
- (5) Data transfer rate: 10 MBd (typ.) (NRZ)
- (6) Threshold input current: 5.0 mA (max)
- (7) Supply current: 4.0 mA (max)
- (8) Common-mode transient immunity:  $\pm 10$  kV/ $\mu$ s (min)
- (9) Isolation voltage: 5000 Vrms (min)
- (10) Safety standards

UL-approved: UL1577, File No.E67349

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

VDE-approved: EN60747-5-5, EN60065 or EN60950-1 (**Note 1**)

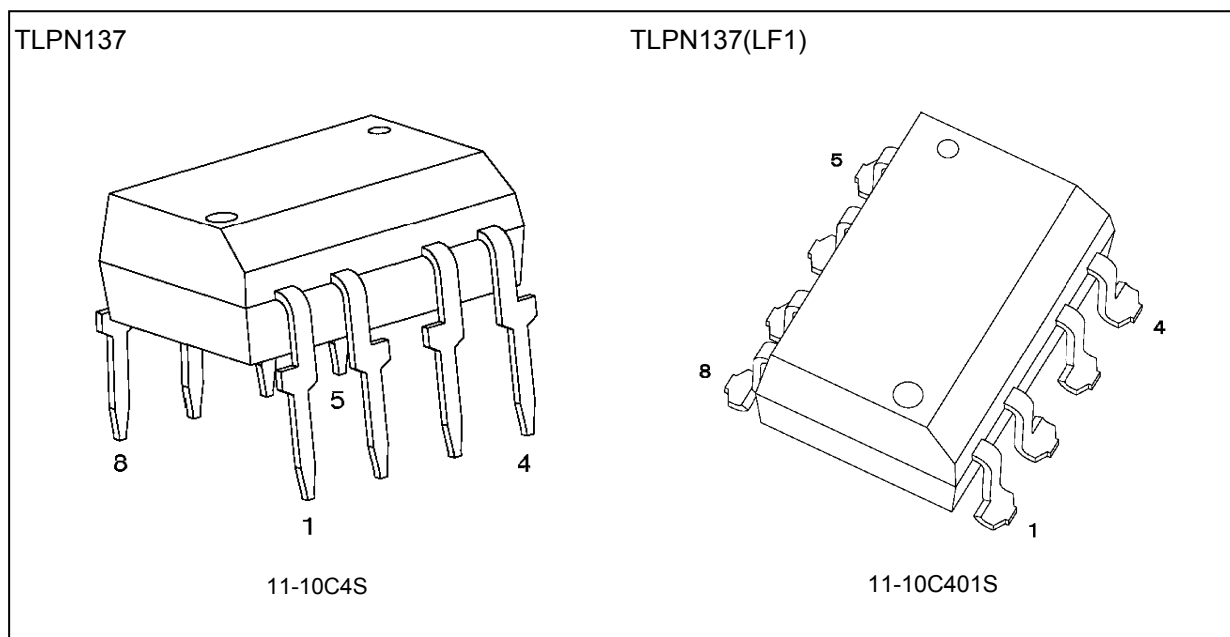
: EN62368-1 (Pending) (**Note 1**)

Note 1: When a VDE approved type is needed, please designate the **Option (D4)**.

Start of commercial production

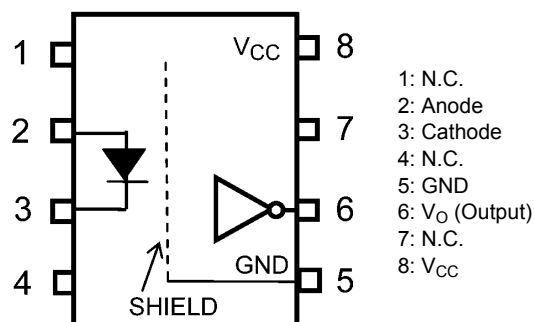
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### 4. Packaging (Note)

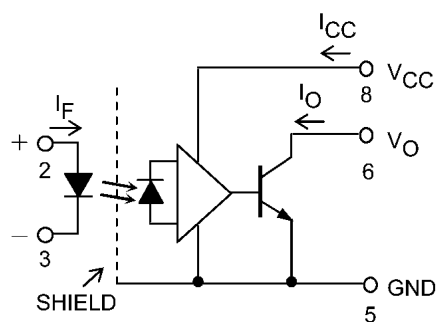


Note: Lead-formed product: (LF1)

### 5. Pin Assignment



### 6. Internal Circuit (Note)



Note: A 0.1- $\mu$ F bypass capacitor must be connected between pin 8 and pin 5.

