Photocouplers GaAℓAs Infrared LED & Photo IC

TLP714

1. Applications

- Intelligent Power Module Signal Isolation
- Factory Automation (FA)
- Industrial Inverters

2. General

The TLP714 is a photocoupler in a 6-pin SDIP package that consists of a GaAℓAs infrared light-emitting diode (LED) optically coupled to an integrated high-gain, high-speed photodetector IC chip. It provides guaranteed performance and specifications at temperatures up to 125 ℃.The TLP714 is physically smaller than the one in an 8-pin DIP package and compliant with international safety standards for reinforced insulation. It thus provides a smaller footprint solution for applications that require safety standard certification. An internal noise shield provides a guaranteed commonmode transient immunity of ±20 kV/μs. The TLP714 guarantees minimum and maximum of propagation delay time, pulse width distortion. Therefore it is suitable for isolation interface between IPM and control IC circuits in motor control application.

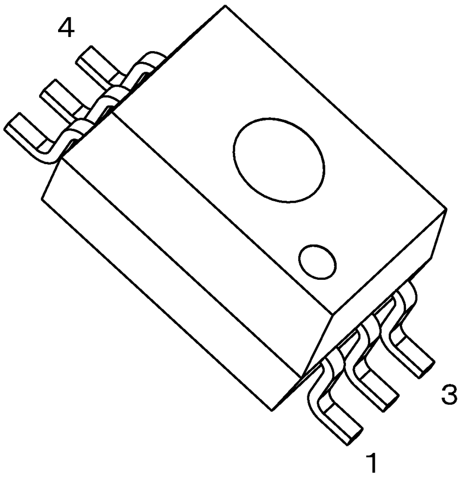
3. Features

(1) Inverter logic type (open collector output)
(2) Package: SDIP6
(3) Operating temperature: -40 to 125 ℃
(4) Supply voltage: -0.5 to 30 V
(5) Threshold input current: 5.0 mA (max)
(6) Supply current: 1.3 mA (max)
(7) Propagation delay time: t_{pHL} = 400 ns (max), t_{pLH} = 550 ns (max)
(8) Pulse width distortion: 400 ns (max)
(9) Common-mode transient immunity: ±20 kV/μs (min)
(10) Isolation voltage: 5000 Vrms (min)
(11) Safety standards
UL-approved: UL1577, File No.E67349
cUL-approved: CSA Component Acceptance Service No.5A File No.E67349
VDE-approved: EN60747-5-5 **(Note 1)**

Note 1: When an EN60747-5-5 approved type is needed, please designate the **Option (D4)**.

Start of commercial production
2011-09

4. Packaging and Pin Configuration



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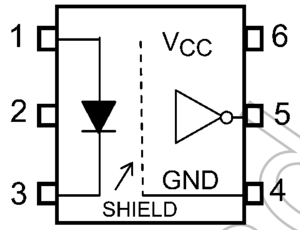
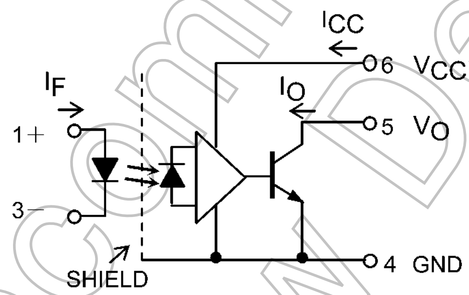


1: Anode
2: N.C.
3: Cathode
4: GND
5: V_O (Output)
6: V_{CC}

5. Internal Circuit



6. Principle of Operation

6.1. Truth Table

Input	LED	Output
H	ON	L
L	OFF	H

6.2. Mechanical Parameters

Characteristics	7.62-mm Pitch TLP714	10.16-mm Pitch TLP714F	Unit
Creepage distances	7.0 (min)	8.0 (min)	mm
Clearance distances	7.0 (min)	8.0 (min)	
Internal isolation thickness	0.4 (min)	0.4 (min)	

7. 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	($T_a \geq$ 116 °C)	$\Delta I_F/\Delta T_a$		-0.6	mA/°C
	Input forward current (pulsed)		I_{FP}	(Note 1)	50	mA
	Input forward current derating (pulsed)	($T_a \geq$ 110 °C)	$\Delta I_{FP}/\Delta T_a$		-1.25	mA/°C
	Input power dissipation		P_D		40	mW
	Input power dissipation derating	($T_a \geq$ 110 °C)	$\Delta P_D/\Delta T_a$		-1.0	mW/°C
	Input reverse voltage		V_R		5	V
Detector	Output current		I_O		15	mA
	Output voltage		V_O		-0.5 to 30	V
	Supply voltage		V_{CC}		-0.5 to 30	
	Output power dissipation		P_O		80	mW
	Output power dissipation derating	($T_a \geq$ 110 °C)	$\Delta P_O/\Delta T_a$		-2.0	mW/°C
Common	Operating temperature		T_{opr}		-40 to 125	°C
	Storage temperature		T_{stg}		-55 to 150	
	Lead soldering temperature	(10 s)	T_{sol}		260	
	Isolation voltage	AC, 60 s, R.H. ≤ 60 %	BV_S	(Note 2)	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: This device is considered as a two-terminal device: Pins 1, 2 and 3 are shorted together, and pins 4, 5 and 6 are shorted together.

