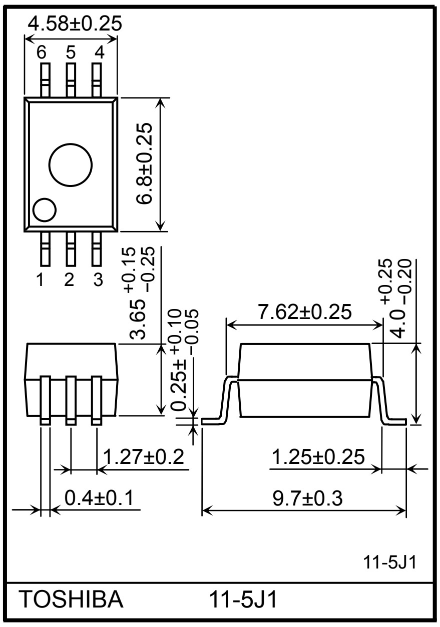
TOSHIBA Photocoupler GaAℓAs IRED + Photo IC

TLP700

Industrial inverters
Inverter for air conditioners
IGBT/Power MOSFET gate drive

Unit in mm



Weight: 0.26 g (typ.)

TLP700 consists of a GaAℓAs light-emitting diode and an integrated photodetector.

This unit is 6-lead SDIP package. The TLP700 is 50% smaller than the 8-pin DIP and meets the reinforced insulation class requirements of international safety standards. Therefore the mounting area can be reduced in equipment requiring safety standard certification.

The TLP700 is suitable for gate driving circuits for IGBTs or power MOSFETs. In particular, the TLP700 is capable of “direct” gate driving of low-power IGBTs.

- Peak output current: ±2.0 A (max)
- Guaranteed performance over temperature: −40 to 100°C
- Supply current: 2 mA (max)
- Power supply voltage: 15 to 30 V
- Threshold input current: I_{FLH} = 5 mA (max)
- Switching time (t_{pLH} / t_{pHL}): 500 ns (max)
- Common mode transient immunity: ±15 kV/μs (min)
- Isolation voltage: 5000 Vrms (min)
- Construction mechanical rating

	7.62-mm pitch standard type	10.16-mm pitch TLPXXXF type
Creepage Distance	7.0 mm (min)	8.0 mm (min)
Clearance	7.0 mm (min)	8.0 mm (min)
Insulation Thickness	0.4 mm (min)	0.4 mm (min)

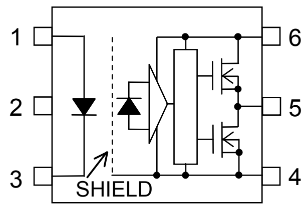
- UL recognized: UL1577, File No. E67349
- Option (D4) type
  TÜV approved: EN60747-5-2

  Maximum operating insulation voltage: 890 Vpk
  Highest permissible over voltage: 8000 Vpk

(Note) When a EN60747-5-2 approved type is needed,

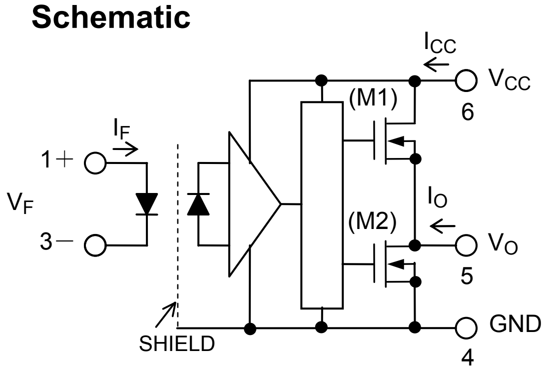
please designate the “Option(D4)”

Pin Configuration (Top View)



1: ANODE
2: N.C
3: CATHODE
4: GND
5: V_O (OUTPUT)
6: V_{CC}

Schematic



A 0.1-μF bypass capacitor must be connected between pins 6 and 4. (See Note 6.)

Truth Table

Input	LED	M1	M2	Output
H	ON	ON	OFF	H
L	OFF	OFF	ON	L

Absolute Maximum Ratings (Ta = 25 °C)

	Characteristics		Symbol	Rating	Unit
LED	Forward current		I_F	20	mA
	Forward current derating (Ta ≥ 85°C)		$\Delta I_F/\Delta Ta$	−0.54	mA/°C
	Peak transient forward current (Note 1)		I_{FP}	1	A
	Reverse voltage		V_R	5	V
	Junction temperature		T_j	125	°C
Detector	"H" peak output current	Ta=-40 to 100 °C (Note 2)	I_{OPH}	−2.0	A
	"L" peak output current		I_{OPL}	2.0	A
	Output voltage		V_O	35	V
	Supply voltage		V_{CC}	35	V
	Junction temperature		T_j	125	°C
Operating frequency (Note 3)			f	50	kHz
Operating temperature range			T_{opr}	−40 to 100	°C
Storage temperature range			T_{stg}	−55 to 125	°C
Lead soldering temperature (10 s) (Note 4)			T_{sol}	260	°C
Isolation voltage (AC, 1 minute, R.H. ≤ 60%) (Note 5)			BV_S	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 P_W ≤ 1 μs, 300 pps

Note 2: Exponential waveform pulse width P_W ≤ 0.3 μs, f ≤15 kHz

Note 3: Exponential waveform I_{OPH} ≥−1.5 A (≤ 0.3 μs), I_{OPL} ≤+1.5 A (≤ 0.3 μs), Ta=100°C

Note 4: For the effective lead soldering area

Note 5: Device considered a two-terminal device: pins 1, 2 and 3 paired with pins 4, 5 and 6 respectively.

Note 6: A ceramic capacitor (0.1 μF) should be connected from pin 6 to pin 4 to stabilize the operation of the high gain linear amplifier. Failure to provide the bypassing may impair the switching property.
The total lead length between capacitor and coupler should not exceed 1 cm.

Recommended Operating Conditions

Characteristics	Symbol	Min	Typ.	Max	Unit
Input current, ON (Note 7)	$I_{F\ (ON)}$	7.5	—	10	mA
Input voltage, OFF	$V_{F\ (OFF)}$	0	—	0.8	V
Supply voltage * (Note 8)	V_{CC}	15	—	30	V
Peak output current	I_{OPH} / I_{OPL}	—	—	± 1.5	A
Operating temperature	T_{opr}	−40	—	100	°C

* This item denotes operating ranges, not meaning of recommended operating conditions.

