Photocouplers GaAℓAs Infrared LED & Photo IC

TLPN137,TLPN137(LF1)

1. Applications

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

2. General

The Toshiba TLPN137 consists of a high-output GaAℓAs 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 ±10 kV/μs.

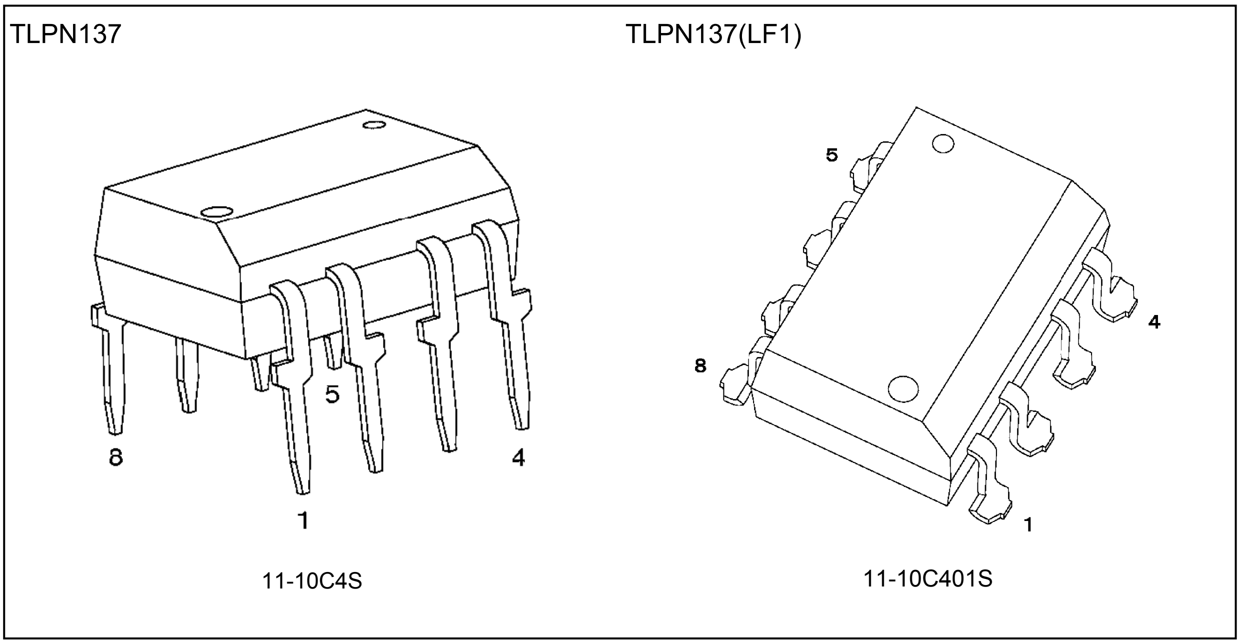
3. Features

(1) Inverter logic type (open collector output)
(2) Package: DIP8
(3) Operating temperature: -40 to 85 ℃
(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: ±10 kV/μs (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)**.

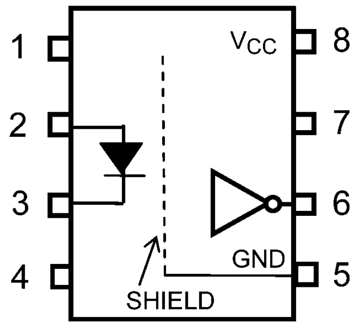
Start of commercial production
2011-09

4. Packaging (Note)



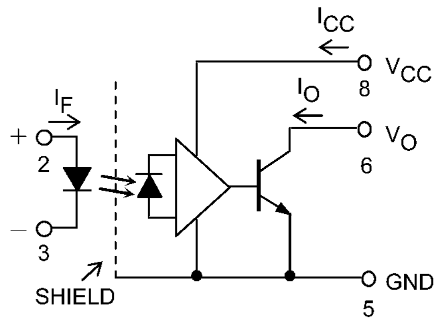
Note: Lead-formed product: (LF1)

5. Pin Assignment



1: N.C.
2: Anode
3: Cathode
4: N.C.
5: GND
6: V_O (Output)
7: N.C.
8: V_{CC}

6. Internal Circuit (Note)



Note: A 0.1-µF 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 °C)

