

Safety Standards for Photocouplers

Overview

This document explains frequently used terminology and examples from component and equipment safety standards for photocoupler products.

Content

1.	Structure of standards	3
2.	Component and equipment standards	5
3.	Safety standards.....	7
3.1	UL 1577	7
3.2	EN 60747-5-5/IEC 60747-5-5.....	7
3.3	IEC 62368-1	8
3.4	IEC 60335-1	8
3.5	UL 508.....	9
4.	Commonly used parameters and terminology in safety standards	9
4.1	Overvoltage category.....	10
4.2	Pollution degree	11
4.3	CTI (Comparative Tracking Index)	11
4.4	Types of insulation.....	12
4.5	Insulation protection class	12
5.	Structural parameters for photocouplers.....	13
5.1	Isolation voltage	14
5.2	Clearance distance	14
5.3	Creepage distance:.....	14
5.4	Insulation thickness:.....	15
5.5	Creepage/clearance distance for typical photocouplers.....	16
6.	Conclusion	17
	Revision history	18
	RESTRICTIONS ON PRODUCT USE	19

Photocouplers are devices that provide important functionality in the form of electrical insulation. They consist of a light-emitting element and a light-receiving element packaged together through an optically transparent insulator. Photocouplers are commonly used in switching power sources in office equipment such as printers and household appliances such as LCD televisions, for signal transmission between the primary and secondary sides of the power supply. Photocoupler designs are subject to the requirements of safety standards for electrical shock prevention. Standards vary from country to country but all are based on the relevant international standards. The most commonly quoted standards are VDE and DIN in Germany and the UL standard in the United States. This document provides a general overview of safety standards.

1. Structure of standards

International standards in fields such as electrical, electronics and communications are set out by the IEC (International Electrotechnical Commission). Regional standards are modified versions of IEC standards and specifications that take account of local variations such as voltage. Safety standards at the national level are based on the IEC standards and/or regional standards, as shown in Figure 1.1, and are administered by local certification authorities. The application process for certification involves testing in accordance with the relevant standard.

Global IEC standards: global standards drawn up and agreed upon by IEC (International Electrotechnical Commission) member nations

Regional standards: applicable to a general region; based on IEC standards, tailored to regional conditions (e.g. EN (European Norm) in Europe)

National standards: applicable to particular nations or territories; based on IEC and regional standards, tailored to local conditions (e.g. UL in the United States, DIN in Germany)

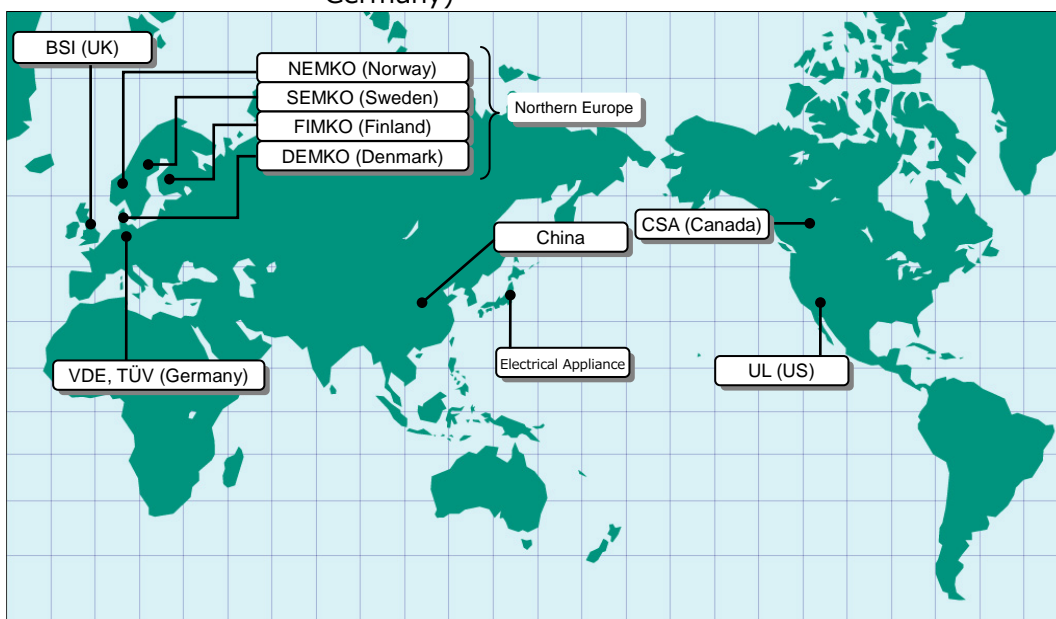


Figure 1.1 Major certification authorities and associated standards

A brief overview of the major certification authorities in the world is provided below.

UL (Underwriters Laboratories Inc.) compiles safety standards and provides related testing and certification services on everything from production materials through to finished products. The UL logo is displayed on products that comply with UL product safety certification requirements. UL certification is required on virtually all imported electric products and products with electrical components in the United States. The UL standard for photocoupler devices, UL 1577, defines insulation performance in terms of the probability of dielectric breakdown under high-voltage load.