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.

Note 7: Input signal rise time (fall time) ≤ 0.5 μs.

Note 8: If the Vcc rise slope is sharp, an internal circuit might not operate with stability. Please design the Vcc rise slope under 3.0 V/μs.

Electrical Characteristics (Ta = −40 to 100 °C, unless otherwise specified)

Characteristics		Symbol	Test Circuit	Test Condition		Min	Typ.*	Max	Unit
Forward voltage		V_F	—	I_F = 10 mA, Ta = 25 °C		—	1.57	1.75	V
Temperature coefficient of forward voltage		$\Delta V_F/\Delta Ta$	—	I_F = 10 mA		—	−1.8	—	mV/°C
Input reverse current		I_R	—	V_R = 5 V, Ta = 25 °C		—	—	10	μA
Input capacitance		C_T	—	V =0 V, f = 1 MHz, Ta = 25 °C		—	100	—	pF
Output current (Note 9)	"H" Level	I_{OPH1}	1	V_{CC} = 15 V, I_F = 5 mA	V_{6-5} = 3.5 V	—	−1.4	−1.0	A
		I_{OPH2}			V_{6-5} = 7 V	—	—	−1.5	
	"L" Level	I_{OPL1}	2	V_{CC} = 15 V, I_F = 0 mA	V_{5-4} = 2.5 V	1.0	1.4	—	
		I_{OPL2}			V_{5-4} = 7 V	1.5	—	—	
Output voltage	"H" Level	V_{OH}	3	V_{CC1}=+15V, V_{EE1}=-15V, R_L = 200Ω, I_F = 5 mA		11	13.7	—	V
	"L" Level	V_{OL}	4	V_{CC1}=+15V, V_{EE1}=-15V, R_L = 200Ω, V_F = 0.8 V		—	-14.9	-12.5	
Supply current	"H" Level	I_{CCH}	5	V_{CC} = 30 V, V_O=Open	I_F = 10 mA	—	1.3	2.0	mA
	"L" Level	I_{CCL}	6		I_F = 0 mA	—	1.3	2.0	
Threshold input current	L → H	I_{FLH}	—	V_{CC} = 15 V, V_O > 1 V		—	1.8	5	mA
Threshold input voltage	H → L	V_{FHL}	—	V_{CC} = 15 V, V_O < 1 V		0.8	—	—	V
Supply voltage		V_{CC}	—	—		15	—	30	V
UVLO thresh hold		V_{UVLO+}	—	V_O > 2.5V, I_F = 5 mA		11.0	12.5	13.5	V
		V_{UVLO-}	—	V_O < 2.5V, I_F = 5 mA		9.5	11.0	12.0	V
UVLO hysteresis		$UVLO_{HYS}$	—	—		—	1.5	—	V

(*): All typical values are at Ta = 25°C

Note 9: Duration of Io time ≤ 50 μs, 1 pulse

Note 10: This product is more sensitive than conventional products to electrostatic discharge (ESD) owing to its low power consumption design.
It is therefore all the more necessary to observe general precautions regarding ESD when handling this component.

Isolation Characteristics (Ta = 25 °C)

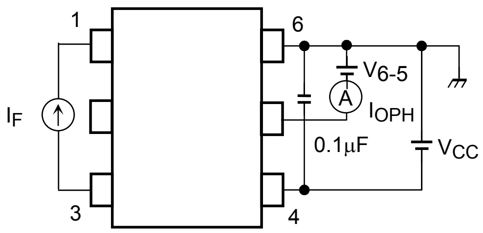
Characteristic	Symbol	Test Condition	Min	Typ.	Max	Unit
Capacitance input to output	C_S	Vs = 0 V , f = 1MHz (Note 5)	—	1.0	—	pF
Isolation resistance	R_S	R.H. ≤ 60 %, V_S = 500 V (Note 5)	1×10^{12}	10^{14}	—	Ω
Isolation voltage	BV_S	AC, 1 minute	5000	—	—	Vrms
		AC, 1 second, in oil	—	10000	—	Vrms
		DC, 1 minute, in oil	—	10000	—	Vdc

Switching Characteristics (Ta = −40 to 100 °C, unless otherwise specified)

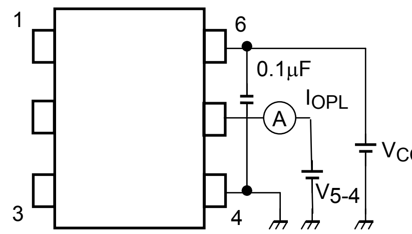
Characteristics		Symbol	Test Circuit	Test Condition		Min	Typ.*	Max	Unit
Propagation delay time	L → H	t_{pLH}	7	V_{CC} = 30 V, R_g = 20 Ω, C_g = 10 nF	I_F = 0 → 5 mA	50	—	500	ns
	H → L	t_{pHL}			I_F = 5 → 0 mA	50	—	500	
Output rise time (10–90 %)		t_r			I_F = 0 → 5 mA	—	50	—	
Output fall time (90–10 %)		t_f			I_F = 5 → 0 mA	—	50	—	
Switching time dispersion between ON and OFF		$\lvert t_{pHL}-t_{pLH} \rvert$			I_F = 0 ↔ 5 mA	—	—	250	
Common mode transient immunity at HIGH level output		CM_H	8	V_{CM} =1000 Vp-p, Ta = 25 °C, V_{CC} = 30 V	I_F = 5 mA, $V_{O\ (min)}$ = 26 V	−15	—	—	kV/μs
Common mode transient immunity at LOW level output		CM_L			I_F = 0 mA, $V_{O\ (max)}$ = 1 V	15	—	—	

(*): All typical values are at Ta = 25 °C.