	Characteristics		Symbol	Note	Rating	Unit
LED	Input forward current		I_F		20	mA
	Input forward current derating	(Ta ≥ 91 °C)	$\Delta I_F/\Delta T_a$		-0.6	mA/°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	(Ta ≥ 91 °C)	$\Delta P_D/\Delta T_a$		-1.18	mW/°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	(Ta ≥ 85 °C)	$\Delta P_O/\Delta T_a$		-2.1	mW/°C
Common	Operating temperature		T_{opr}		-40 to 85	°C
	Storage temperature		T_{stg}		-55 to 125	°C
	Lead soldering temperature	(10 s)	T_{sol}		260	°C
	Isolation voltage	AC, 60 s, R.H. ≤ 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) ≤ 1 ms, duty = 50 %

Note 2: Pulse width (PW) ≤ 1 μs, 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	℃

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 μF) 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 μs.

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

10. Electrical Characteristics (Note) (Unless otherwise specified, T_a = -40 to 85 ℃, 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 ℃	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/℃
Input reverse current	I_R		—	V_R = 5 V, T_a = 25 ℃	—	—	10	μA
Input capacitance	C_t		—	V = 0 V, f = 1 MHz, T_a = 25 ℃	—	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	μA
				V_F = 0.8 V, V_O = 5.5 V, V_{CC} = 5.5 V, T_a = 25 ℃	—	—	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 ℃.

11. Isolation Characteristics (Unless otherwise specified, T_a = 25 ℃)

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. ≤ 60 %	1×10^{12}	10^{14}	—	Ω
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 °C, V_{CC} = 4.5 to 5.5 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 → 7.5 mA, R_L = 350 Ω, C_L = 15 pF, T_a = 25 °C	—	35	75	ns
				I_F = 0 → 7.5 mA, R_L = 350 Ω, C_L = 15 pF	—	—	100	
Propagation delay time (L/H)	t_{pLH}	(Note 1)		I_F = 7.5 → 0 mA, R_L = 350 Ω, C_L = 15 pF, T_a = 25 °C	—	25	75	
				I_F = 7.5 → 0 mA, R_L = 350 Ω, C_L = 15 pF	—	—	100	
Pulse width distortion	$\|t_{pHL}-t_{pLH}\|$	(Note 1)		I_F = 7.5 mA, R_L = 350 Ω, C_L = 15 pF	—	—	35	
Propagation delay skew (device to device)	t_{psk}	(Note 1), (Note 2)		I_F = 7.5 mA, R_L = 350 Ω, C_L = 15 pF	-40	—	40	
Fall time	t_f	(Note 1)		I_F = 0 → 7.5 mA, R_L = 350 Ω, C_L = 15 pF	—	3	—	
Rise time	t_r	(Note 1)		I_F = 7.5 → 0 mA, R_L = 350 Ω, C_L = 15 pF	—	12	—	
Common-mode transient immunity at output high	CM_H		Fig. 13.1.6	V_{CM} = 1000 V_{p-p}, I_F = 0 mA, V_{CC} = 5 V, T_a = 25 °C	±10	±15	—	kV/μs
Common-mode transient immunity at output low	CM_L			V_{CM} = 1000 V_{p-p}, I_F = 10 mA, V_{CC} = 5 V, T_a = 25 °C	±10	±15	—	

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

Note 1: f = 5 MHz, duty = 50 %, input current t_r = t_f = 5 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