CSA (Canadian Standard Association) compiles safety standards for electrical equipment and devices within Canada. Under provincial laws, electrical equipment connected to commercial power must be compliant with CSA standards. A Multi Recognition Agreement (MRA) between Canada and the United States allows mutual recognition of standards in both countries. Thus, CSA approved products made for Canadian markets are accepted by UL for distribution in the United States, bearing the cUL logo. Many Toshiba photocoupler devices are cUL certified.

VDE (Verband Der Elektrotechnik Elektronik Informationstechnik e.V, or Association of German Electrical Engineers) is a private-sector agency in Germany that provides compliance testing and certification services in accordance with its own VDE standards as well as government standards such as DIN. The DIN standard for photocoupler devices, DIN EN 60747-5-5 (formerly DIN VDE 0884), uses the partial discharge test to evaluate photocoupler insulation performance. VDE certified Toshiba photocouplers are compliant with EN 60747-5-5, and many also have additional certification options such as EN 60065, EN60950-1 or EN 62368-1.

SEMKO (Svenska Elektriska Materialkontroll Anstalten or Sweden Electric Equipment Testing and Appraisal Institution) is the agency in charge of standards and certification services for electrical products in Sweden. Toshiba photocoupler products with EN 60065 and EN 60950-1 certification are SEMKO compliant.

CQC (China Quality Certification Center) is the Chinese government agency responsible for testing and approval of compliance with Chinese standards, primarily under the CCC (China Compulsory Certification) scheme for imported products. Toshiba photocouplers such as GB4943.1 (IEC 60950-1 MOD*) and GB8898 (IEC 60065 MOD*) are CCC certified.

* MOD denotes a modified version of the IEC standard. This is permitted in cases where the local standard is structured in the same way as the international standard to allow direct comparison so that revisions to technical content can be readily identified.

2. Component and equipment standards

Safety standards for design and manufacture are broadly divided into component standards and equipment standards. Table 2.1 lists the major component and equipment standards applicable to photocouplers.

Equipment standards are established to ensure the safety of equipments.

Many of these standards have expired due to the transition to regional and national standards based on IEC 62368-1 by December 20, 2020. 62368-1 specifies the dielectric strength and physical distance between parts to be separated by insulation, and the photocouplers used in the insulated parts are tested for these requirements and certified.

Table 2.1 Major component and equipment standards applicable to photocouplers

Safety standards		IEC	EN	Country-specific standards
Equipment standards	IT equipment	IEC 60950-1	EN 60950-1 (Expires December 2020)	DIN EN 60950-1 (Expires December 2020), BS EN 60950-1 (Expires December 2020), GB4943.1, etc.
	Audio and video equipment	IEC 60065	EN 60065 (Expires December 2020)	DIN EN 60065, (Expires December 2020) BS EN 60065 (Expires December 2020), GB8898, etc.
	IT equipment (IEC60950/IEC60065 combined)	IEC 62368-1	EN 62368-1	DIN EN 62368-1 etc
	Household electrical appliances	IEC 60335-1	EN 60335-1	DIN EN 60335-1 etc
	Inverters	IEC 61800-5	EN 61800-5	DIN EN 61800-5 etc
	Solar power systems	IEC 62109-1	EN 62109-1	DIN EN 62109-1 etc
	Industrial controllers	IEC 61010-1	EN 61010-1	DIN EN 61010-1 etc
	Low-voltage systems	IEC 60664-1	EN 60664-1	DIN EN 60664-1 etc
Component standards	Photocouplers	-	-	UL1577* CSA component acceptance notice No.5A (CA5A)*
		IEC 60747-5-5	EN 60747-5-5	DIN EN 60747-5-5
	Magnetic / Capacitive coupling method	IEC 60747-17	-	DIN VDE V 0884-11: 2017-01

* UL1577 and CA5A have different insulation testing standards to IEC60747-5-5.

IEC 60950-1 : Information technology equipment - Safety - Part 1: General requirements

IEC 60065 : Audio, video and similar electronic apparatus - Safety requirements

IEC 62368-1 : Audio/video, information and communication technology equipment - Part 1:
Safety requirements

- IEC 60335-1 : Household and similar electrical appliances - Safety - Part 1:
General requirements
- IEC 61800-5-1 : Adjustable speed electrical power drive systems - Part 5-1:
Safety requirements - Electrical, thermal and energy
- IEC 62109-1 : Safety of power converters for use in photovoltaic power systems - Part 1:
General requirements
- IEC 61010-1 : Safety requirements for electrical equipment for measurement, control, and
laboratory use - Part 1: General requirements
- IEC 60664-1 : Insulation coordination for equipment within low-voltage systems - Part 1:
Principles, requirements and tests
- IEC 60747-5-5 : Semiconductor devices - Discrete devices - Part 5-5:
Optoelectronic devices – Photocouplers
- IEC 60747-17 : Semiconductor devices - Part 17: Magnetic and capacitive coupler for basic and
reinforced insulation

On the other hand, component standards are for individual components, and standards for photocouplers include UL 1577 and IEC 60747-5-5. These standards define completely different test methods and judgment criteria for measuring the insulation performance between input and output. Although component standards and equipment standards are basically independent, IEC 62368-1, an equipment standard, exempts the requirement of 0.4 mm isolation thickness inside couplers for the reinforced insulation by obtaining IEC 60747-5-5, a component standard, and some of the contents of the standards may be mutual. The details of these standards are described in the following section 3.