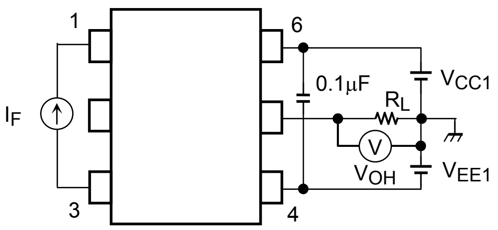
Test Circuit 1: I_{OPH}



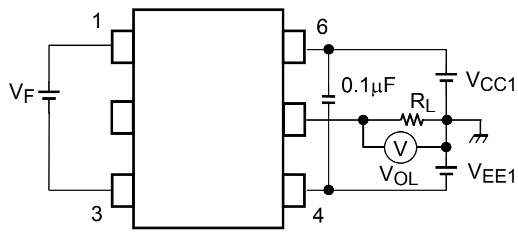
Test Circuit 2: I_{OPL}



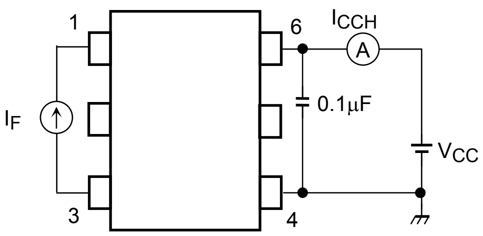
Test Circuit 3: V_{OH}



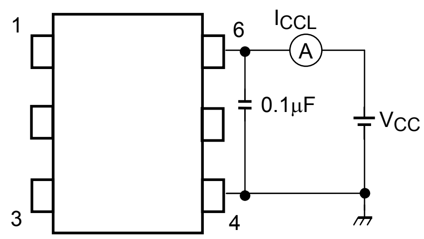
Test Circuit 4: V_{OL}



Test Circuit 5: I_{CCH}

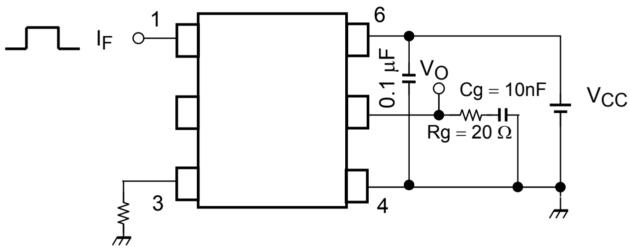


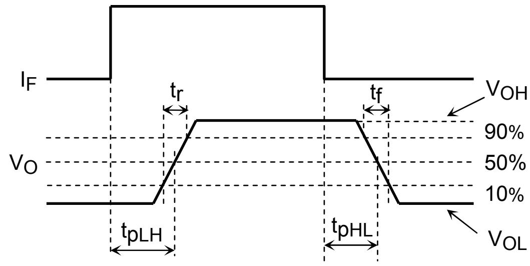
Test Circuit 6: I_{CCL}



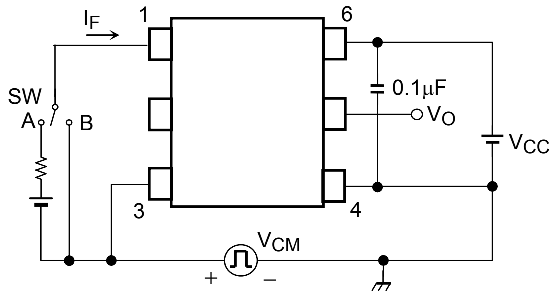
Test Circuit 7: t_{pLH}, t_{pHL}, t_r, t_f, $|t_{pHL}-t_{pLH}|$

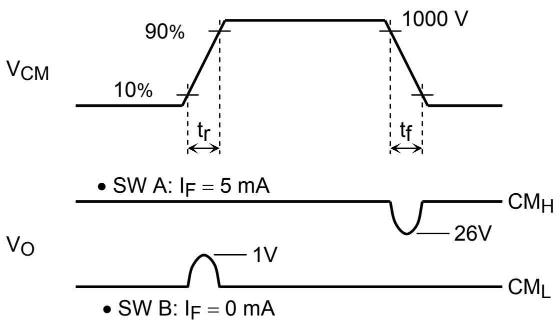
(f=25kHz, duty=50%, less than tr=tf=5ns)