## 7. Principle of Operation

### 7.1. Truth Table

| Input | LED | Output |
|-------|-----|--------|
| H     | ON  | L      |
| L     | OFF | H      |

### 7.2. Mechanical Parameters

| Characteristics              | Min | Unit |
|------------------------------|-----|------|
| Creepage distances           | 7.0 | mm   |
| Clearance distances          | 7.0 | mm   |
| Internal isolation thickness | 0.4 | mm   |

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

|          | Characteristics                                                             | Symbol                    | Note     | Rating     | Unit                   |
|----------|-----------------------------------------------------------------------------|---------------------------|----------|------------|------------------------|
| LED      | Input forward current                                                       | $I_F$                     |          | 20         | mA                     |
|          | Input forward current derating ( $T_a \geq 91\text{ }^{\circ}\text{C}$ )    | $\Delta I_F / \Delta T_a$ |          | -0.6       | mA/ $^{\circ}\text{C}$ |
|          | Input forward current (pulsed)                                              | $I_{FP}$                  | (Note 1) | 40         | mA                     |
|          | Peak transient input forward current                                        | $I_{FPT}$                 | (Note 2) | 1          | A                      |
|          | Input reverse voltage                                                       | $V_R$                     |          | 5          | V                      |
|          | Input power dissipation                                                     | $P_D$                     |          | 40         | mW                     |
|          | Input power dissipation derating ( $T_a \geq 91\text{ }^{\circ}\text{C}$ )  | $\Delta P_D / \Delta T_a$ |          | -1.18      | mW/ $^{\circ}\text{C}$ |
| Detector | Output current                                                              | $I_O$                     |          | 50         | mA                     |
|          | Output voltage                                                              | $V_O$                     |          | 6          | V                      |
|          | Supply voltage                                                              | $V_{CC}$                  |          | 6          | V                      |
|          | Output power dissipation                                                    | $P_O$                     |          | 85         | mW                     |
|          | Output power dissipation derating ( $T_a \geq 85\text{ }^{\circ}\text{C}$ ) | $\Delta P_O / \Delta T_a$ |          | -2.1       | mW/ $^{\circ}\text{C}$ |
| Common   | Operating temperature                                                       | $T_{opr}$                 |          | -40 to 85  | $^{\circ}\text{C}$     |
|          | Storage temperature                                                         | $T_{stg}$                 |          | -55 to 125 | $^{\circ}\text{C}$     |
|          | Lead soldering temperature (10 s)                                           | $T_{sol}$                 |          | 260        | $^{\circ}\text{C}$     |
|          | Isolation voltage AC, 60 s, R.H. $\leq 60\%$                                | $BV_S$                    | (Note 3) | 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: Pulse width (PW)  $\leq 1\text{ ms}$ , duty = 50 %

Note 2: Pulse width (PW)  $\leq 1\text{ }\mu\text{s}$ , 300 pps

Note 3: 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.

### 9. Recommended Operating Conditions (Note)

| Characteristics         | Symbol       | Note     | Min | Typ. | Max | Unit |
|-------------------------|--------------|----------|-----|------|-----|------|
| Input on-state current  | $I_{F(ON)}$  | (Note 1) | 6.3 | —    | 15  | mA   |
| Input off-state voltage | $V_{F(OFF)}$ |          | 0   | —    | 0.8 | V    |
| Supply voltage          | $V_{CC}$     | (Note 2) | 4.5 | 5.0  | 5.5 |      |
| Operating temperature   | $T_{opr}$    | (Note 2) | -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.

Note: A ceramic capacitor (0.1  $\mu$ F) should be connected between pin 8 and pin 5 to stabilize the operation of a high-gain linear amplifier. Otherwise, this photocoupler may not switch properly. The bypass capacitor should be placed within 1 cm of each pin.

Note 1: The rise and fall times of the input on-current should be less than 0.5  $\mu$ s.

Note 2: Denotes the operating range, not the recommended operating condition.

### 10. Electrical Characteristics (Note) (Unless otherwise specified, $T_a = -40$ to $85$ °C, $V_{CC} = 4.5$ to $5.5$ V)

| Characteristics                               | Symbol                    | Note | Test Circuit | Test Condition                                                | Min  | Typ. | Max | Unit    |
|-----------------------------------------------|---------------------------|------|--------------|---------------------------------------------------------------|------|------|-----|---------|
| Input forward voltage                         | $V_F$                     |      | —            | $I_F = 10$ mA, $T_a = 25$ °C                                  | 1.45 | 1.55 | 1.7 | V       |
| Input forward voltage temperature coefficient | $\Delta V_F / \Delta T_a$ |      | —            | $I_F = 10$ mA                                                 | —    | -2.0 | —   | mV/°C   |
| Input reverse current                         | $I_R$                     |      | —            | $V_R = 5$ V, $T_a = 25$ °C                                    | —    | —    | 10  | $\mu$ A |
| Input capacitance                             | $C_t$                     |      | —            | $V = 0$ V, $f = 1$ MHz, $T_a = 25$ °C                         | —    | 60   | —   | pF      |
| High-level output current                     | $I_{OH}$                  |      | Fig. 13.1.1  | $V_F = 0.8$ V, $V_O = 5.5$ V, $V_{CC} = 5.5$ V                | —    | —    | 50  | $\mu$ A |
|                                               |                           |      |              | $V_F = 0.8$ V, $V_O = 5.5$ V, $V_{CC} = 5.5$ V, $T_a = 25$ °C | —    | —    | 10  |         |
| Low-level output voltage                      | $V_{OL}$                  |      | Fig. 13.1.2  | $I_F = 5$ mA, $I_O = 13$ mA (Sinking)                         | —    | 0.23 | 0.6 | V       |
| High-level supply current                     | $I_{CCH}$                 |      | Fig. 13.1.3  | $I_F = 0$ mA                                                  | —    | 1.6  | 4.0 | mA      |
| Low-level supply current                      | $I_{CCL}$                 |      | Fig. 13.1.4  | $I_F = 10$ mA                                                 | —    | 1.8  | 4.0 |         |
| Threshold input current (H/L)                 | $I_{FHL}$                 |      | —            | $I_O = 13$ mA (Sinking), $V_O < 0.6$ V                        | —    | 1.3  | 5.0 |         |