As mentioned in section 3.2, IEC 60747-5-5 in particular imposes partial discharge testing as a component standard. IEC 61800-5, IEC 62109-1, IEC 61010-1, etc., which are typical industrial equipment standards, also impose partial discharge tests as equipment standards.

In addition, IEC 60747-17 was published in September 2020 as the first international standard covering magnetic/capacitive couplers.

Compliance with safety standards is evaluated by national testing and accreditation bodies, which are also responsible for issuing certifications. Table 2.2 lists the main safety standards used for accreditation of photocoupler components. The safety standards vary by product depending on how the component is used. For product selection purposes, the applicable standards are listed on the Toshiba Electronic Device & Storage Corporation website and on the relevant product data sheets.

Table 2.2 Main safety standards for photocouplers

Accreditation agency	Safety standards	Description
UL	UL 1577 CA5A (cUL)	Based on insulating resin properties such as dielectric strength resistance.
VDE	DIN EN 60747-5-5 EN 62368-1	Based on partial discharge test
CQC	GB4943.1 GB8898	Based on insulation distance and insulation resistance/dielectric strength test

3. Safety standards

This section provides a general overview of UL 1577 and EN 60747-5-5, the main component standards applicable to photocouplers, as well as the equipment standards IEC 62368-1 and IEC 60335-1, which are typically used on products containing photocouplers and UL 508 (NRNT) , which covers mechanical relays and SSR (Solid State Relay; our photo relay is also a type of SSR).

3.1 UL 1577

UL 1577 uses the dielectric strength test method to assess dielectric breakdown characteristics under high-voltage load. Generally this involves applying an AC sinusoidal voltage at 50 Hz or 60 Hz for one minute and monitoring insulation performance between the input and output terminals. Note that there is no prescribed safety action for the voltage normally applied between the input and output terminals. Toshiba photocouplers are tested for isolation voltage BVs in accordance with UL 1577.

3.2 EN 60747-5-5/IEC 60747-5-5

EN 60747-5-5 uses the partial discharge test method to measure insulation performance under high-voltage load. Electric charge from partial corona discharge should be no greater than 5 pC. For example, in a 100% test on photocoupler components using the voltages shown in Figure 3.1(b), electric charge should be below 5 pC. Thus, the partial discharge test must be used on EN 60747-5-5 compliant products. For Toshiba photocouplers, this test has been incorporated in addition to the standard load testing regimen.

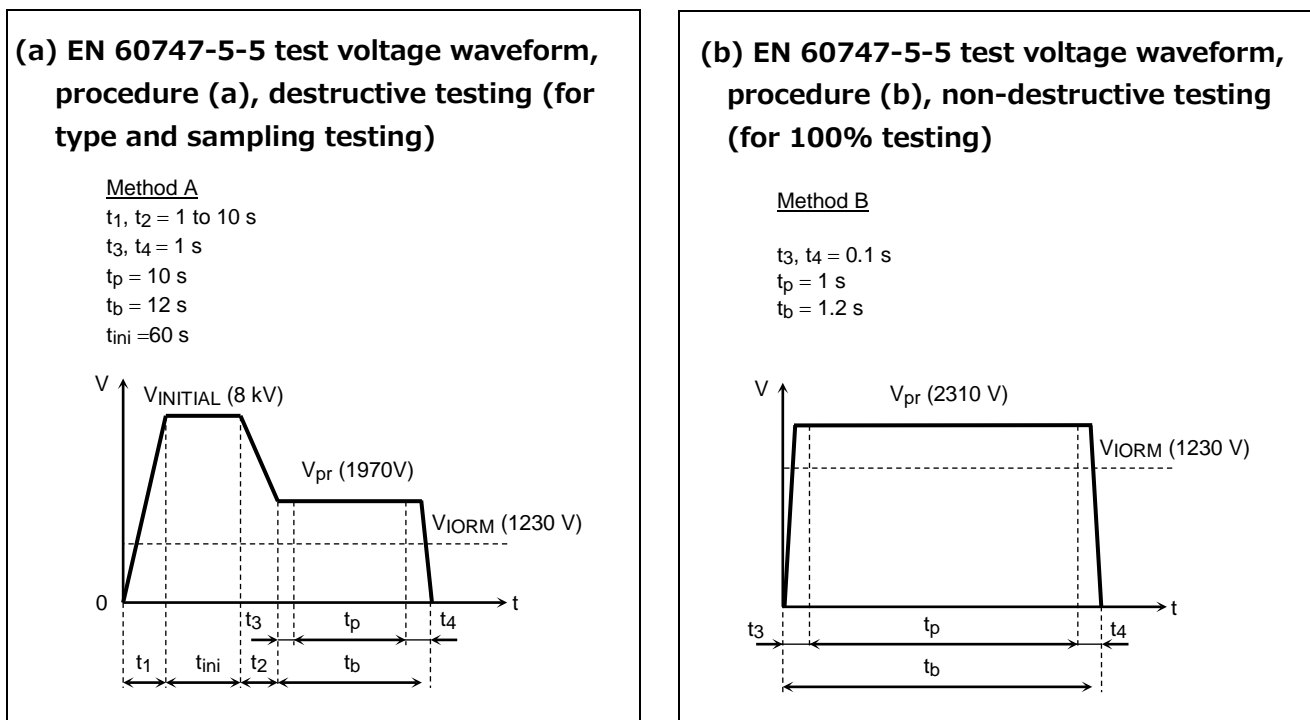


Figure 3.1 EN 60747-5-5 test voltage waveform (TLP701H)