Test Circuit 8: CM_H, CM_L

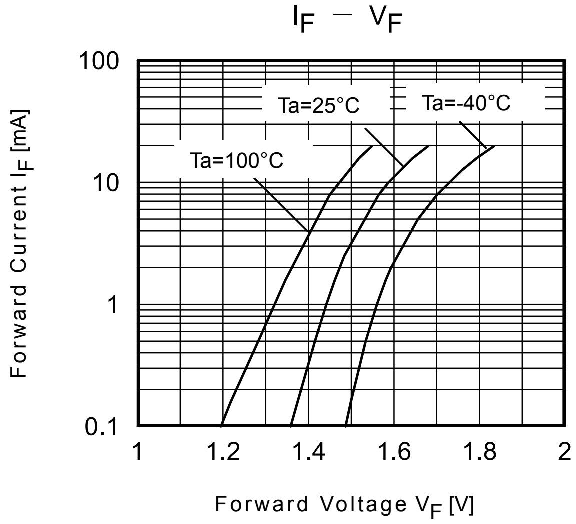


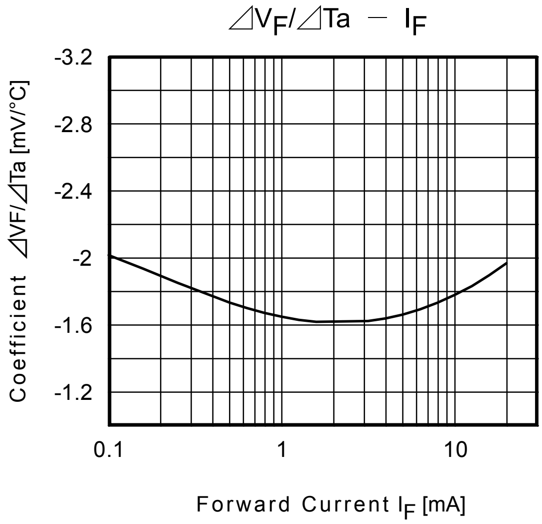


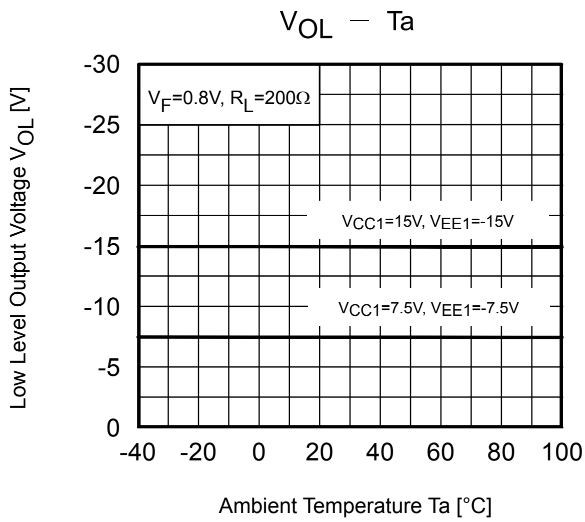
$$CM_H = -\frac{800\ V}{t_f\ (\mu s)}$$

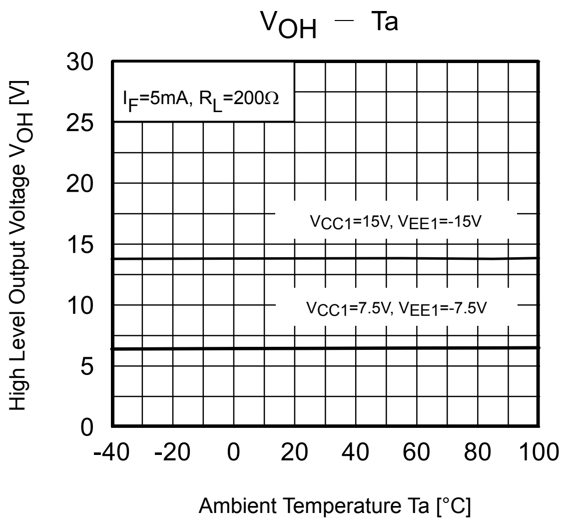
$$CM_L = \frac{800\ V}{t_r\ (\mu s)}$$

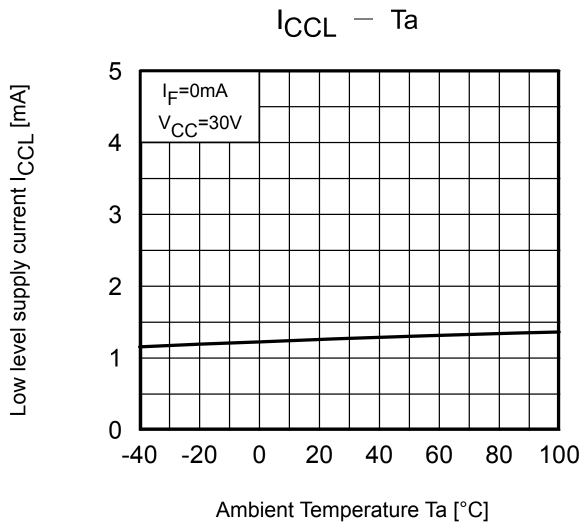
CM_L (CM_H) is the maximum rate of rise (fall) of the common mode voltage that can be sustained with the output voltage in the LOW (HIGH) state.

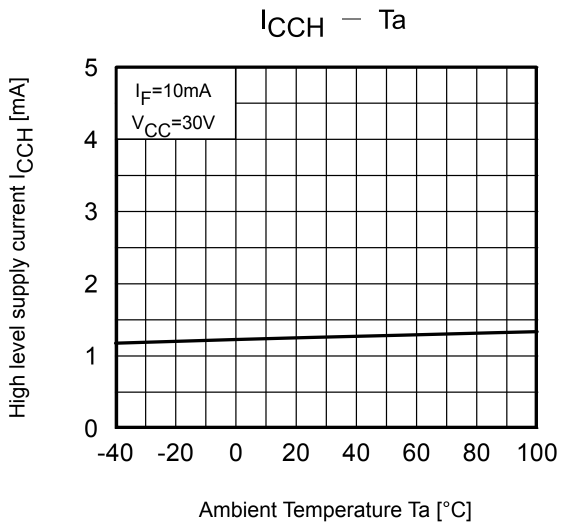

IF — VF
Ta=25°C
Ta=-40°C
Ta=100°C
Forward Current IF [mA]
Forward Voltage VF [V]
100
10
1
0.1
1
1.2
1.4
1.6
1.8
2

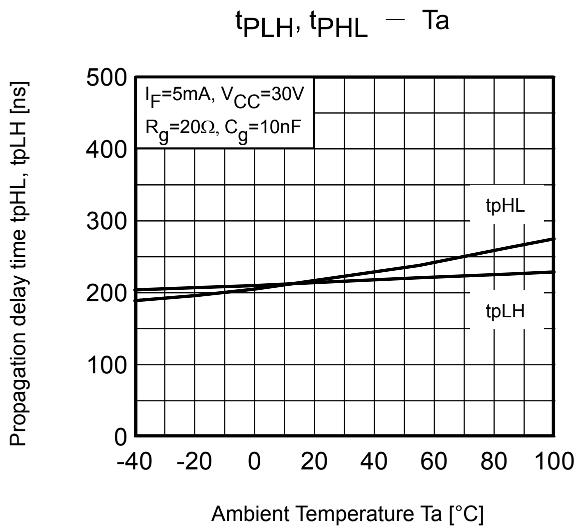

⊿VF/⊿Ta — IF
Coefficient ⊿VF/⊿Ta [mV/°C]
Forward Current IF [mA]
-3.2
-2.8
-2.4
-2
-1.6
-1.2
0.1
1
10

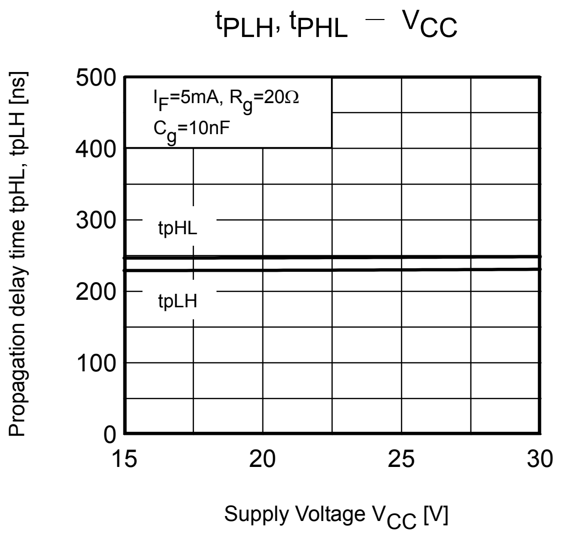

VOL — Ta
VF=0.8V, RL=200Ω
VCC1=15V, VEE1=-15V
VCC1=7.5V, VEE1=-7.5V
Low Level Output Voltage VOL [V]
Ambient Temperature Ta [°C]
-30
-25
-20
-15
-10
-5
0
-40
-20
0
20
40
60
80
100