8. Recommended Operating Conditions (Note)

Characteristics	Symbol	Note	Min	Typ.	Max	Unit
Input on-state current	$I_{F(ON)}$	(Note 1)	7.5	—	15	mA
Input off-state voltage	$V_{F(OFF)}$		0	—	0.8	V
Supply voltage	V_{CC}	(Note 2)	4.5	—	30	
Operating temperature	T_{opr}	(Note 2)	-40	—	125	°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 datasheet should also be considered.

Note: A ceramic capacitor (0.1 μF) should be connected between pin 6 and pin 4 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.

9. Electrical Characteristics (Note) (Unless otherwise specified, T_a = -40 to 125 °C, V_{CC} = 4.5 to 30 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	μA
Input capacitance	C_t		—	V = 0 V, f = 1 MHz	—	60	—	pF
High-level output current	I_{OH}		Fig. 12.1.1	V_F = 0.8 V, V_O < V_{CC}	—	—	50	μA
Low-level output voltage	V_{OL}		Fig. 12.1.2	I_F = 10 mA, I_O = 2.4 mA	—	0.2	0.6	V
High-level supply current	I_{CCH}		Fig. 12.1.3	I_F = 0 mA	—	1.0	1.3	mA
Low-level supply current	I_{CCL}		Fig. 12.1.4	I_F = 10 mA	—	1.0	1.3	
Output current	I_O		Fig. 12.1.5	I_F = 10 mA, V_O = 0.6 V	4.0	—	—	
Threshold input current (H/L)	I_{FHL}		—	I_O = 0.75 mA, V_O < 0.8 V	—	1.0	5.0	
Threshold input voltage (L/H)	V_{FLH}		—	I_O = 0.75 mA, V_O > 2.0 V	0.8	—	—	V

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

10. Isolation Characteristics (Unless otherwise specified, T_a = 25 °C)

Characteristics	Symbol	Note	Test Conditions	Min	Typ.	Max	Unit
Total capacitance (input to output)	C_S	(Note 1)	V_S = 0 V, f = 1 MHz	—	0.8	—	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 and 3 are shorted together, and pins 4, 5 and 6 are shorted together.

11. Switching Characteristics (Note) (Unless otherwise specified, T_a = -40 to 125 °C, V_{CC} = 15 V)

Characteristics	Symbol	Note	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Propagation delay time (H/L)	t_{pHL}	(Note 1)	Fig. 12.1.6	I_F = 0 → 10 mA, R_L = 20 kΩ, C_L = 100 pF	30	150	400	ns
				I_F = 0 → 10 mA, R_L = 20 kΩ, C_L = 10 pF	—	70	—	
Propagation delay time (L/H)	t_{pLH}	(Note 1)		I_F = 10 → 0 mA, R_L = 20 kΩ, C_L = 100 pF	150	350	550	
				I_F = 10 → 0 mA, R_L = 20 kΩ, C_L = 10 pF	—	110	—	
Pulse width distortion	$\lvert t_{pHL} - t_{pLH} \rvert$	(Note 1)		I_F = 10 mA, R_L = 20 kΩ, C_L = 100 pF	—	—	400	
Propagation delay skew (device to device)	t_{psk}	(Note 1), (Note 2)			-50	—	450	
Common-mode transient immunity at output high	CM_H		Fig. 12.1.7	V_{CM} = 1500 V_{p-p}, I_F = 0 mA, R_L = 20 kΩ, T_a = 25 °C, C_L = 10 pF or 100 pF	±20	±25	—	kV/μs
Common-mode transient immunity at output low	CM_L			V_{CM} = 1500 V_{p-p}, I_F = 10 mA, R_L = 20 kΩ, T_a = 25 °C, C_L = 10 pF or 100 pF	±20	±25	—	

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

Note 1: Input signal (f = 10 kHz, duty = 10 %, input current t_r = t_f = 5 ns or less)

Note 2: The propagation delay skew, t_{psk}, is defined as the propagation delay time of the largest or smallest t_{pLH} minus the largest or smallest t_{pHL} of multiple samples. Evaluations of these samples are conducted under identical test conditions (supply voltage, input current, temperature, etc).