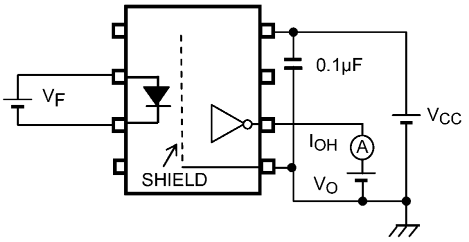


Fig. 13.1.1 I_{OH} Test Circuit

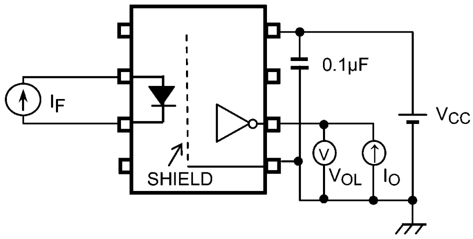


Fig. 13.1.2 V_{OL} Test Circuit

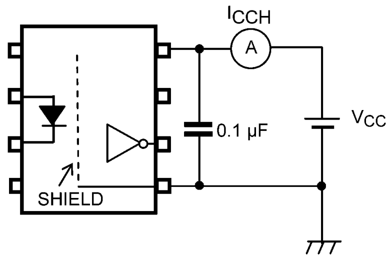


Fig. 13.1.3 I_{CCH} Test Circuit

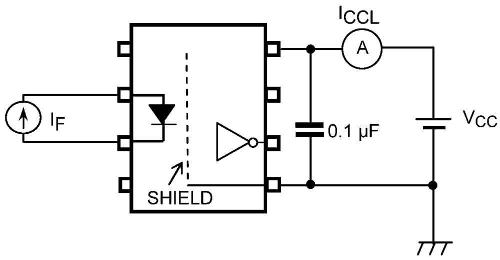
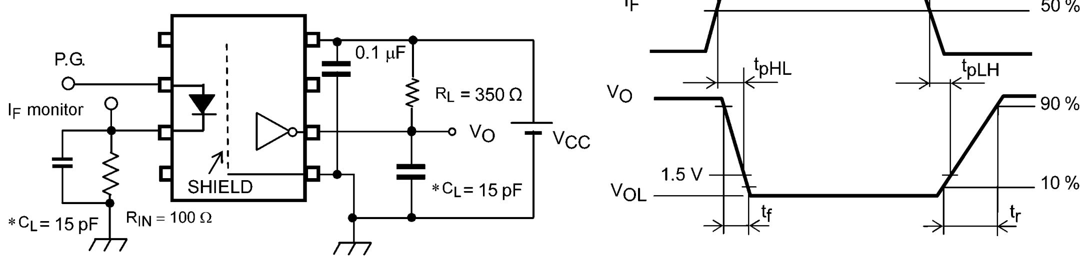


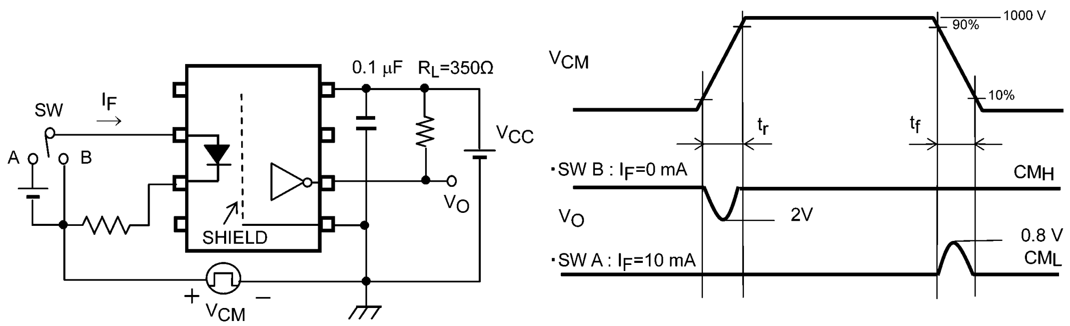
Fig. 13.1.4 I_{CCL} Test Circuit

I_F = 7.5 mA (P.G.)
(f = 5 MHz, duty = 50 %, t_r = t_f = less than 5 ns)