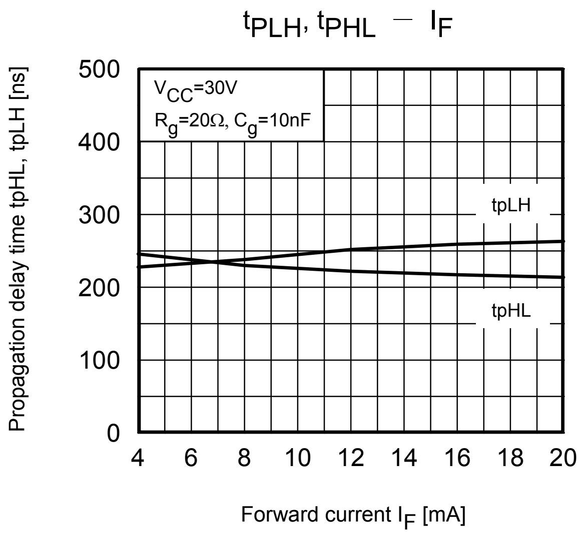

VOH — Ta
IF=5mA, RL=200Ω
VCC1=15V, VEE1=-15V
VCC1=7.5V, VEE1=-7.5V
High Level Output Voltage VOH [V]
Ambient Temperature Ta [°C]
30
25
20
15
10
5
0
-40
-20
0
20
40
60
80
100

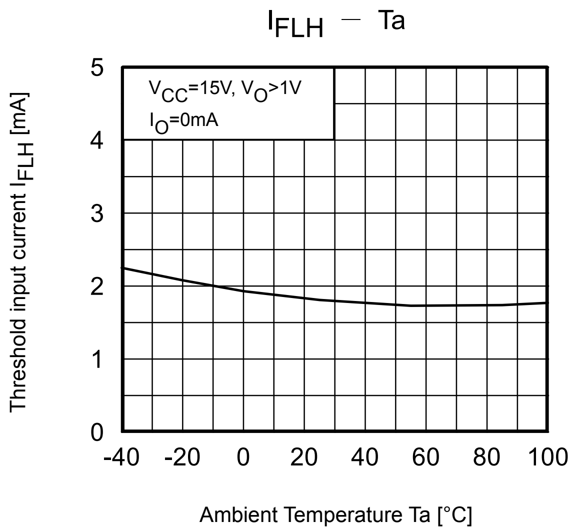

ICCL — Ta
IF=0mA
VCC=30V
Low level supply current ICCL [mA]
Ambient Temperature Ta [°C]
5
4
3
2
1
0
-40
-20
0
20
40
60
80
100

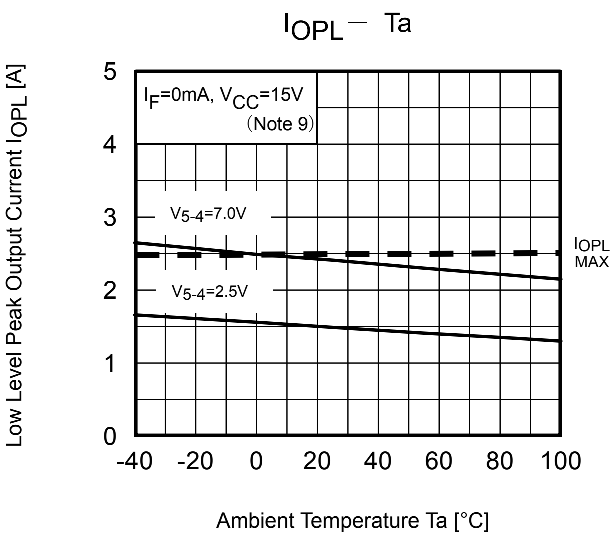

ICCH — Ta
IF=10mA
VCC=30V
High level supply current ICCH [mA]
Ambient Temperature Ta [°C]
5
4
3
2
1
0
-40
-20
0
20
40
60
80
100

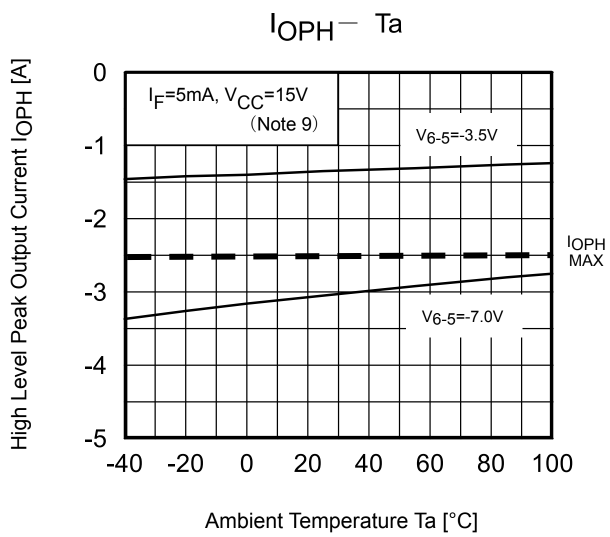

tPLH, tPHL – Ta
IF=5mA, VCC=30V
Rg=20Ω, Cg=10nF
tpHL
tpLH
Propagation delay time tpHL, tpLH [ns]
Ambient Temperature Ta [°C]
0
100
200
300
400
500
-40
-20
0
20
40
60
80
100

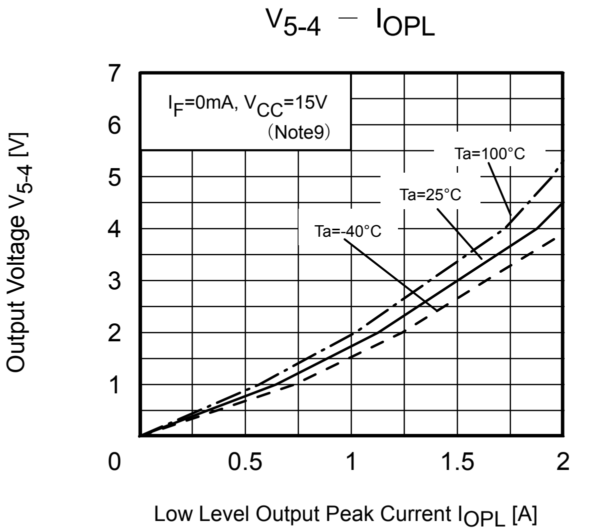

tPLH, tPHL – VCC
IF=5mA, Rg=20Ω
Cg=10nF
tpHL
tpLH
Propagation delay time tpHL, tpLH [ns]
Supply Voltage VCC [V]
0
100
200
300
400
500
15
20
25
30