12. Test Circuits and Characteristics Curves

12.1. Test Circuits

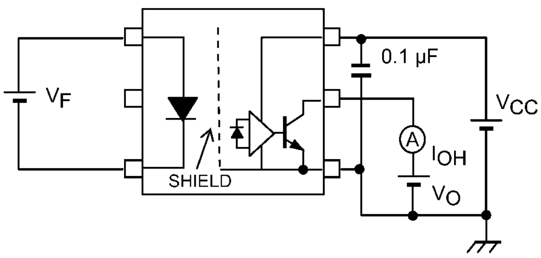


Fig. 12.1.1 I_{OH} Test Circuit

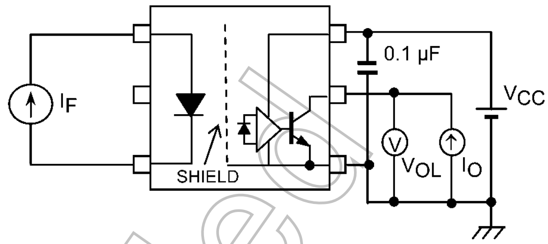


Fig. 12.1.2 V_{OL} Test Circuit

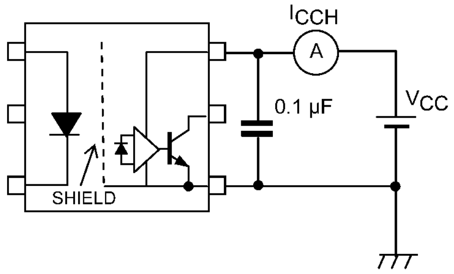


Fig. 12.1.3 I_{CCH} Test Circuit

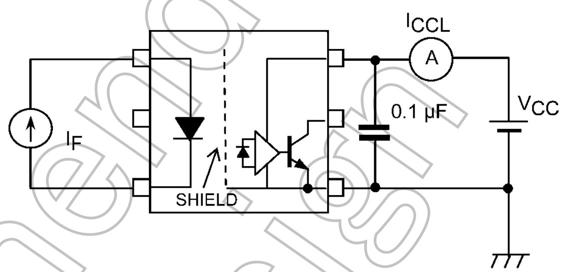


Fig. 12.1.4 I_{CCL} Test Circuit

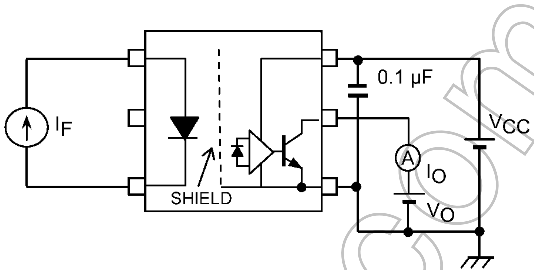
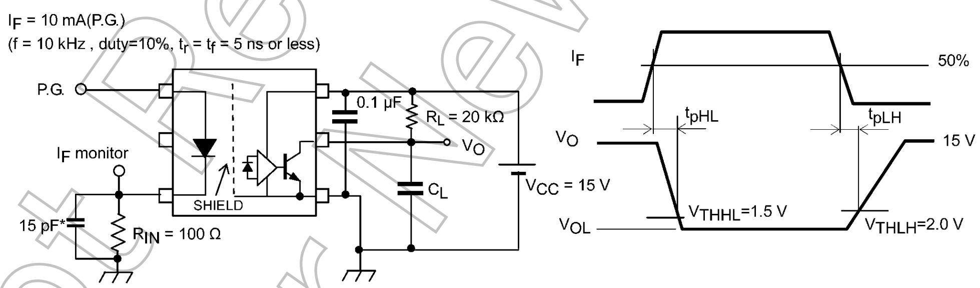


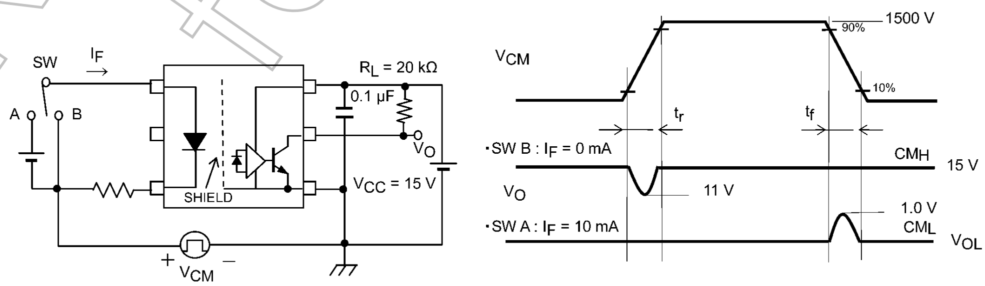
Fig. 12.1.5 I_O Test Circuit



C_L includes probe and stray capacitance.