Note: All typical values are at  $T_a = 25$  °C.

### 11. 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        | —                  | 1.0       | —   | pF       |
| Isolation resistance                | $R_S$  | (Note 1) | $V_S = 500$ V, R.H. $\leq 60$ % | $1 \times 10^{12}$ | $10^{14}$ | —   | $\Omega$ |
| Isolation voltage                   | $BV_S$ | (Note 1) | AC, 60 s                        | 5000               | —         | —   | Vrms     |
|                                     |        |          | AC, 1 s in oil                  | —                  | 10000     | —   |          |
|                                     |        |          | DC, 60 s in oil                 | —                  | 10000     | —   | Vdc      |

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.

### 12. Switching Characteristics (Note) (Unless otherwise specified, $T_a = -40$ to $85\text{ }^\circ\text{C}$ , $V_{CC} = 4.5$ to $5.5\text{ V}$ )

| Characteristics                               | Symbol                | Note               | Test Circuit | Test Condition                                                                                                            | Min      | Typ.     | Max | Unit              |
|-----------------------------------------------|-----------------------|--------------------|--------------|---------------------------------------------------------------------------------------------------------------------------|----------|----------|-----|-------------------|
| Propagation delay time (H/L)                  | $t_{pHL}$             | (Note 1)           | Fig. 13.1.5  | $I_F = 0 \rightarrow 7.5\text{ mA}$ , $R_L = 350\text{ }\Omega$ , $C_L = 15\text{ pF}$ , $T_a = 25\text{ }^\circ\text{C}$ | —        | 35       | 75  | ns                |
|                                               |                       |                    |              | $I_F = 0 \rightarrow 7.5\text{ mA}$ , $R_L = 350\text{ }\Omega$ , $C_L = 15\text{ pF}$                                    | —        | —        | 100 |                   |
| Propagation delay time (L/H)                  | $t_{pLH}$             | (Note 1)           |              | $I_F = 7.5 \rightarrow 0\text{ mA}$ , $R_L = 350\text{ }\Omega$ , $C_L = 15\text{ pF}$ , $T_a = 25\text{ }^\circ\text{C}$ | —        | 25       | 75  |                   |
|                                               |                       |                    |              | $I_F = 7.5 \rightarrow 0\text{ mA}$ , $R_L = 350\text{ }\Omega$ , $C_L = 15\text{ pF}$                                    | —        | —        | 100 |                   |
| Pulse width distortion                        | $ t_{pHL} - t_{pLH} $ | (Note 1)           |              | $I_F = 7.5\text{ mA}$ , $R_L = 350\text{ }\Omega$ , $C_L = 15\text{ pF}$                                                  | —        | —        | 35  |                   |
| Propagation delay skew (device to device)     | $t_{psk}$             | (Note 1), (Note 2) |              | $I_F = 7.5\text{ mA}$ , $R_L = 350\text{ }\Omega$ , $C_L = 15\text{ pF}$                                                  | -40      | —        | 40  |                   |
| Fall time                                     | $t_f$                 | (Note 1)           |              | $I_F = 0 \rightarrow 7.5\text{ mA}$ , $R_L = 350\text{ }\Omega$ , $C_L = 15\text{ pF}$                                    | —        | 3        | —   |                   |
| Rise time                                     | $t_r$                 | (Note 1)           |              | $I_F = 7.5 \rightarrow 0\text{ mA}$ , $R_L = 350\text{ }\Omega$ , $C_L = 15\text{ pF}$                                    | —        | 12       | —   |                   |
| Common-mode transient immunity at output high | $CM_H$                |                    | Fig. 13.1.6  | $V_{CM} = 1000\text{ V}_{p-p}$ , $I_F = 0\text{ mA}$ , $V_{CC} = 5\text{ V}$ , $T_a = 25\text{ }^\circ\text{C}$           | $\pm 10$ | $\pm 15$ | —   | kV/ $\mu\text{s}$ |
| Common-mode transient immunity at output low  | $CM_L$                |                    |              | $V_{CM} = 1000\text{ V}_{p-p}$ , $I_F = 10\text{ mA}$ , $V_{CC} = 5\text{ V}$ , $T_a = 25\text{ }^\circ\text{C}$          | $\pm 10$ | $\pm 15$ | —   |                   |

Note: All typical values are at  $T_a = 25\text{ }^\circ\text{C}$ .