Since EN 60747-5-5 certification requires a partial discharge test in addition to the standard load test, Toshiba has adopted the following position on EN 60747-5-5 certification:

- (1) Products that comply with EN 60747-5-5 testing requirements are given consistent naming conventions for D4 and V4 options.
- (2) Product names are consistent across all products with D4/V4 options, as shown in Table 3.1.
- (3) D4 denotes packages with guaranteed creepage/clearance distance of at least 6.4 mm (such as DIP and SO6L) while V4 denotes surface-mounted packages with creepage/clearance distance of up to 5 mm (such as SO4, SO6 and MFSOP6).

Table 3.1 Naming conventions for D4 and V4 options

<p>Example 1: DIP8 package Standard TLP352 (TP1,F) → TLP352 (D4-TP1,F) D4: EN 60747-5-5 option TP1: taping specs F : [[G]]/ RoHS compatible Note: Use standard model name (as per previously) for multiple safety standard application. Example: TLP352(D4-TP1,F) → TLP352</p> <p>Example 2: SO6 package Standard TLP2368 (TPL,E → TLP2368(V4-TPL,E) V4 : EN60747-5-5 option TPL: taping specs E : [[G]]/ RoHS compatible Note: Use standard model name (as per previously) for multiple safety standard application. Example: TLP2368(V4-TPL,E → TLP2368</p>

3.3 IEC 62368-1

The IEC 62368-1 safety standard is designed to minimize the potential for electric shock and injury from digital equipment and devices during normal usage or maintenance procedures. Photocouplers are commonly used to provide insulation for safety purposes. Insulating components in electrical equipment are defined by physical parameters such as creepage/clearance distance. Requirements may vary depending on factors such as the operating environment and the nature of the insulating material. This is because the protection level of the equipment depends on the way it is used, as set out in IEC 60664-1. This is discussed in Section 4 onwards, along with details of the corresponding Toshiba photocoupler products.

3.4 IEC 60335-1

IEC 60335-1 is an equipment safety standard primarily intended for household electrical appliances. Table 3.2 lists insulation test voltages. The test voltage is a sinusoidal voltage at 50 Hz or 60 Hz applied for a period of one minute. Toshiba produces a wide range of photocouplers to suit the test voltages listed in IEC 60335-1.

Table 3.2 Insulation test voltage in IEC 60335-1

Rated voltage	Basic insulation	Supplementary insulation	Reinforced insulation
Safety extra-low voltage (SELV) <25Vac/60Vdc	500 Vac	–	–
≤ 130V	1000 Vac	1500 Vac	2500 Vac
> 130V	1000 Vac	2750 Vac	3750 Vac

3.5 UL 508

UL is a safety standard certification aimed at standardization related to functions and safety of materials, equipment, products and tool sets, certified by the American Underwriters Laboratories.

Tests are conducted based on this safety standard and a certificate letter and mark are issued for the products that pass.

Global manufacturers of equipment such as programmable logic controllers (PLC), power units, uninterruptable power supplies (UPS), and industrial control equipment achieve UL 508 certification for their products.

Within this unit certification, the parts mounted in the unit are also defined by UL 508.

Specifically, switching devices including mechanical relays and solid-state relays compliant with the UL 508 standard are desired. General-purpose photocouplers such as logic output optocouplers are not within this scope, but photorelays belonging to the Solid State Relay product group are within the scope, and need to adopt it.

For Solid State Relays (SSRs) the resin temperature constraint is defined as a 105° C upper limit. [Note 1] The following Toshiba photorelays (a MOSFET output type of solid-state relay) are certified by UL 508, corresponding to NRNT. [Note 2] They can be used up to this temperature limit.

By using our UL-certified products, you can manufacture control equipment conforming to UL standards, and can secure the temperature design margin of solid-state relays.

[Note 1] Temperature constraint on plastic (epoxy)

[Note 2] Industrial control switch, solid-state control device for non-motor load

4. Commonly used parameters and terminology in safety standards

The safety of an electrical device depends on factors such as the operating environment and voltage class. When selecting a photocoupler it is important to know the class of the electrical equipment and the parameter requirements. Safety standards are arranged in terms of parameters. This section describes the most important parameters with respect to compatibility between photocouplers and equipment standards, along with the associated terminology. Equipment standards frequently refer to or quote from IEC 60664-1, so IEC 60664-1 definitions will be used here.

IEC 60664-1 : Insulation coordination for equipment within low-voltage systems - Part 1:
Principles, requirements and tests

4.1 Overvoltage category

Overvoltage is the phenomenon of a voltage in excess of the normal operating voltage reaching the electrical equipment from the AC main power source. The overvoltage level is governed by the voltage of the power source and the equipment status. There are four overvoltage categories for electrical equipment that denote the level of protection provided to installed equipment.