P.G.: Pulse generator

Fig. 12.1.6 Switching Time Test Circuit and Waveform



$$CM_H = \frac{1200(V)}{t_r(\mu s)} \qquad CM_L = -\frac{1200(V)}{t_f(\mu s)}$$

Fig. 12.1.7 Common-Mode Transient Immunity and Waveform

12.2. Characteristics Curves (Note)

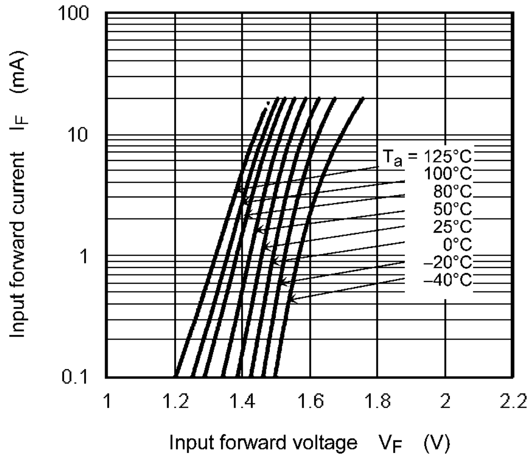


Fig. 12.2.1 I_F - V_F

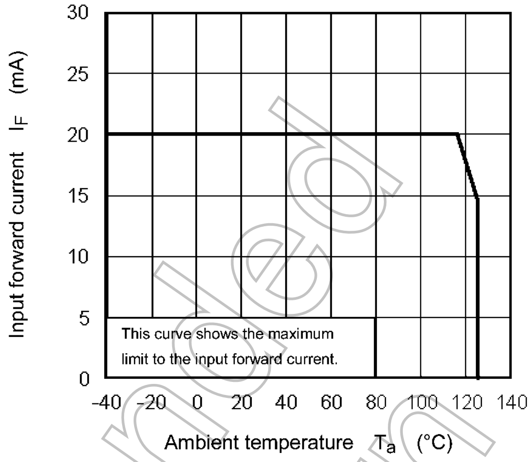


Fig. 12.2.2 I_F - T_a

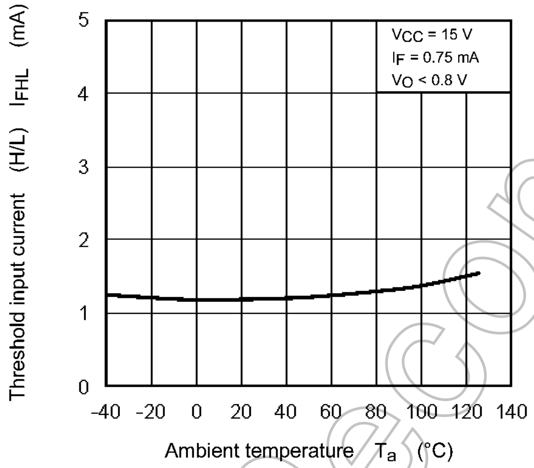


Fig. 12.2.3 I_{FHL} - T_a

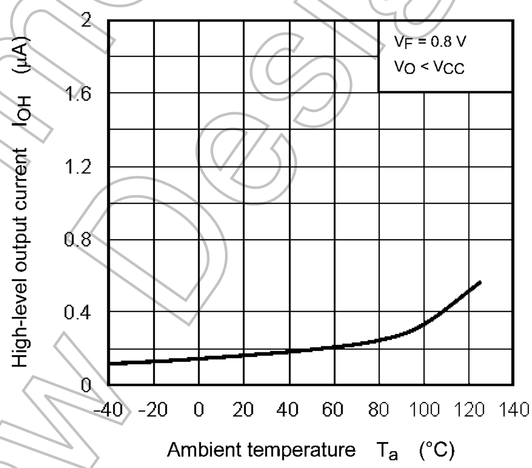


Fig. 12.2.4 I_{OH} - T_a

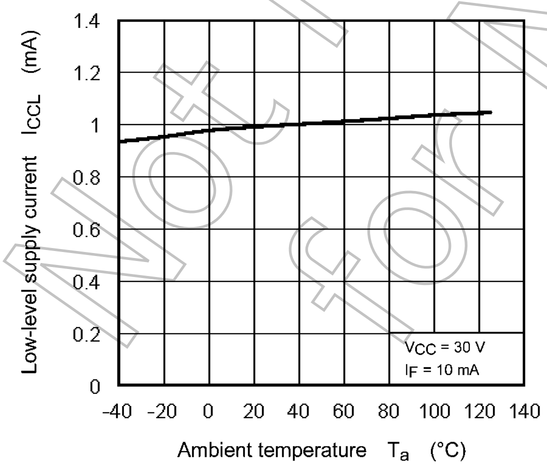


Fig. 12.2.5 I_{CCL} - T_a

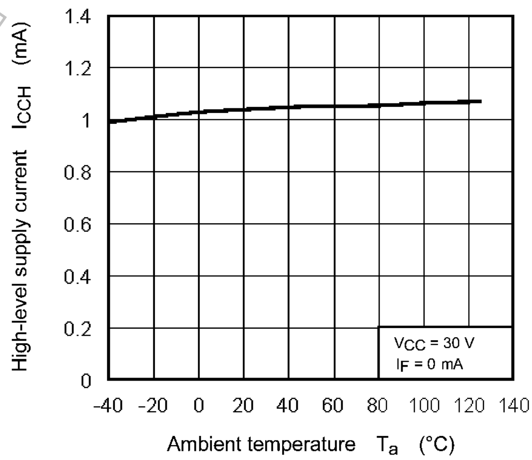


Fig. 12.2.6 I_{CCH} - T_a

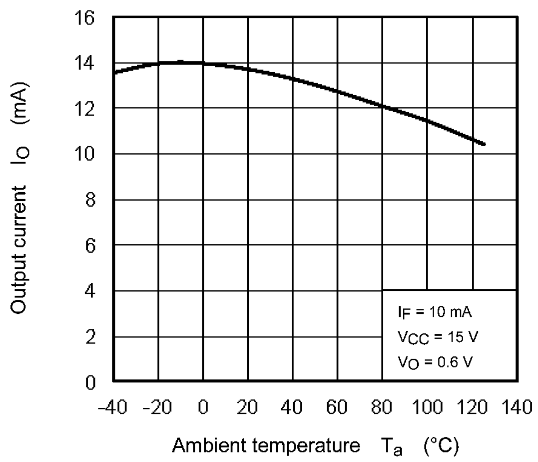