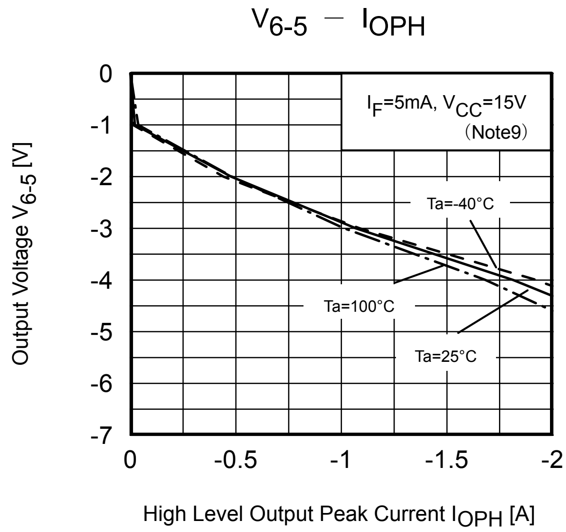

tPLH, tPHL – IF
VCC=30V
Rg=20Ω, Cg=10nF
tpLH
tpHL
Propagation delay time tpHL, tpLH [ns]
Forward current IF [mA]
0
100
200
300
400
500
4
6
8
10
12
14
16
18
20

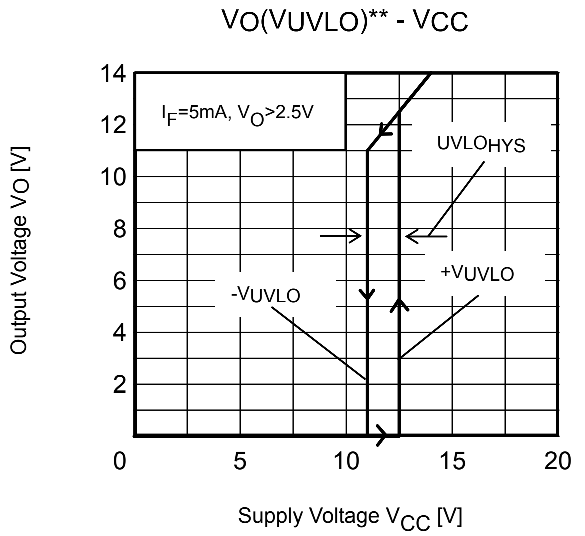

IFLH – Ta
VCC=15V, VO>1V
IO=0mA
Threshold input current IFLH [mA]
Ambient Temperature Ta [°C]
0
1
2
3
4
5
-40
-20
0
20
40
60
80
100


IOPL – Ta
IF=0mA, VCC=15V
(Note 9)
V5-4=7.0V
V5-4=2.5V
IOPL
MAX
Low Level Peak Output Current IOPL [A]
Ambient Temperature Ta [°C]
0
1
2
3
4
5
-40
-20
0
20
40
60
80
100

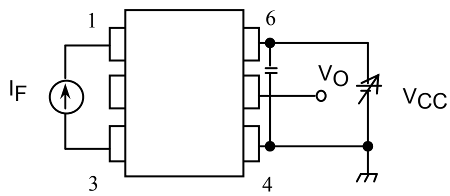

IOPH – Ta
IF=5mA, VCC=15V
(Note 9)
V6-5=-3.5V
V6-5=-7.0V
IOPH
MAX
High Level Peak Output Current IOPH [A]
Ambient Temperature Ta [°C]
0
-1
-2
-3
-4
-5
-40
-20
0
20
40
60
80
100







**Test Circuit : $V_O(V_{UVLO})$ - V_{CC}



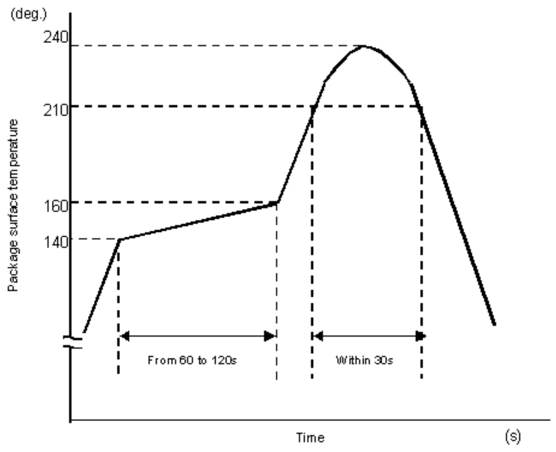
*: The above graphs show typical characteristics.

Soldering and Storage

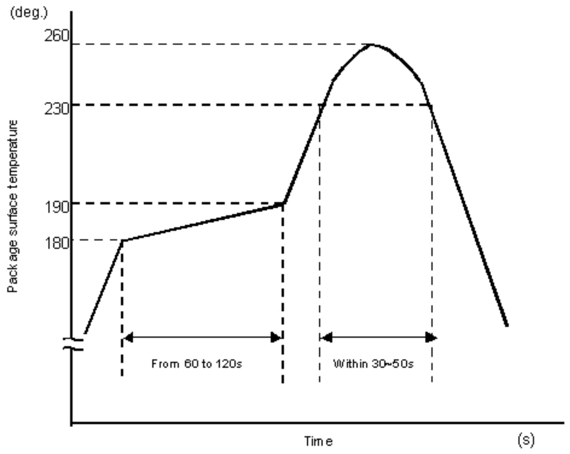
(1) Precautions for Soldering

1) When Using Soldering Reflow

- An example of a temperature profile when Sn-Pb eutectic solder is used:



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



- Reflow soldering must be performed once or twice.
- The mounting should be completed with the interval from the first to the last mountings being 2 weeks.