Note 1:  $f = 5\text{ MHz}$ , duty = 50 %, input current  $t_r = t_f = 5\text{ ns}$ ,  $C_L$  is approximately 15 pF which includes probe and stray wiring capacitance.

Note 2: The propagation delay skew,  $t_{psk}$ , is equal to the magnitude of the worst-case difference in  $t_{pHL}$  and/or  $t_{pLH}$  that will be seen between units at the same given conditions (supply voltage, input current, temperature, etc).

### 13. Test Circuits and Characteristics Curves

#### 13.1. Test Circuits

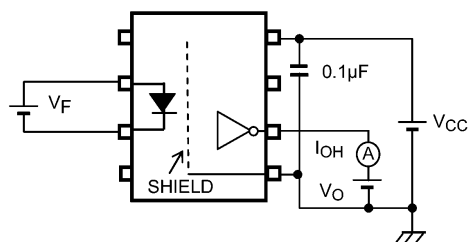


Fig. 13.1.1  $I_{OH}$  Test Circuit

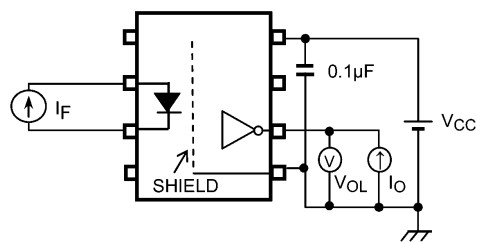


Fig. 13.1.2  $V_{OL}$  Test Circuit

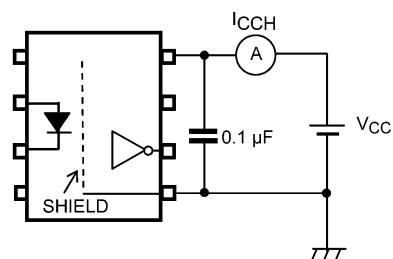


Fig. 13.1.3  $I_{CCH}$  Test Circuit

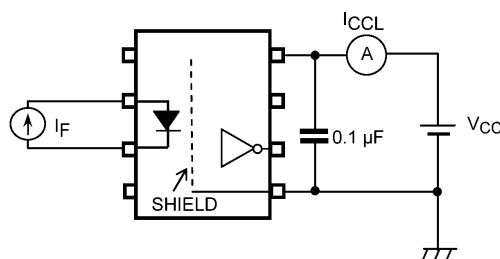
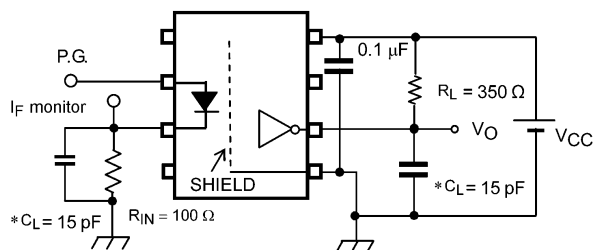


Fig. 13.1.4  $I_{CCL}$  Test Circuit

$I_F = 7.5 \text{ mA}$  (P.G.)

( $f = 5 \text{ MHz}$ , duty = 50 %,  $t_r = t_f = \text{less than } 5 \text{ ns}$ )



\* $C_L$ : includes probe and stray wiring capacitance.