Fig. 12.2.7 I_O - T_a

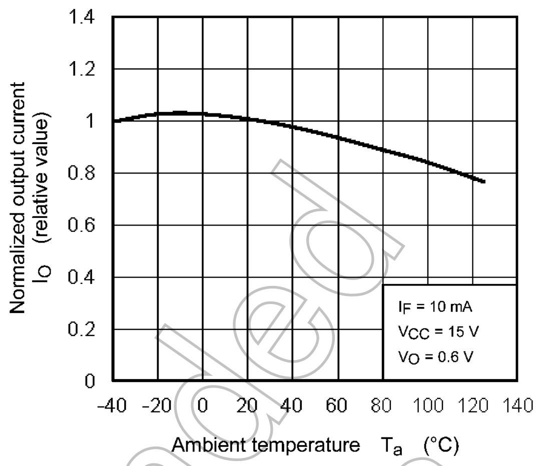


Fig. 12.2.8 Normalized I_O - T_a

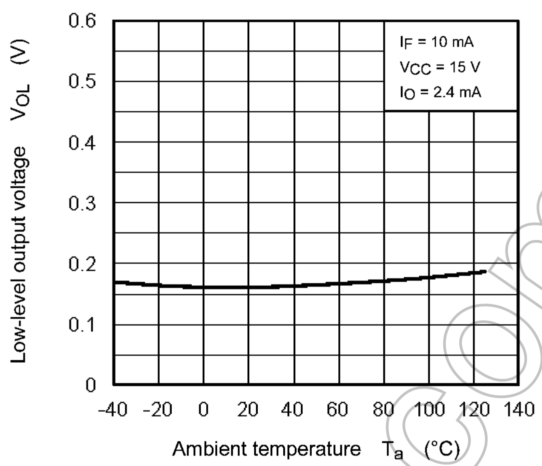


Fig. 12.2.9 V_{OL} - T_a

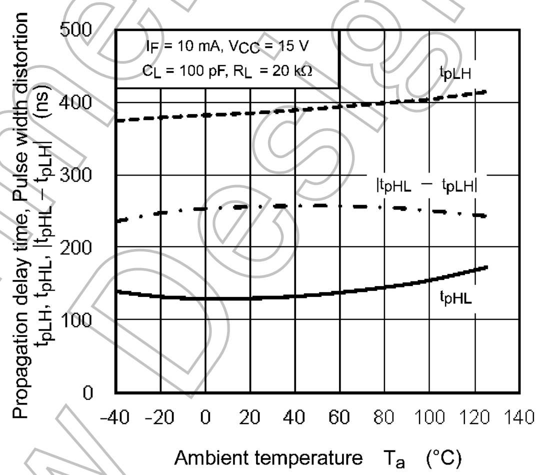


Fig. 12.2.10 t_{pLH},t_{pHL},$|t_{pHL}-t_{pLH}|$ - T_a

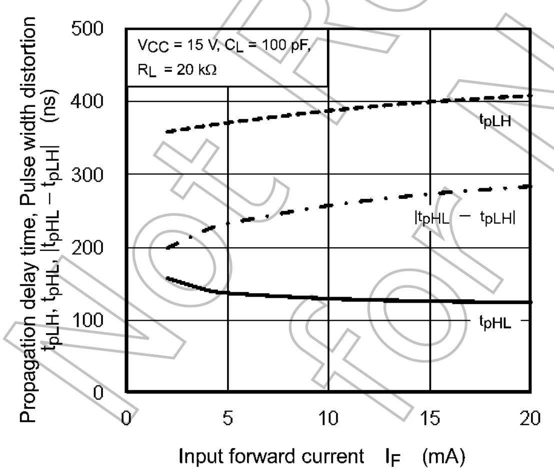


Fig. 12.2.11 t_{pLH},t_{pHL},$|t_{pHL}-t_{pLH}|$ - I_F

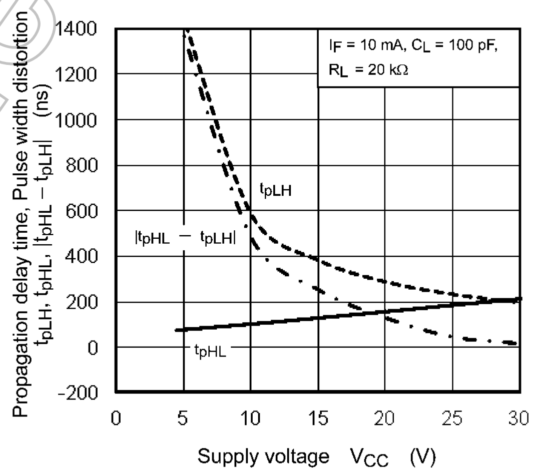


Fig. 12.2.12 t_{pLH},t_{pHL},$|t_{pHL}-t_{pLH}|$ - V_{CC}

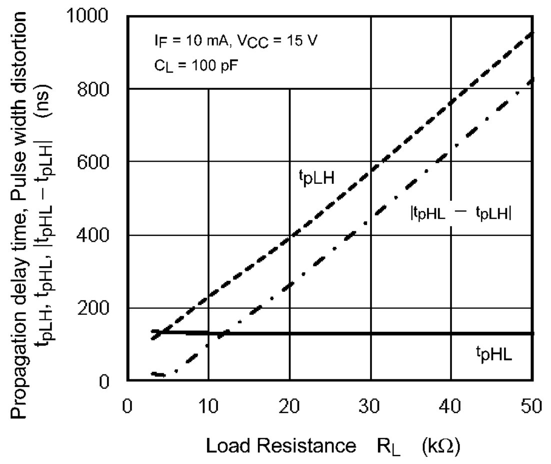


Fig. 12.2.13 $t_{pLH}, t_{pHL}, |t_{pHL}-t_{pLH}|$ - R_L

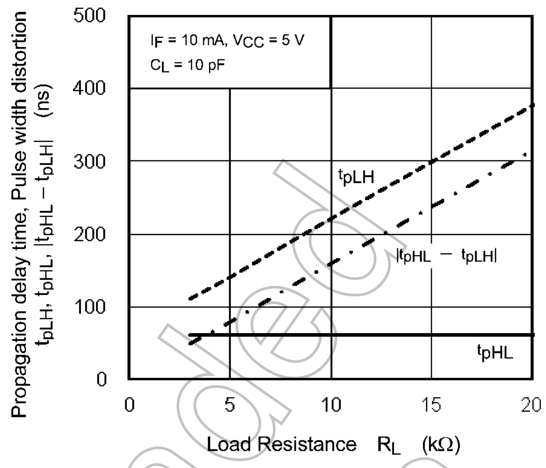


Fig. 12.2.14 $t_{pLH}, t_{pHL}, |t_{pHL}-t_{pLH}|$ - R_L

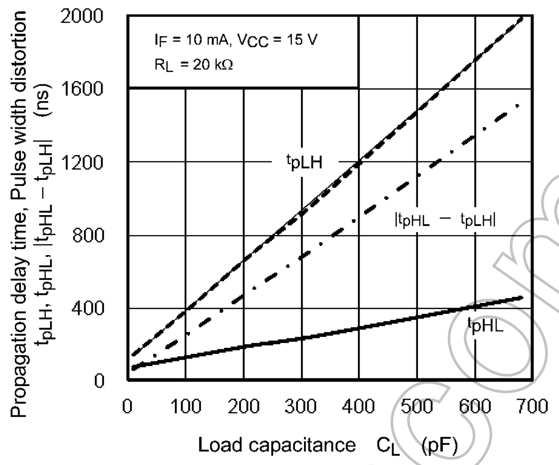