Overvoltage category I: Secondary circuit of equipment connected to hard-wired power outlet or equivalent

Overvoltage category II: Primary circuit of equipment connected to hard-wired power outlet or equivalent (such as common and household appliances)

Overvoltage category III: Equipment connected to building distribution board either directly or through a power outlet or equivalent (typically industrial equipment)

Overvoltage category IV : Equipment connected outside the distribution board, for instance to wiring between the pole transformer and the switchboard (such as power meters)

A higher overvoltage category indicates a greater risk of exposure to overvoltage. Overvoltage category IV applies to power meters and other equipment used in the place to contact with high-voltage power from transmission lines. Overvoltage category III denotes a lower risk of overvoltage, typically due to the presence of safety circuits on a building distribution board or equivalent, and is intended for installed equipment such as air conditioners. Household appliances powered from a standard wall outlet, such as televisions and refrigerators, are normally classified as standard overvoltage category II. Household appliances are generally not designed to withstand category III levels of overvoltage and therefore must not be connect to direct lines from the distribution board.

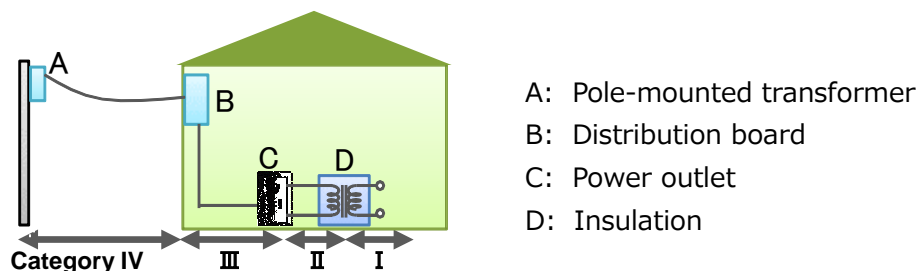


Figure 4.1 Overvoltage categories

Table 4.1 Rated impulse voltage

Mains voltage Vrms	Rated impulse voltage (V)			
	Category I	Category II	Category III	Category IV
50	330	500	800	1500
100	500	800	1500	2500
150	800	1500	2500	4000
300	1500	2500	4000	6000
600	2500	4000	6000	8000
1000	4000	6000	8000	12000

4.2 Pollution degree

The pollution level of the operating environment is similarly classified into four categories. Pollution creates a harsher operating environment, necessitating higher insulation performance in terms of parameters such as creepage/clearance distance.

Pollution degree 1: Pollutants are either non-existent or present only in dry, non-conductive form; for example, potted and fully sealed devices that prevent ingress of dust and humidity.

Pollution degree 2: Pollutants are entirely non-conductive but could potentially be rendered conductive by condensation; for example, at the typical office or home environment.

Pollution degree 3: Either conductive pollutants are present, or condensation could cause dry, non-conductive pollutants to become conductive; for example, at a manufacturing facility.

Pollution degree 4: Conductive matter is present on an ongoing basis (such as dust particles, rain or snow); for example, in an outdoor environment.

4.3 CTI (Comparative Tracking Index)

Tracking refers to dielectric breakdown caused by repeated micro discharges forming a carbonized conductive path on the surface of the insulating material. IEC 60112 defines CTI as the maximum possible voltage before droplets of ammonium chloride solution on the surface of the insulating material cause tracking, under the given test conditions. IEC 60664-1 groups molded materials according to CTI value. Most Toshiba photocouplers use Group IIIa insulating materials.

Material Group I : $600 \leq \text{CTI}$

Material Group II : $400 \leq \text{CTI} < 600$

Material Group III a : $175 \leq \text{CTI} < 400$

Material Group III b : $100 \leq \text{CTI} < 175$

IEC 60664-1 : Insulation coordination for equipment within low-voltage systems - Part 1:
Principles, requirements and tests

IEC 60112 : Method for the determination of the proof and the comparative tracking indices
of solid insulating materials

4.4 Types of insulation

The preceding three sections have described classification of environmental conditions affecting insulation performance. In IEC 60950-1 and some other standards, the insulation structure is divided into five classes as follows.

- Functional insulation: Minimum level of insulation required to ensure intended operation. Won't prevent electric shock but should reduce the likelihood of sparking.
- Basic insulation: Base level of protection from electric shock.
- Supplementary insulation: Additional independent insulation designed to mitigate the risk of electric shock in the event of damage to the basic insulation.
- Double insulation: Combination of basic and supplementary insulation.
- Reinforced insulation: Single insulation layer deemed equivalent to double insulation in terms of protection from electric shock.

4.5 Insulation protection class

IEC 60950-1 and other standards use the following classifications for electric shock protection for electrical devices.


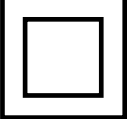
Class I: Provides basic insulation against electric shock as well as electrical earthing of all potentially conductive parts via earth conductor to provide a higher level of protection in the event of damage to the basic insulation.

Class II: Augments basic insulation against electric shock with a separate layer of either double insulation or supplementary insulation.

Class III: Uses a SELV power supply to ensure that voltage cannot cause electric shock.