P.G.: Pulse Generator

Fig. 13.1.5 Switching Time Test Circuit and Waveform

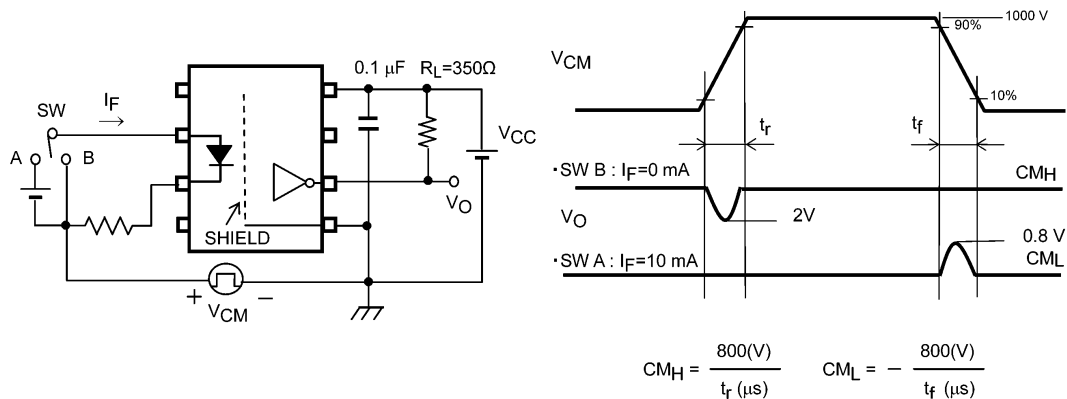


Fig. 13.1.6 Common-Mode Transient Immunity and Waveform

### 13.2. Characteristics Curves (Note)

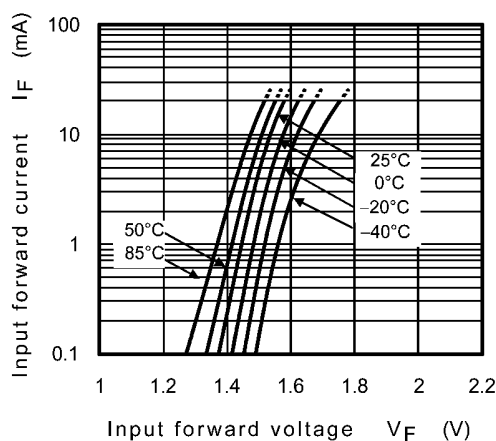


Fig. 13.2.1  $I_F - V_F$

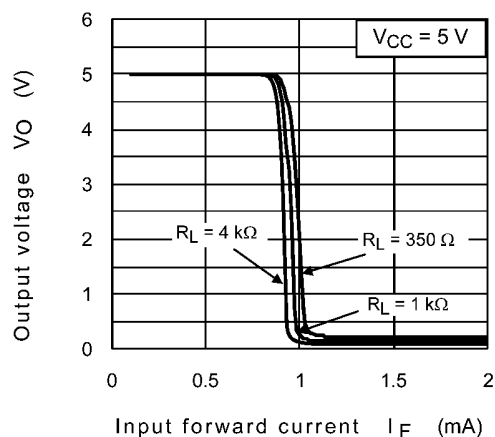


Fig. 13.2.2  $V_O - I_F$

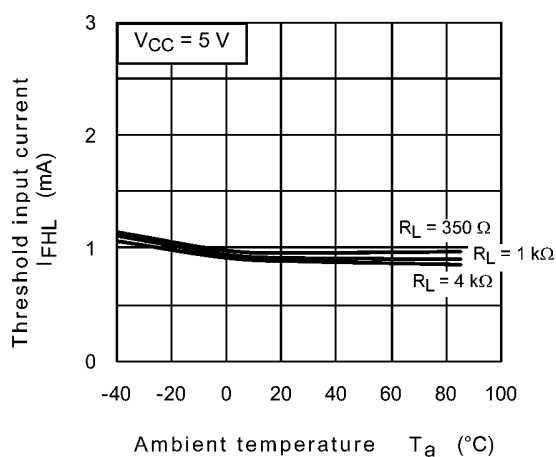


Fig. 13.2.3  $I_{FHL} - T_a$

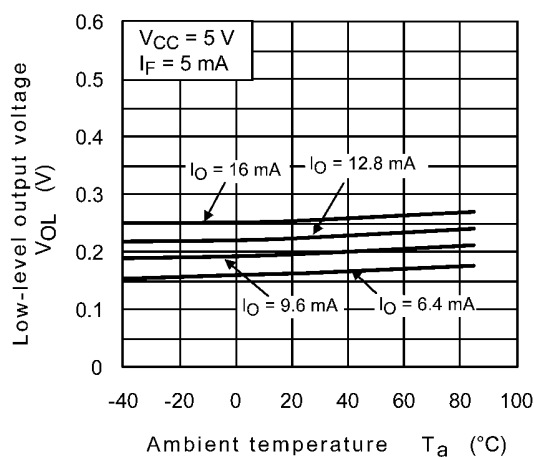


Fig. 13.2.4  $V_{OL} - T_a$

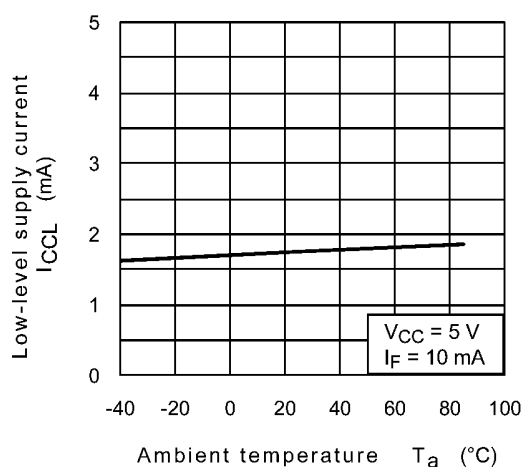


Fig. 13.2.5  $I_{CCL} - T_a$

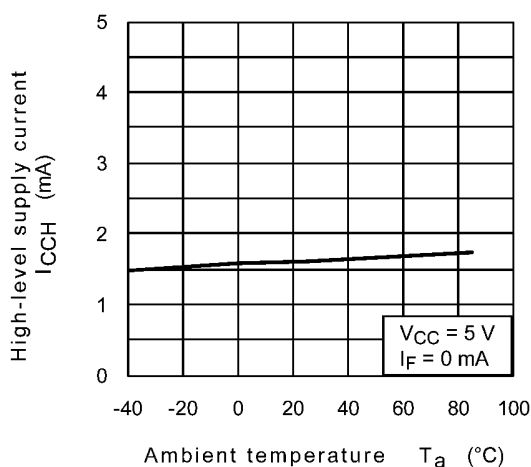
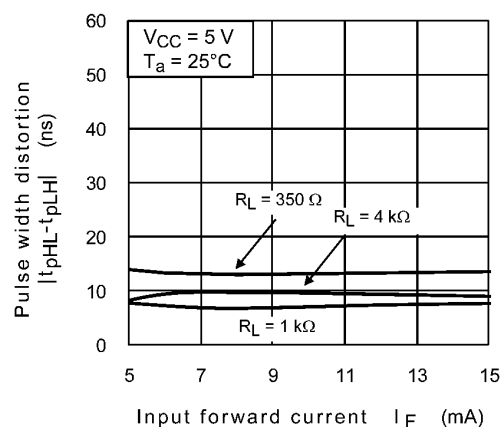