Fig. 12.2.15 $t_{pLH}, t_{pHL}, |t_{pHL}-t_{pLH}|$ - C_L

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

13. Soldering and Storage

13.1. Precautions for Soldering

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

- When using soldering reflow.
  The soldering temperature profile is based on the package surface temperature.
  (See the figure shown below, which is based on the package surface temperature.)
  Reflow soldering must be performed once or twice.
  The mounting should be completed with the interval from the first to the last mountings being 2 weeks.

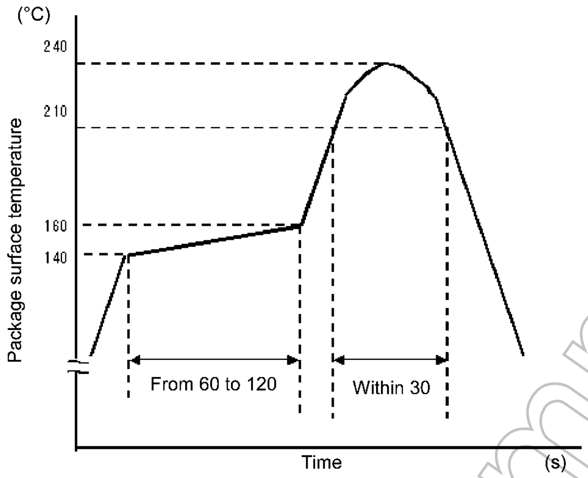


Fig. 13.1.1 An Example of a Temperature Profile When Sn-Pb Eutectic Solder Is Used