*C_L: includes probe and stray wiring capacitance.
P.G.: Pulse Generator

Fig. 13.1.5 Switching Time Test Circuit and Waveform



$CM_H = \frac{800(V)}{t_r\ (\mu s)}$ $CM_L = -\frac{800(V)}{t_f\ (\mu s)}$

Fig. 13.1.6 Common-Mode Transient Immunity and Waveform

13.2. Characteristics Curves (Note)

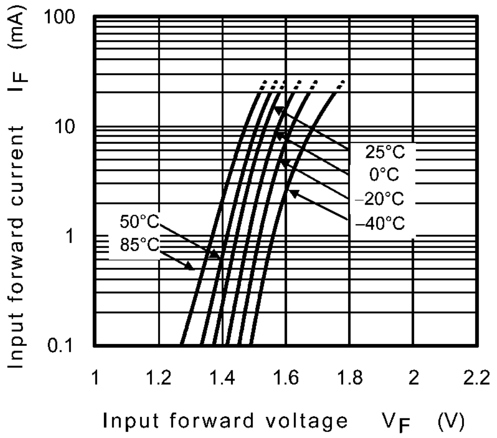


Fig. 13.2.1 I_F - V_F

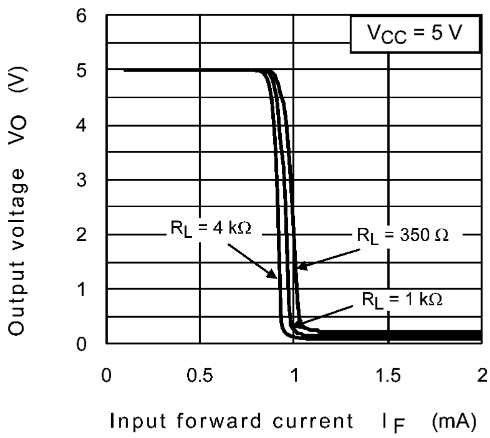


Fig. 13.2.2 V_O - I_F

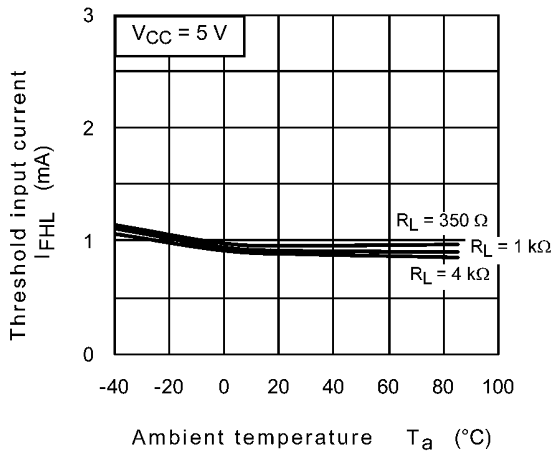


Fig. 13.2.3 I_{FHL} - T_a

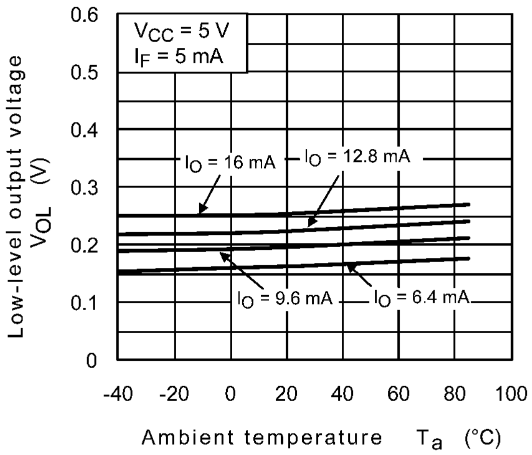


Fig. 13.2.4 V_{OL} - T_a

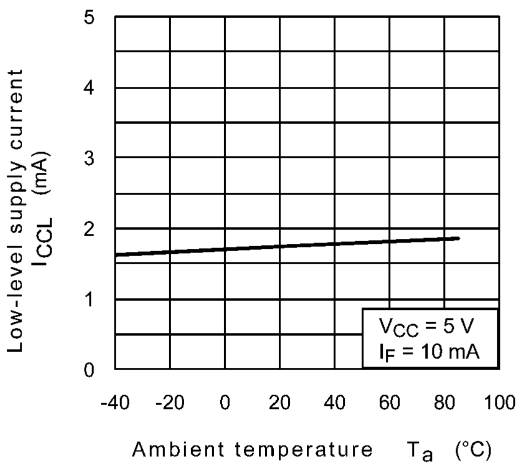


Fig. 13.2.5 I_{CCL} - T_a

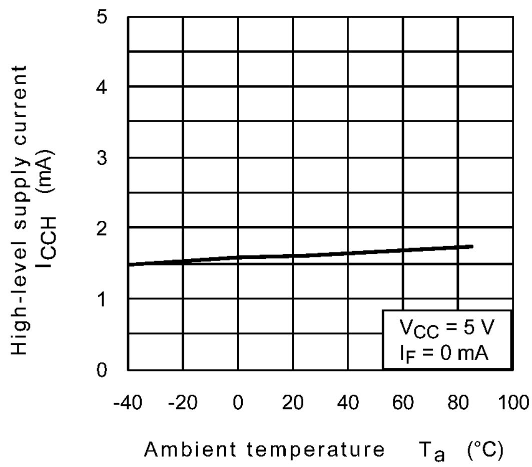