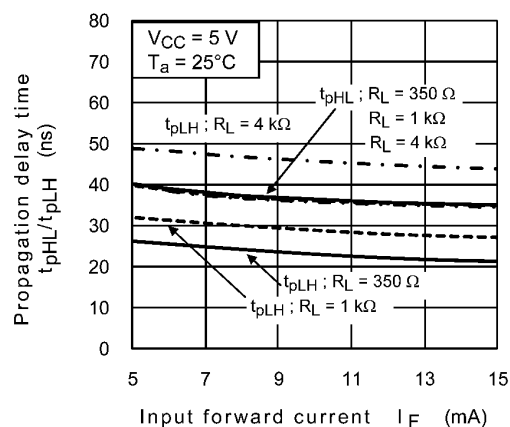
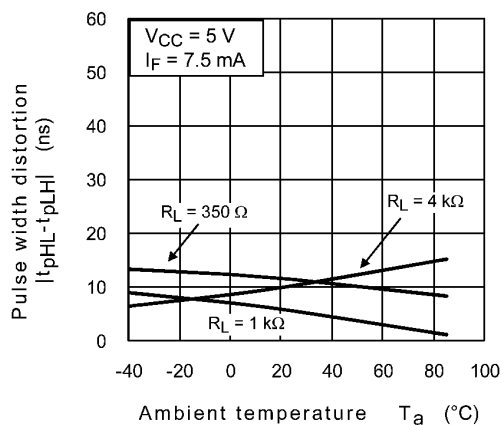
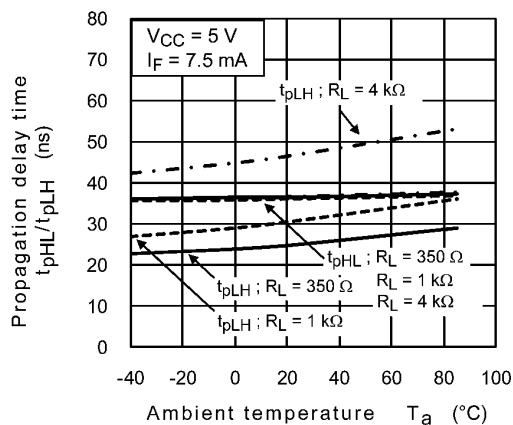


Fig. 13.2.6  $I_{CCH} - T_a$



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



### 14. Soldering and Storage

#### 14.1. Precautions for Soldering

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

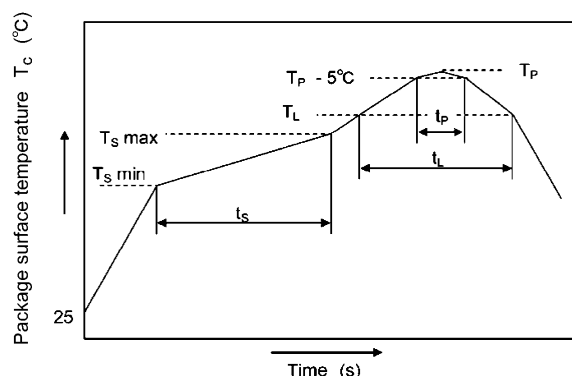
- When using soldering reflow.

The soldering temperature profile is based on the package surface temperature.

(See the figure shown below, which is based on the package surface temperature.)

Reflow soldering must be performed once or twice.