2) When using soldering Flow (Applicable to both eutectic solder and Lead(Pb)-Free solder)

- Apply preheating of 150 deg.C for 60 to 120 seconds.
- Mounting condition of 260 deg.C or less within 10 seconds is recommended.
- Flow soldering must be performed once

3) When using soldering Iron (Applicable to both eutectic solder and Lead(Pb)-Free solder)

- Complete soldering within 10 seconds for lead temperature not exceeding 260 deg.C or within 3 seconds not exceeding 350 deg.C.
- Heating by soldering iron must be only once per 1 lead

(2) Precautions for General Storage

1) Do not store devices at any place where they will be exposed to moisture or direct sunlight.

2) When transportation or storage of devices, follow the cautions indicated on the carton box.

3) The storage area temperature should be kept within a temperature range of 5 degree C to 35 degree C, and relative humidity should be maintained at between 45% and 75%.

4) Do not store devices in the presence of harmful (especially corrosive)gases, or in dusty conditions.

5) Use storage areas where there is minimal temperature fluctuation. Because rapid temperature changes can cause condensation to occur on stored devices, resulting in lead oxidation or corrosion, as a result, the solderability of the leads will be degraded.

6) When repacking devices, use anti-static containers.

7) Do not apply any external force or load directly to devices while they are in storage.

8) If devices have been stored for more than two years, even though the above conditions have been followed, it is recommended that solderability of them should be tested before they are used.

Specifications for Embossed-Tape Packing (TP) for SDIP6 Type Photocoupler

1. Applicable Package

Package Name	Product Type
SDIP6	Photocouplers

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) TLP700 (TP, F)

- F → [[G]]/RoHS COMPATIBLE (Note11)
- TP → Tape type
- TLP700 → Device name

3. Tape Dimensions

3.1 Orientation of Devices in Relation to Direction of Tape Movement

Device orientation in the recesses is as shown in Figure 1.

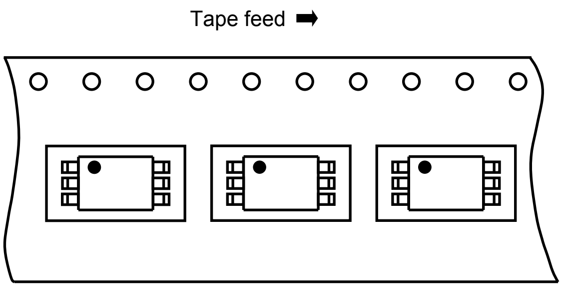


Figure 1 Device Orientation

3.2 Tape Packing Quantity: 1500 devices per reel

3.3 Empty Device Recesses Are as Shown in Table 1.

Table 1 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 30 or more empty holes and two empty turns only for a cover tape.

3.5 Tape Specification

(1) Tape material: Plastic (protection against electrostatics)
(2) Dimensions: The tape dimensions are as shown in Figure 2 and Table 2.

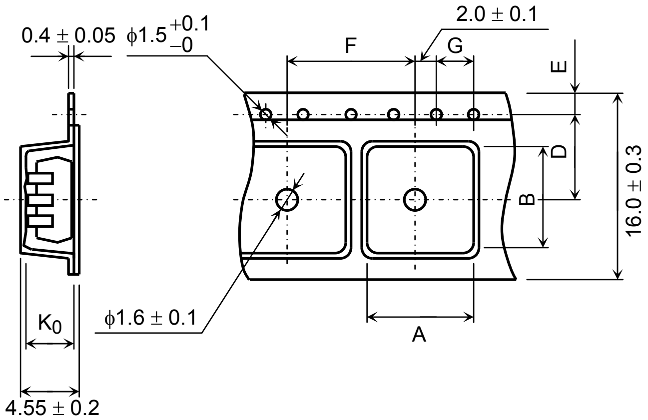


Figure 2 Tape Forms

Table 2 Tape Dimension

Unit: mm
Unless otherwise specified: ±0.1

Symbol	Dimension	Remark
A	10.4	—
B	5.1	—
D	7.5	Center line of indented square hole and sprocket hole
E	1.75	Distance between tape edge and hole center
F	12.0	Cumulative error $^{+0.1}_{-0.3}$ (max) per 10 feed holes
G	4.0	Cumulative error $^{+0.1}_{-0.3}$ (max) per 10 feed holes
K_0	4.1	Internal space

3.6 Reel

(1) Material: Plastic
(2) Dimensions: The reel dimensions are as shown in Figure 3 and Table 3.

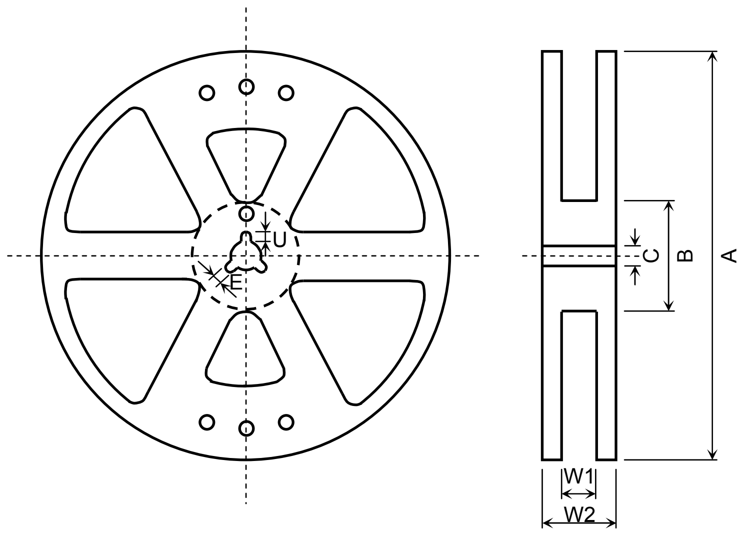


Figure 3 Reel Forms

Table 3 Reel Dimension

Unit: mm

記　号	寸　法
A	ϕ380 ± 2
B	ϕ80 ± 1
C	ϕ13 ± 0.5
E	2.0 ± 0.5
U	4.0 ± 0.5
W1	17.5 ± 0.5
W2	21.5 ± 1.0

4. Packing

Either one reel or five 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 Method

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) TLP700 (TP, F) 1500 pcs

- 1500 pcs → Quantity (must be a multiple of 1500)
- F → [[G]]/RoHS COMPATIBLE (Note 11)
- TP → Tape type
- TLP700 → Device name

Note 11 :Please contact your TOSHIBA sales representative for details as to environmental matters such as the RoHS compatibility of Product.
RoHS is the Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronics equipment.