Fig. 13.2.6 I_{CCH} - T_a

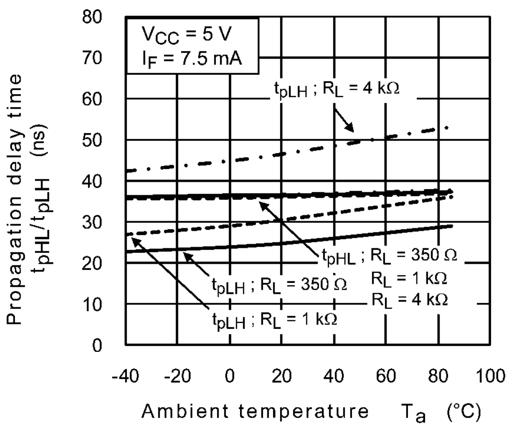


Fig. 13.2.7 t_{pHL}/t_{pLH} - T_a

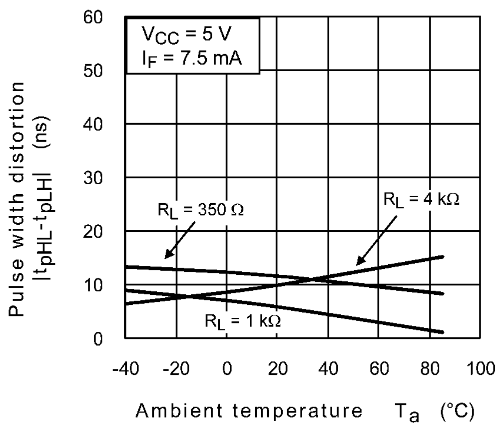


Fig. 13.2.8 $|t_{pHL} - t_{pLH}|$ - T_a

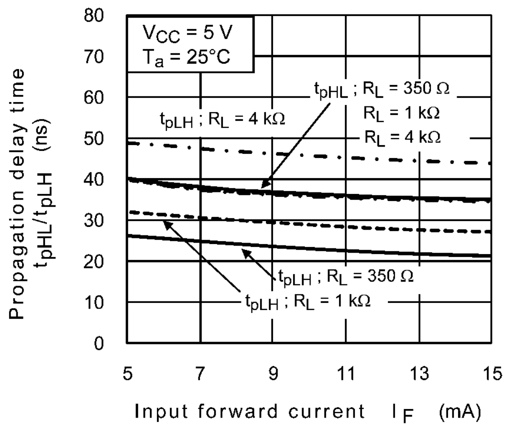


Fig. 13.2.9 t_{pHL}/t_{pLH} - I_F

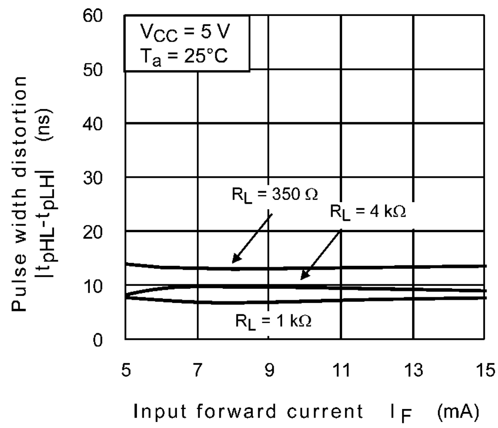


Fig. 13.2.10 $|t_{pHL} - t_{pLH}|$ - I_F

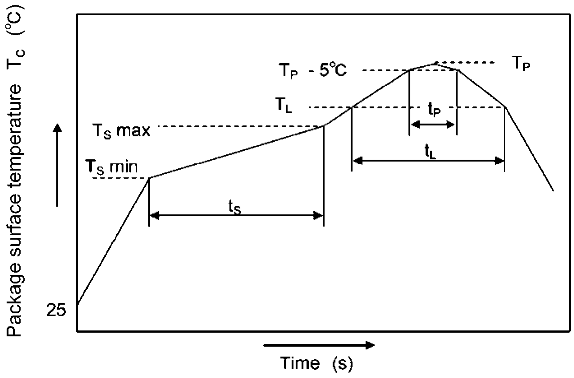
Note: The above characteristics curves are presented for reference only and not guaranteed by production test, unless otherwise noted.

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

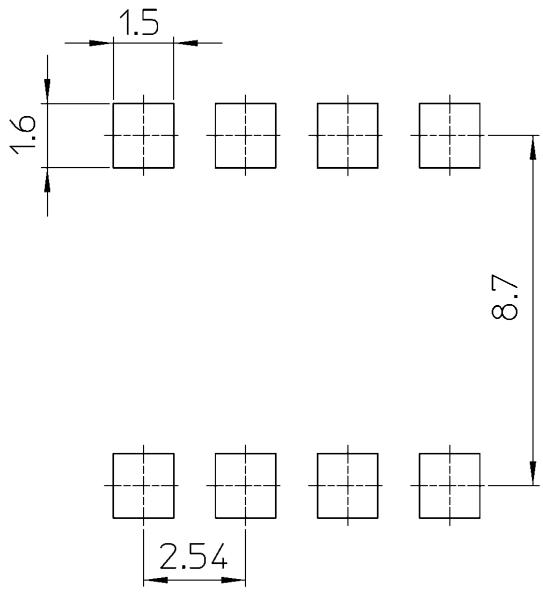
An Example of a Temperature Profile When Lead(Pb)-Free Solder Is Used

