

**Clearance and Creepage Distances (Coil to Contacts)
Distance through Insulation (Solid Insulation)
Dielectric Strength**

Current Relay Standards

Widely used standards:

VDE 0110, part 1 (Nov. 2003); IEC 60664-1: 'Insulation coordination for equipment within low-voltage systems'

VDE 0435, part 201 (July 2004); IEC 61810-1, except 2 : 'Electromechanical non-specified time all or nothing relays - general requirements'

VDE 0631, part 1 (Jan. 2002); EN 60730-1; IEC 60730-1: 'Automatic electrical controls for household and similar use, general requirements'

VDE 0700, part 1 (July 2003); EN 60335-1, IEC 60335-1: 'Safety of household and similar electrical appliances'

Insulation, protection class

Basic insulation; protection class 0: insulation between live parts and exposed conductive parts, basic protection against electric shock

Reinforced insulation: protection class II: insulation which provides an even better protection against electric shock by additional safety precautions.

Overvoltage categories

The overvoltage category classifies overvoltages into categories I, II, III and IV.

To classify equipment in the overvoltage categories, the following points must be taken into account:

- overvoltages that arise from external sources and enter via the terminals, and
- overvoltages that are created in the actual equipment and occur at the terminals

The overvoltage category is one of the factors that decide spacing (determined by the overvoltage category and pollution degree)

Overvoltage Categories	Equipment Description	Examples
I	equipment connected to circuits protected against overvoltages	electronic circuits protected from power supplies by isolating transformers
II	energy-saving equipment <u>supplied by hard-wired power supply installations</u> (i.e. electrical outlets)	data processing equipment, portable tools and electric household appliances with plug: In these applications lower overvoltages occur
III	equipment <u>in</u> hard-wired facilities where equipment reliability and efficiency are particularly important	switches in hard-wired power supply installations, industrial equipment permanently connected to hard-wired power supply installations, equipment for fixed installations, protective equipment, contactors: In these application higher overvoltages may occur
IV	equipment used in power receiving installations	primary side overcurrent protection equipment

Pollution Degrees (ambient influence on insulation)

The pollution degree is the most important factor in deciding clearances (determined by the pollution degree and overvoltage categories) as well as creepage (determined by the pollution degree and CTI value) and it is classified into four degrees depending on the air pollution of the equipment used.

Pollution Degree 1	There is no pollution or only dry, non-conductive pollution that has no effect on components. Pollution Degree 1 is possible in clean rooms or other places with clean air.
Pollution Degree 2	There is only non-conductive pollution. The non-conductive pollution may be conductive on occasions due to unexpected condensation near the relay (if the relay is protected by an additional suitable housing, this degree may be applicable even in very dirty surroundings) Pollution Degree is normal for electric products that are used inside control panels, electric household appliances and business equipment.
Pollution Degree 3	There is conductive pollution or dry, non-conductive pollution that becomes conductive due to expected condensation near the relay, for instance: household appliances with non-enclosed electronic parts. (the relay is not protected by an additional suitable housing) Pollution Degree 3 in normal in ordinary factories.
Pollution Degree 4	There is a pollution that is continuously conductive due to the presence of conductive dust, rainfall or snowfall. Pollution Degree 4 is normal for outdoor areas.

Remark

Overvoltage Categories II and III and Pollution Degree 2 and 3 apply to relay applications.

Tracking resistance of plastics (CTI/PTI)

Comparative Tracking Index

The CTI value is a measure of the resistance to surface tracking that a particular material exhibits under specific test conditions. The CTI value of an insulation material is the maximum possible voltage that does not cause tracking when 50 drops of 0,1% ammonium chloride solution are dripped onto the material at a rate of 30 seconds per drop. The lower the CTI for a material, the greater the creepage distance required.

Materials fall into four material groups:

Group I: $CTI \geq 600$

Group II: $CTI \geq 400$ and < 600

Group IIIa: $CTI \geq 175$ and < 400

Group IIIb: $CTI \geq 100$ and < 175

Proof Tracking Index

The PTI is also used to identify the tracking characteristics of materials. IEC 60335 and IEC60065 stipulate that electric household appliances and consumer electronic appliances such as TVs, VTRs and radios must use PTI-175 or PTI-250 materials.

For relay applications a CTI value of min. 100 is presupposed, values of min. 175 are current. The VDE standard 0700 (EN 60336-1) prescribes a CTI value of min. 250 'for very critical applications'.

A lot of customers tend to apply still higher CTI values, for example 300, even when this is unnecessary according to the corresponding norm.

Remark

Only the relay user knows what conditions are decisive in the relay choice: corresponding standard, required insulation, pollution degree (depending on the application of the relay and particularly the enclosing of the electronic).