EN60747-5-2 Option:(D4)

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

Types : TLP700, TLP700F

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

Ex.: TLP700 (D4-TP,F)

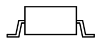
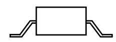
D4 : EN60747 option
TP : Standard tape & reel type
F : [[G]]/RoHS COMPATIBLE (Note 11)

Note: Use TOSHIBA standard type number for safety standard application.
Ex.: TLP700 (D4-TP,F) → TLP700

EN60747 Isolation Characteristics

Description		Symbol	Rating	Unit
Application classification for rated mains voltage≤300V_{rms} for rated mains voltage≤600V_{rms}			I-IV I-III	—
Climatic classification			40/ 100 / 21	—
Pollution degree			2	—
Maximum operating insulation voltage	TLPxxx type	V_{IORM}	890	Vpk
	TLPxxxFtype		1140	
Input to output test voltage, method A Vpr=1.5×V_{IORM}, type and sample test tp=10s, partial discharge<5pC	TLPxxx type	Vpr	1335	Vpk
	TLPxxxFtype		1710	
Input to output test voltage, method B Vpr=1.875×V_{IORM}, 100% production test t_p=1s, partial discharge<5pC	TLPxxx type	Vpr	1670	Vpk
	TLPxxxFtype		2140	
Highest permissible overvoltage (transient overvoltage, t_{pr} = 60s)		V_{TR}	8000	Vpk
Safety limiting values (max. permissible ratings in case of fault, also refer to thermal derating curve) current (input current I_F, P_{si} = 0) power (output or total power dissipation) temperature		 Isi Psi Tsi	 300 700 150	 mA mW ℃
Insulation resistance, V_{IO}=500V, Ta=25°C V_{IO}=500V, Ta=100°C V_{IO}=500V, Ta=Tsi		Rsi	≥ 10^{12} ≥ 10^{11} ≥ 10^{9}	Ω

Insulation Related Specifications

		 7.62mm pitch TLPxxx type	 10.16mm pitch TLPxxxF type
Minimum creepage distance	Cr	7.0mm	8.0mm
Minimum clearance	Cl	7.0mm	8.0mm
Minimum insulation thickness	ti	0.4mm	
Comperative 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.

Marking on product for EN60747 : 4

Marking Example :

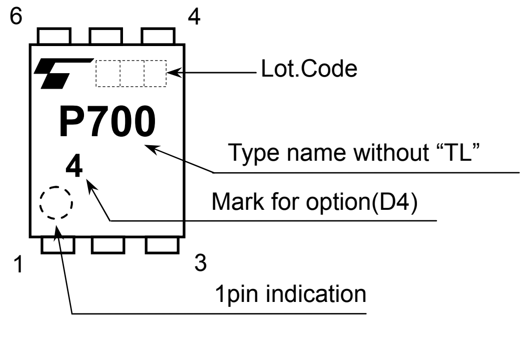


Figure 1 Partial discharge measurement procedure according to EN60747
Destructive test for qualification and sampling tests.

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

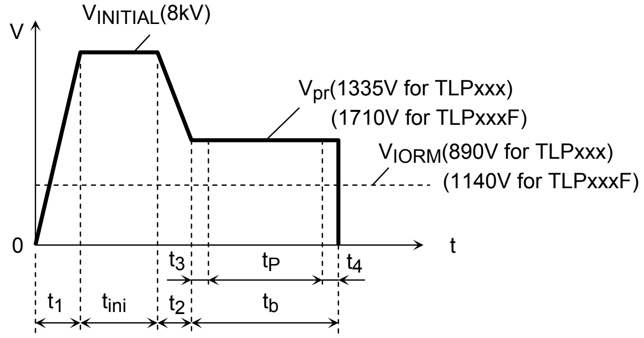


Figure 2 Partial discharge measurement procedure according to EN60747
Non-destructive test for100% inspection.

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

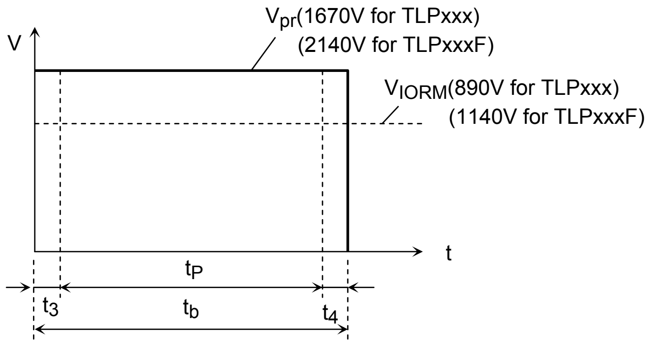
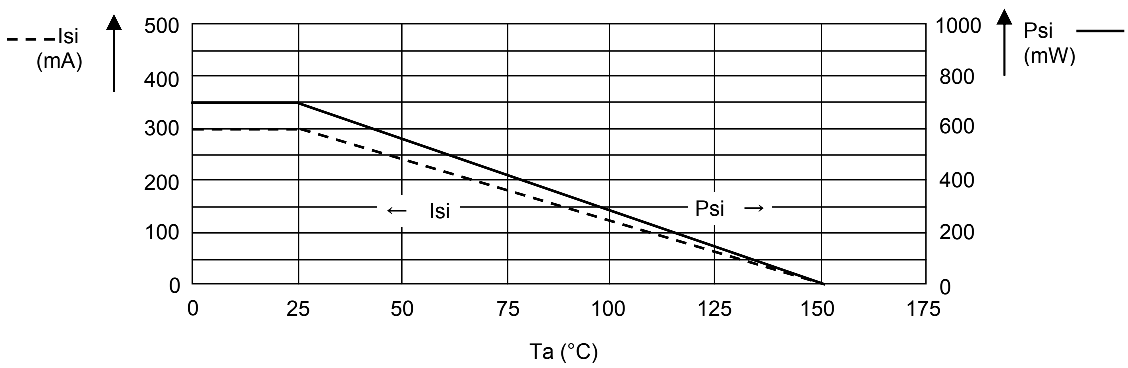


Figure 3 Dependency of maximum safety ratings on ambient temperature



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