Class I electrical equipment must be connected to protective earth. For permanently connected equipment, the protective earth terminal must be labeled as shown in Table 4.2. Class II equipment should be provided with supplementary insulation to prevent dangerous voltage in the event of damage to the basic insulation. Most but not all Class II equipment is labeled as such. For instance, some household appliances that are rated at AC 150 V or below and use the standard twin-prong power plug may be classified as Class 0 in Japan, and so are not labeled as Class II. Meanwhile, AC adaptors for laptop computers typically accept a wide range of voltages and are therefore Class II. Class III electrical equipment fitted with a SELV (Separated Extra Low Voltage) power supply is essentially incapable of causing an electric shock so the safety requirements do not apply.

Table 4.2 4.5 Insulation protection class marks

Class I protection earth	Class II
	

5. Structural parameters for photocouplers

The required physical separation for insulated parts varies depending on the operating environment and type of insulation, as we have seen. Table 5.1 and Figure 5.1 show the relevant structural parameters for photocouplers.

Table 5.1 Structural parameters for photocouplers

Parameter	Description
Isolation Voltage	Insulation performance between input and output terminals expressed as voltage
Creepage Distance	Shortest distance along the surface of insulating material between the two conductors (input and output)
Clearance Distance	Shortest distance in air clearance between the two conductors (input and output)
Internal isolation thickness	Minimum thickness of insulating material between the two conductors (input and output)

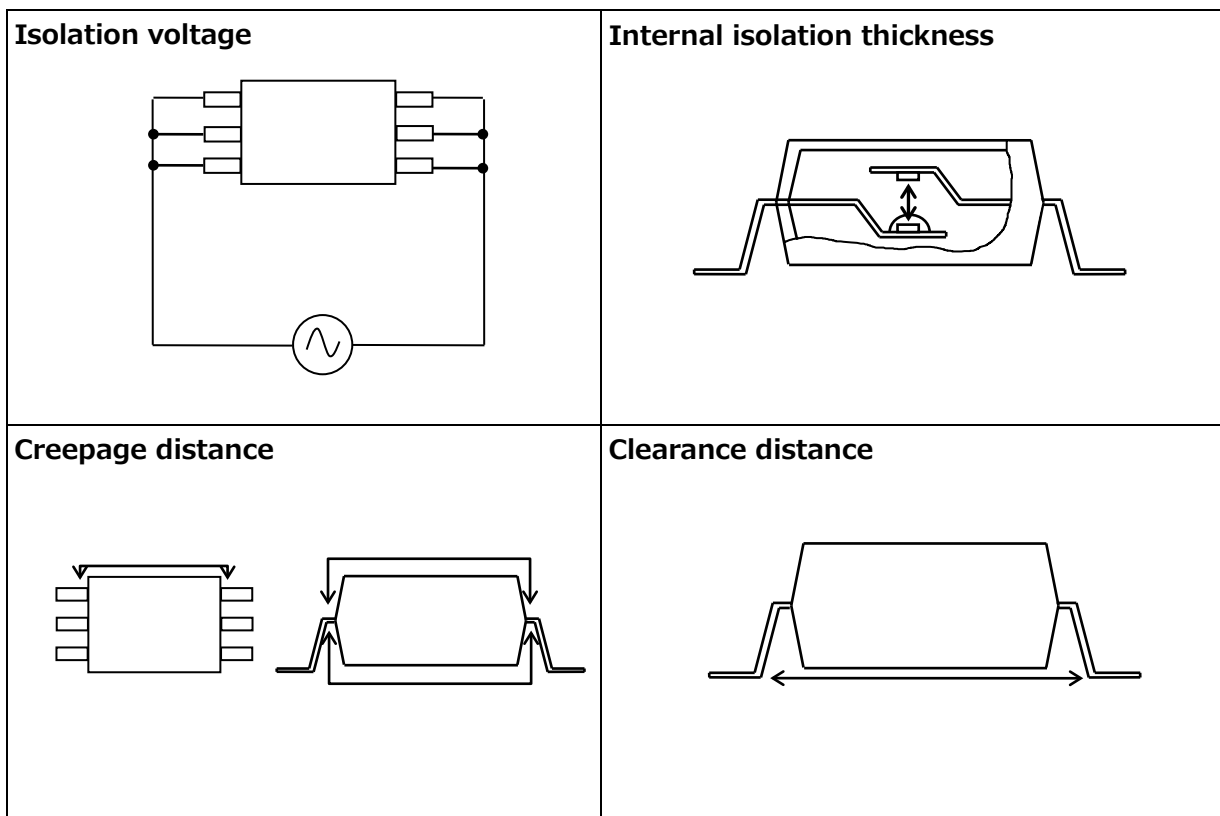


Figure 5.1 Structural parameters for photocouplers

5.1 Isolation voltage

Insulation should be able to withstand AC 50Hz/60Hz sinusoidal wave or DC voltage equivalent to peak value without deterioration in performance. The test voltage is governed by the type of insulation (typically basic or reinforced) and the operating voltage.