The norms of following tables are only valid for:

Nominal Voltage of the power distribution system (mains voltage):230/400VAC

Rated voltage : 250 VAC

Plastics according to insulation group III (CTI value : 100 ... 375)

VDE-Standard		Basic Insulation		Reinforced Insulation**	
Minimum Clearance Distance (distance measured through air)					
0110 (11/03), 0435 (7/04)	Choice of overvoltage category according to the application of the relay	II	III	II	III
0631 (1/02)	Surge voltage (1,2/50 μs)	2.500 V	4.000 V	4.000 V	6.000 V
0700 (7/03)	Clearance Distance	1,5 mm	3,0 mm	3,0 mm	5,5 mm
		2,0 mm	3,5 mm	3,5 mm	6,0 mm
Minimum Creepage Distance (distance measured along the surface of the insulation)					
0110, 0435, 0631, 0700	Choice of the pollution degree according to the application of the relay	2	3	2	3
	Creepage Distance	2,5 mm	4,0 mm	5,0 mm	8,0 mm
Minimum Distance through Insulation (Solid Insulation)					
0110		no minimum distances required			
0435, 0700		no requirements		2,0 mm *	
0631		no requirements		0,7 mm *	
Dielectric Strength (Dielectric Test Voltage AC, 60 seconds)					
0110		1.450 VAC (5 sec.)		2.900 VAC (5 sec.)	
0435		1.500 VAC		3.000 VAC	
0631		1.250 VAC		3.750 VAC	
0700		1.250 VAC		3.000 VAC	

* A less thick insulation can be admitted depending on the corresponding standard of the appliance or when the insulation consists of 3 layers

** In the series of VDE standards 0631 / 0700 there are, beyond the general 'part 1', a lot of specific standards for the different applications. These may have been published already a longer time ago and thus refer to an older issue of 'part 1'.

These older issues specified:

clearance distance: min. 6,0 mm (VDE 0631) et min. 8,0 mm (VDE 0700)

creepage distance: min. 8,0 mm (VDE 0631 / 0700)

distance through insulation : min. 2,0 mm (VDE 0631 / 0700)

What this means for relay users:

Regarding creepage and clearance distances, the relay user has to know about the standard that decides on the distances in the specific application and he has to be aware of the publication date of this standard. On the basis of the current standard, the relay user has to find out about the minimum creepage and clearance distances for the application. (Zettler has not got the disposal of specific standards for all appliances and cannot inform each customer about distances in the specific application). When the user asks for more security (when he demands higher values as those of the standard), Zettler possibly has to offer him a more expensive relay with larger insulation distances than technically required. In this case, the user has to find out if the test voltage at the open contact and a certain contact distance are compulsory prescribed.

IEC and VDE:

VDE is controlling according to the IEC standards

3 mm Insulation for the 230V mains:

The insulation has to protect the person working on an electric appliance.

There are two possible solutions: the relay has 3 mm of insulation between open contacts or the user has to plug out the appliance when he uses a relay with less than 3 mm insulation between open contacts.

Examples

Relay in a household appliance

Assumption: basic insulation is enough, 230 VAC, judgement according to VDE 0631, part 1 (January 02); EN 60730-1

Overvoltage Category II → clearance distance 1,5 mm

Pollution Degree 3 → creepage distance 4,0 mm

No requirements concerning distance through insulation

Test voltage: 1250 VAC

CTI norm requires a value of min. 250

Relay in an industrial application

Assumption: reinforced insulation, 230 VAC, judgement according to VDE 0435, part 201 (draft); IEC 61810-1

Overvoltage category III → clearance distance 5,5 mm

Pollution Degree 2 → creepage distance 5,0 mm, because the creepage distance cannot be less than the clearance distance → creepage distance: 5,5 mm

Distance through insulation: 2,0 mm

Test voltage 3000 VAC

UL CATEGORIES (UL 508)

Tested life according to norm 6.050, operations
All loads of the categories have been tested

Direct Current 'DC'

Category	Voltage	Current	Power	Tau (= L/R)	Thermal Constant Current
	VDC	A	W	ms	A
Q300	125	0,55	69	100	2,5
	250	0,27	69	100	
R300	125	0,22	28	56	1,0
	250	0,11	28	56	

Alternating Current 'AC'

Category	Voltage	Inrush current	Breaking current	cos phi	Thermal Constant Current
	VAC	A	A		A
A300	120	60	6,0	0,35	10
	240	30	3,0		
B300	120	30	3,0	0,35	5
	240	15	1,5		
C300	120	15	1,5	0,35	2,5
	240	7,5	0,75		