The mounting should be completed with the interval from the first to the last mountings being 2 weeks.



|                                                            | Symbol | Min | Max | Unit |
|------------------------------------------------------------|--------|-----|-----|------|
| Preheat temperature                                        | $T_S$  | 150 | 200 | °C   |
| Preheat time                                               | $t_S$  | 60  | 120 | s    |
| Ramp-up rate ( $T_L$ to $T_P$ )                            |        |     | 3   | °C/s |
| Liquidus temperature                                       | $T_L$  | 217 |     | °C   |
| Time above $T_L$                                           | $t_L$  | 60  | 150 | s    |
| Peak temperature                                           | $T_P$  |     | 260 | °C   |
| Time during which $T_c$ is between ( $T_P - 5$ ) and $T_P$ | $t_P$  |     | 30  | s    |
| Ramp-down rate ( $T_P$ to $T_L$ )                          |        |     | 6   | °C/s |

**An Example of a Temperature Profile When Lead(Pb)-Free 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

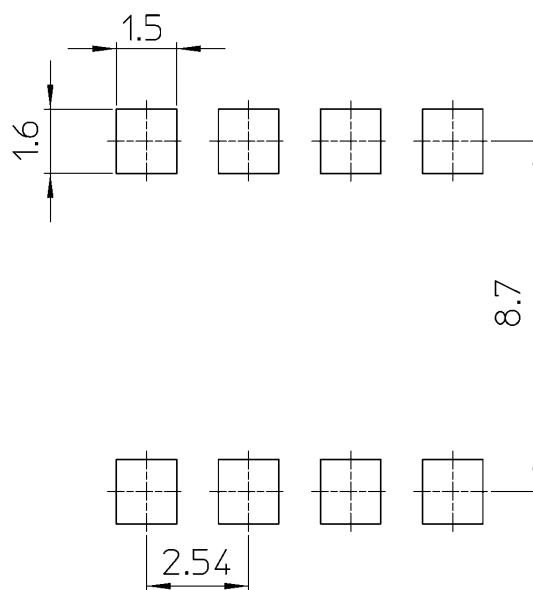
Complete soldering within 10 seconds for lead temperature not exceeding 260 °C or within 3 seconds not exceeding 350 °C

Heating by soldering iron must be done only once per lead.

#### 14.2. Precautions for General Storage

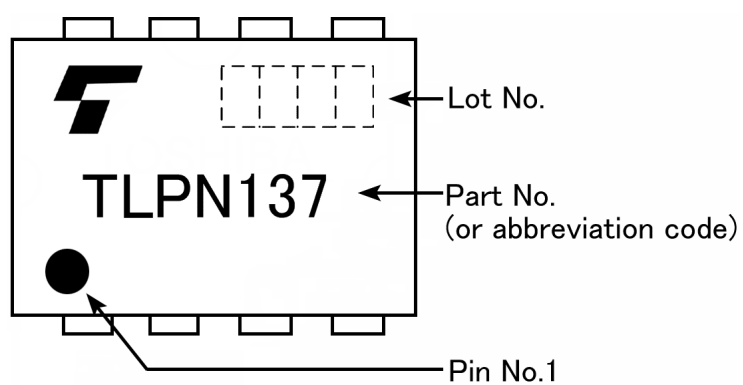
- Avoid storage locations where devices may be exposed to moisture or direct sunlight.
- Follow the precautions printed on the packing label of the device for transportation and storage.
- Keep the storage location temperature and humidity within a range of 5 °C to 35 °C and 45% to 75%, respectively.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

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



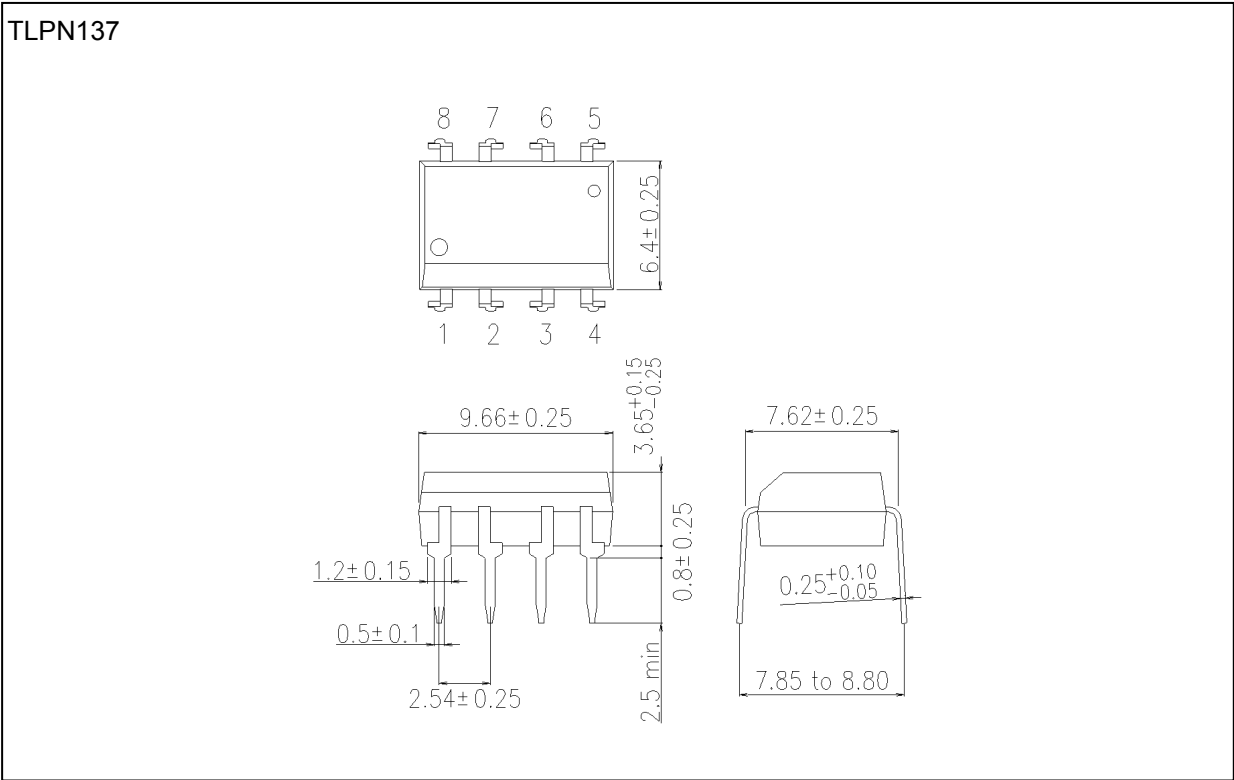
(LF1) (Unit: mm)