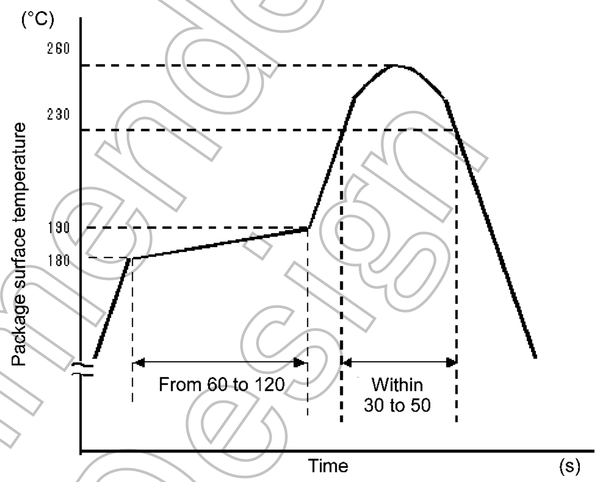


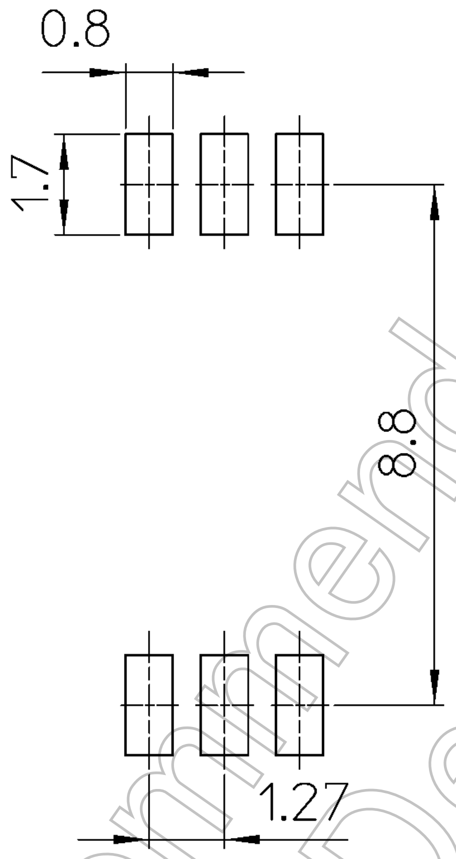
Fig. 13.1.2 An Example of a Temperature Profile When Lead(Pb)-free Solder Is Used

- When using soldering flow (Applicable to both eutectic solder and Lead(Pb)-Free solder)
  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.

13.2. Precautions for General Storage

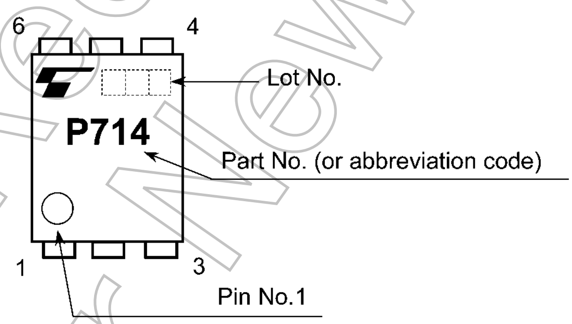
- Avoid storage locations where devices may be exposed to moisture or direct sunlight.
- Follow the precautions printed on the packing label of the device for transportation and storage.
- Keep the storage location temperature and humidity within a range of 5 °C to 35 °C and 45 % to 75 %, respectively.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

14. Land Pattern Dimensions for Reference Only



Unit: mm

15. Marking



16. EN60747-5-5 Option (D4) Specification

- Part number: TLP714, TLP714F **(Note 1)**
- The following part naming conventions are used for the devices that have been qualified according to option (D4) of EN60747.
  Example: TLP714(D4-TP, F)
  D4: EN60747 option
  TP: Tape type
  F: [[G]]/RoHS COMPATIBLE **(Note 2)**

Note 1: Use TOSHIBA standard type number for safety standard application.
e.g., TLP714(D4-TP,F) → TLP714

Note 2: Please contact your Toshiba sales representative for details on environmental information such as the product's RoHS compatibility.
RoHS is the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronics equipment.

Description		Symbol	Rating	Unit
Application classification for rated mains voltage ≤ 300 Vrms for rated mains voltage ≤ 600 Vrms			I-IV I-III	—
Climatic classification			40 / 125 / 21	—
Pollution degree			2	—
Maximum operating insulation voltage	TLPxxx type	V_{IORM}	890	Vpeak
	TLPxxxF type		1140	
Input to output test voltage, Method A V_{pr} = 1.6 × V_{IORM}, type and sample test t_p = 10 s, partial discharge < 5 pC	TLPxxx type	V_{pr}	1424	Vpeak
	TLPxxxF type		1824	
Input to output test voltage, Method B V_{pr} = 1.875 × V_{IORM}, 100 % production test t_p = 1 s, partial discharge < 5 pC	TLPxxx type	V_{pr}	1670	Vpeak
	TLPxxxF type		2140	
Highest permissible overvoltage (transient overvoltage, t_{pr} = 60 s)		V_{TR}	8000	Vpeak
Safety limiting values (max. permissible ratings in case of fault, also refer to thermal derating curve) current (input current I_F, P_{so} = 0) power (output or total power dissipation) temperature		I_{si} P_{so} T_s	300 700 150	mA mW °C
Insulation resistance	V_{IO} = 500 V, T_a = 25 °C V_{IO} = 500 V, T_a = 100 °C V_{IO} = 500 V, T_a = T_s	R_{si}	$\geq 10^{12}$ $\geq 10^{11}$ $\geq 10^{9}$	Ω

Fig. 16.1 EN60747 Isolation Characteristics

		7.62-mm pitch TLPxxx type	10.16-mm pitch TLPxxxF 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	

Fig. 16.2 Insulation Related Specifications (Note)

Note: This photocoupler is suitable for **safe electrical isolation** only within the safety limit data. Maintenance of the safety data shall be ensured by means of protective circuits.

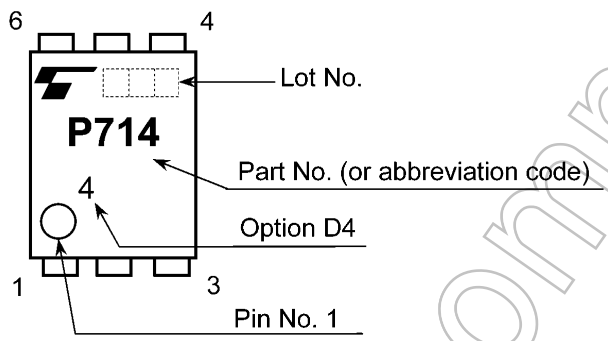


Fig. 16.3 Marking Example (Note)

Note: The above marking is applied to the photocouplers that have been qualified according to option (D4) of EN60747.