- 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

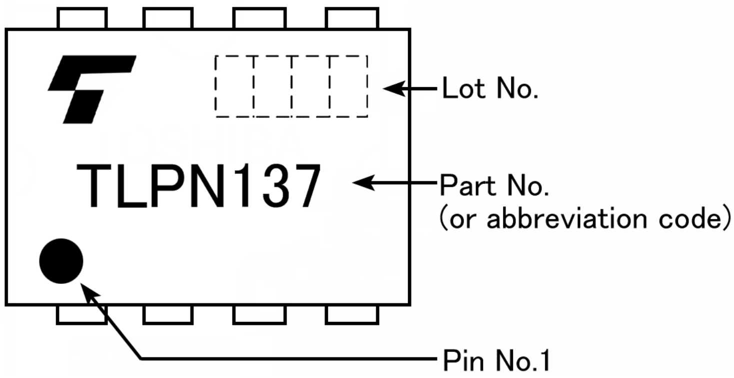
- Avoid storage locations where devices may be exposed to moisture or direct sunlight.
- Follow the precautions printed on the packing label of the device for transportation and storage.
- Keep the storage location temperature and humidity within a range of 5 °C to 35 °C and 45% to 75%, respectively.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

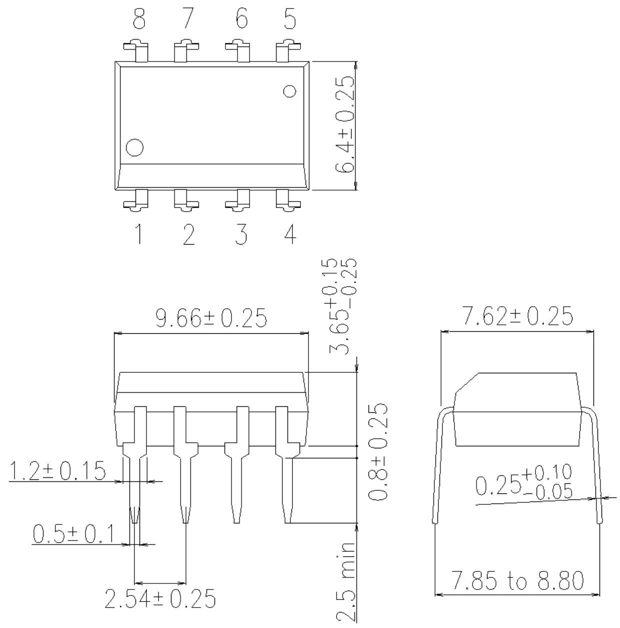
16. Marking



Package Dimensions

Unit: mm

TLPN137



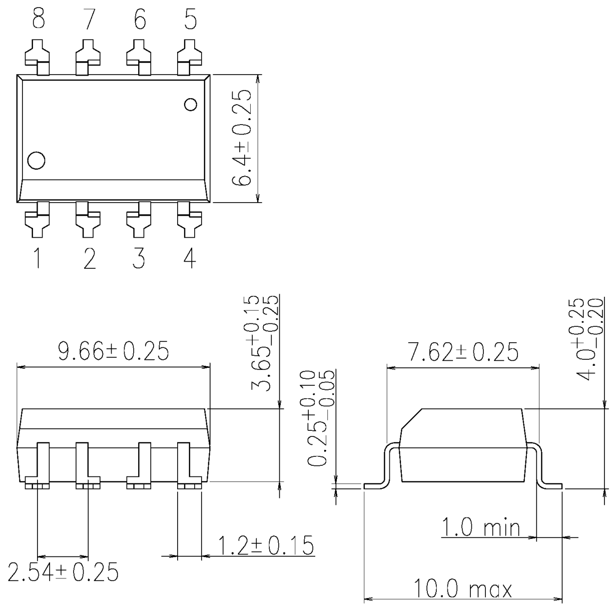
Weight: 0.54 g (typ.)

Package Name(s)
TOSHIBA: 11-10C4S

Package Dimensions

Unit: mm

TLPN137(LF1)



Weight: 0.53 g (typ.)

Package Name(s)
TOSHIBA: 11-10C401S

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