## 16. Marking



Package Dimensions

Unit: mm

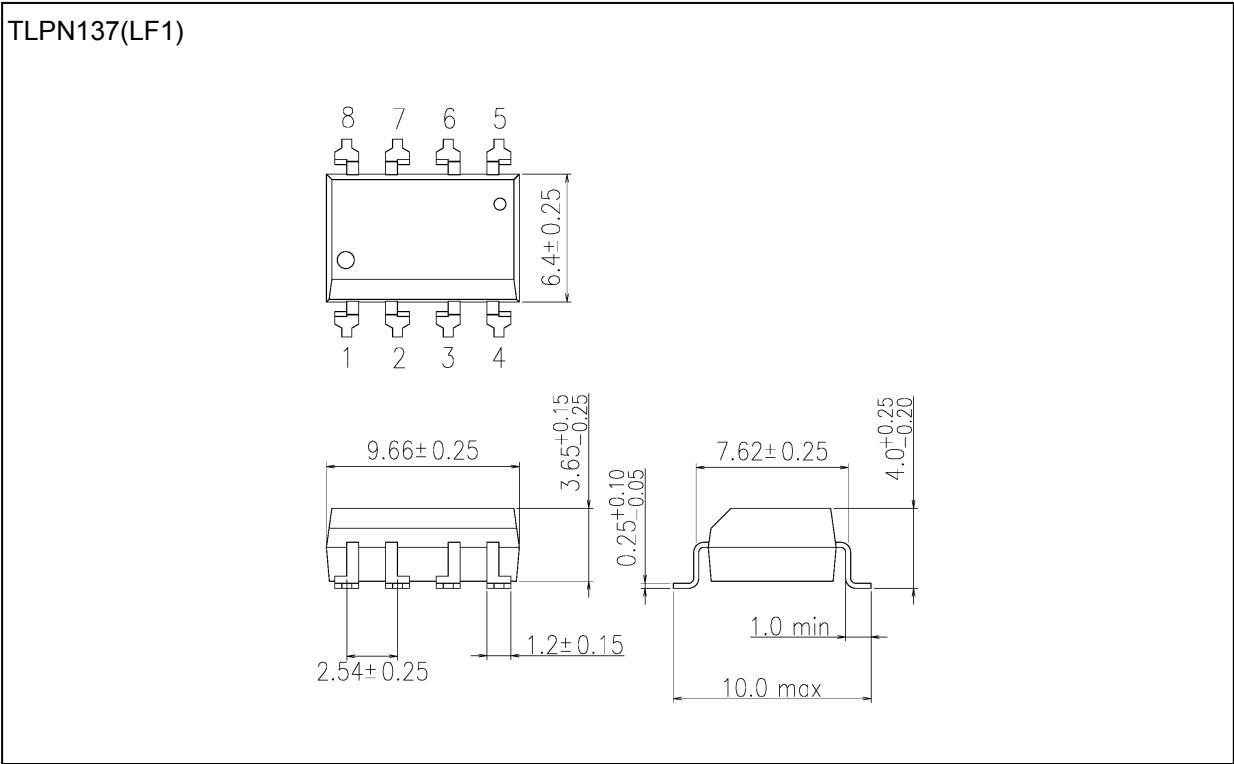


Weight: 0.54 g (typ.)

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

Package Dimensions

Unit: mm



Weight: 0.53 g (typ.)

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

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