5.2 Clearance distance

Clearance distance and creepage distance are governed by a range of factors including installation category and pollution level mentioned earlier. The leading equipment standards for IT systems and industrial equipment stipulate minimum clearance distances corresponding to the overvoltage categories described in Section 4.1, based on definitions taken from IEC 60664-1. Table 5.2 shows clearances for IT systems from IEC 62368-1. The clearance distance is governed by factors affecting insulation performance; a greater distance is required in harsh operating environments. At high-altitude multiplier also comes into effect at altitudes of 2,000 m or more. In GB 4943.1-2011, the clearance distance high-altitude multiplier is 1.48 for equipment used at altitudes in the range 2,000 – 4,999 m.

Table 5.2 Minimum clearance distance based on IEC 62368-1 definitions

Unit : [mm]

Overvoltage category	AC mains voltage Vrms	Basic insulation	Reinforced insulation
II (IT equipment)	150	0.5	1.0
	300	1.5	3.0
	400	3.0	5.5
III (industrial equipment)	600 (includes 400 and 690)	5.5	8.0

Pollution degree 2

5.3 Creepage distance:

For photocouplers, creepage distance is measured along outside the package, and is therefore governed to some extent by the CTI of the package material (or material group). Creepage distance should always be equal to or greater than clearance distance. Toshiba photocouplers are made from Group IIIa materials. Table 5.3 lists the minimum creepage distances for Group IIIa materials, as per the definitions in IEC 62368-1. Normally the clearance distance required for reinforced insulation is double the distance for basic insulation.

Table 5.3 Minimum creepage distance using IEC 62368-1 definitions

Unit : [mm]

Maximum working voltage Vrms	Basic insulation	Reinforced insulation
160	1.6	3.2
200	2.0	4.0
250	2.5	5.0
320	3.2	6.4
400	4.0	8.0
630	6.3	12.6
800	8.0	16.0

Note: Assumes Group IIIa materials and pollution degree 2; linear interpolation may be used for voltages that lie between the figures given above.

5.4 Insulation thickness:

The IEC 62368-1 equipment standard specifies a minimum insulation thickness of 0.4 mm for supplementary and reinforced insulation but no minimum for functional and basic insulation. Minimum insulation thickness requirements do not apply to products that are compliant with IEC 60747-5-5. Some other equipment standards give 0.4 mm as the minimum thickness. The vast majority of Toshiba products guarantee minimum 0.4 mm thickness, equivalent to reinforced insulation.




5.5 Creepage/clearance distance for typical photocouplers

The following is an example of our 5Mbps class high-speed IC coupler representative product.

One of our small package products is the SO6 package TLP2355, which guarantees a creepage and clearance distance of 5 mm (minimum). By optimizing the package design, we have expanded the lineup of SO6 products that can be used in higher voltage classes despite their small size. The SO6L (TLP2745), which guarantees 8mm creepage and clearance distance, and the SO6L LF4 leadforming (TLP2745(LF4)) are available for much higher voltage classes.

The TLP2355 in the SO6 package and the TLP2745 and TLP2745(LF4) in the SO6L and SO6L(LF4) packages have the same product characteristics and can be selected according to the required safety class.

Table 5.4 Package type and creepage/clearance distance

Package	Product code	Creepage distance	Clearance distance	Insulation thickness
 SO6	TLP2355	5.0 mm	5.0 mm	0.4 mm
 SO6L	TLP2745	8.0 mm	8.0 mm	0.4 mm
 SO6L(LF4)	TLP2745 (LF4)	8.0 mm	8.0 mm	0.4 mm

Using IEC 62368-1 as an example, Table 5.5 summarizes the creepage distance, clearance distance, and insulation thickness requirements and the recommend 5 Mbps class high-speed IC coupler products discussed in Table 5.4. The SO6 TLP2355 is guaranteed to have an isolation thickness of 0.4 mm and can support systems with reinforced insulation for the operating voltage of 250 Vrms. That makes this product a flexible for the future system design changes. In the case of reinforced insulation, the SO6L TLP2745 can support systems with an operating voltage of up to 400 Vrms.

Table 5.5 Creepage distance, clearance distance and insulation thickness for IEC 62368-1 equipment standard and applicable scope for high-speed IC photocoupler product

Overvoltage category II, pollution degree 2, material group IIIa, reinforced insulation
Unit:[mm]

Maximum operating voltage Vrms	Creepage distance	Clearance distance	Insulation thickness	Recommended product
150	3.0	1.0	0.4	TLP2355
200	4.0	3.0	0.4	TLP2355
250	5.0	3.0	0.4	TLP2355
300	6.0	3.0	0.4	TLP2745
400	8.0	5.5	0.4	TLP2745(LF4)

6. Conclusion

This document provides a general overview of safety standards. Safety standards stipulate performance requirements for photocouplers, which can vary depending on the nature of the equipment operating environment and the operating voltage class. Note that the information provided in this document does not cover all installation and all situations, and that exceptions may apply. When selecting a photocoupler product, be sure to check the latest edition of the relevant safety standard for the equipment in which it will be used.

Revision history

Version	Date	Page reference	Details
Rev. 1.0	2018-06-11	-	Created
Rev. 2.0	2021-03-08	-	Revision of a manuscript

RESTRICTIONS ON PRODUCT USE

Toshiba Corporation and its subsidiaries and affiliates are collectively referred to as "TOSHIBA". Hardware, software and systems described in this document are collectively referred to as "Product".