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_{ini} = 60 s

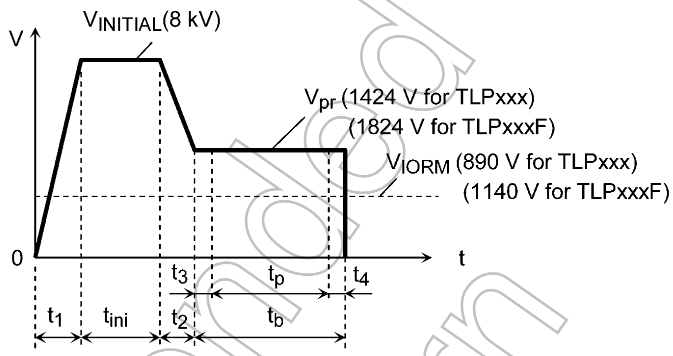


Figure 2 Partial discharge measurement procedure according to EN60747
Non-destructive test for 100 % inspection.

Method B

(for sample test,non-destructive test)

t_3, t_4 = 0.1 s
t_p (Measuring time for partial discharge) = 1 s
t_b = 1.2 s

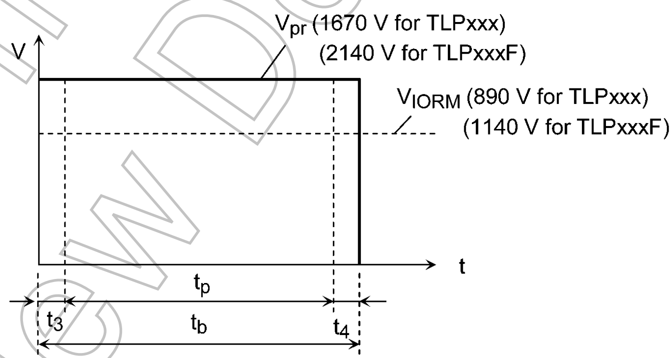


Figure 3 Dependency of maximum safety ratings on ambient temperature

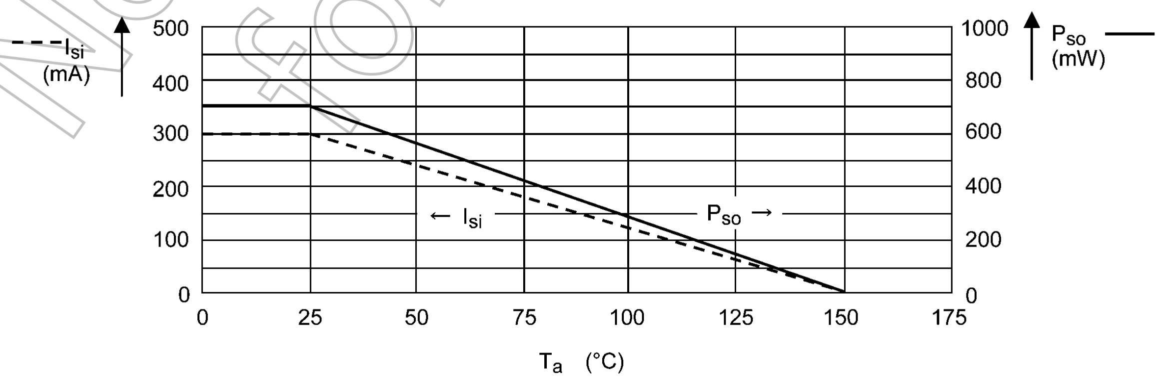
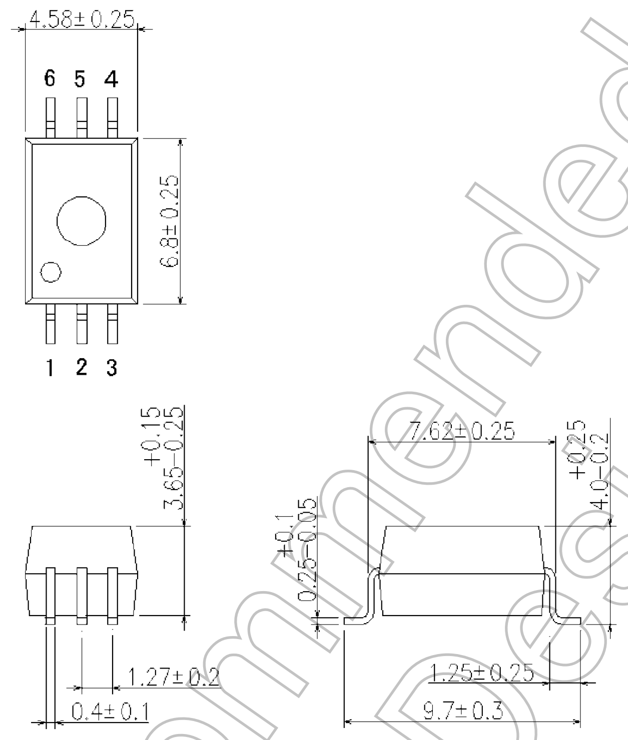


Fig. 16.4 Measurement Procedure

Package Dimensions

Unit: mm



Weight: 0.26 g (typ.)

Package Name(s)
TOSHIBA: 11-5J1S

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