- TOSHIBA reserves the right to make changes to the information in this document and related Product without notice.
- This document and any information herein may not be reproduced without prior written permission from TOSHIBA. Even with TOSHIBA's written permission, reproduction is permissible only if reproduction is without alteration/omission.
- Though TOSHIBA works continually to improve Product's quality and reliability, Product can malfunction or fail. Customers are responsible for complying with safety standards and for providing adequate designs and safeguards for their hardware, software and systems which minimize risk and avoid situations in which a malfunction or failure of Product could cause loss of human life, bodily injury or damage to property, including data loss or corruption. Before customers use the Product, create designs including the Product, or incorporate the Product into their own applications, customers must also refer to and comply with (a) the latest versions of all relevant TOSHIBA information, including without limitation, this document, the specifications, the data sheets and application notes for Product and the precautions and conditions set forth in the "TOSHIBA Semiconductor Reliability Handbook" and (b) the instructions for the application with which the Product will be used with or for. Customers are solely responsible for all aspects of their own product design or applications, including but not limited to (a) determining the appropriateness of the use of this Product in such design or applications; (b) evaluating and determining the applicability of any information contained in this document, or in charts, diagrams, programs, algorithms, sample application circuits, or any other referenced documents; and (c) validating all operating parameters for such designs and applications. **TOSHIBA ASSUMES NO LIABILITY FOR CUSTOMERS' PRODUCT DESIGN OR APPLICATIONS.**
- **PRODUCT IS NEITHER INTENDED NOR WARRANTED FOR USE IN EQUIPMENTS OR SYSTEMS THAT REQUIRE EXTRAORDINARILY HIGH LEVELS OF QUALITY AND/OR RELIABILITY, AND/OR A MALFUNCTION OR FAILURE OF WHICH MAY CAUSE LOSS OF HUMAN LIFE, BODILY INJURY, SERIOUS PROPERTY DAMAGE AND/OR SERIOUS PUBLIC IMPACT ("UNINTENDED USE").** Except for specific applications as expressly stated in this document, Unintended Use includes, without limitation, equipment used in nuclear facilities, equipment used in the aerospace industry, lifesaving and/or life supporting medical equipment, equipment used for automobiles, trains, ships and other transportation, traffic signaling equipment, equipment used to control combustions or explosions, safety devices, elevators and escalators, and devices related to power plant. **IF YOU USE PRODUCT FOR UNINTENDED USE, TOSHIBA ASSUMES NO LIABILITY FOR PRODUCT.** For details, please contact your TOSHIBA sales representative or contact us via our website.
- Do not disassemble, analyze, reverse-engineer, alter, modify, translate or copy Product, whether in whole or in part.
- Product shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable laws or regulations.
- The information contained herein is presented only as guidance for Product use. No responsibility is assumed by TOSHIBA for any infringement of patents or any other intellectual property rights of third parties that may result from the use of Product. No license to any intellectual property right is granted by this document, whether express or implied, by estoppel or otherwise.
- **ABSENT A WRITTEN SIGNED AGREEMENT, EXCEPT AS PROVIDED IN THE RELEVANT TERMS AND CONDITIONS OF SALE FOR PRODUCT, AND TO THE MAXIMUM EXTENT ALLOWABLE BY LAW, TOSHIBA (1) ASSUMES NO LIABILITY WHATSOEVER, INCLUDING WITHOUT LIMITATION, INDIRECT, CONSEQUENTIAL, SPECIAL, OR INCIDENTAL DAMAGES OR LOSS, INCLUDING WITHOUT LIMITATION, LOSS OF PROFITS, LOSS OF OPPORTUNITIES, BUSINESS INTERRUPTION AND LOSS OF DATA, AND (2) DISCLAIMS ANY AND ALL EXPRESS OR IMPLIED WARRANTIES AND CONDITIONS RELATED TO SALE, USE OF PRODUCT, OR INFORMATION, INCLUDING WARRANTIES OR CONDITIONS OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, ACCURACY OF INFORMATION, OR NONINFRINGEMENT.**
- GaAs (Gallium Arsenide) is used in Product. GaAs is harmful to humans if consumed or absorbed, whether in the form of dust or vapor. Handle with care and do not break, cut, crush, grind, dissolve chemically or otherwise expose GaAs in Product.
- Do not use or otherwise make available Product or related software or technology for any military purposes, including without limitation, for the design, development, use, stockpiling or manufacturing of nuclear, chemical, or biological weapons or missile technology products (mass destruction weapons). Product and related software and technology may be controlled under the applicable export laws and regulations including, without limitation, the Japanese Foreign Exchange and Foreign Trade Law and the U.S. Export Administration Regulations. Export and re-export of Product or related software or technology are strictly prohibited except in compliance with all applicable export laws and regulations.
- Please contact your TOSHIBA sales representative for details as to environmental matters such as the RoHS compatibility of Product. Please use Product in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. **TOSHIBA ASSUMES NO LIABILITY FOR DAMAGES OR LOSSES OCCURRING AS A RESULT OF NONCOMPLIANCE WITH APPLICABLE LAWS AND REGULATIONS.**

TOSHIBA ELECTRONIC DEVICES & STORAGE CORPORATION

<https://toshiba.semicon-storage.com/>