

## The Relation Between the Comparative Tracking Index and Working Voltage

### IDEA IN BRIEF

*Improving the Comparative Tracking Index allows smaller packages to achieve high working voltages.*

The maximum working voltage of an isolated system depends on a number of parameters according to IEC 60950. These include creepage distance, pollution degree, and material group. Pollution degree, a measure of the surface contamination, is set by the system and has a typical value of 2, but creepage distance and material group depend on the materials used in isolating elements such as digital isolators and optocouplers. Table 1, from IEC 60950, shows the relationships among these parameters.

To achieve a 400 V rms working voltage in a system designed for a pollution degree of 2, an isolator needs 4 mm of creepage for a material group of III for basic insulation. This doubles to 8 mm for reinforced insulation. For convenience, other working voltages can be determined by linearly interpolating between the creepage distances (as indicated in Table 1).

Note that, for a given working voltage, creepage distance can be reduced if the material group can be improved; this allows designers to save space by using smaller packages while still adhering to IEC 60950.

To measure the material group of an insulator, a 0.1% ammonium chloride solution is applied to the material, and a voltage is applied across the insulator, allowing current to flow. The material is rated for the highest voltage for which carbon tracks are not formed on the surface. This testing method is specified in IEC 60112. Table 2 shows the material group classification for a range of CTI voltage measurements.

**Table 1. Creepage Distance Requirements in Millimeters (mm) for IEC 60950**

Working Voltage $V_{rms}$	Pollution Degree						
	1	2			3		
	Material Group						
	I, II, III	I	II	III	I	II	III
<b>Basic Insulation</b>							
250	0.56	1.25	1.8	2.5	3.2	3.6	4.0
320	0.75	1.6	2.2	3.2	4.0	4.5	5.0
400	1.0	2.0	2.8	4.0	5.0	5.6	6.3
<b>Reinforced Insulation</b>							
250	1.12	2.5	3.6	5.0	6.4	7.2	8.0
320	1.5	3.2	4.4	6.4	8.0	9.0	10.0
400	2.0	4.0	5.6	8.0	10.0	11.2	12.6

**Table 2. CTI Measures for Material Groups**

Material Group	CTI [ $V_{rms}$ ]
Group I	>600
Group II	400 to 600
Group IIIa	175 to 400
Group IIIb	100 to 175

Under IEC 60112 guidelines, IIIb is the default material group. Analog Devices, Inc., (ADI) *iCoupler*<sup>®</sup> product packaging material, however, has been tested and demonstrated to achieve a CTI of more than 600 V rms, meeting the requirements for Material Group I. For simplicity and guard banding, ADI specifies Material Group II for new products. For example, the [ADuM347x](#) uses an SSOP package with 5.1 mm of creepage and Material Group II, which is rated for a maximum working voltage of 360 V rms

for reinforced insulation. If the [ADuM347x](#) were categorized as Material Group III, it would be limited to only 250 V rms.

By measuring and specifying the CTI of *iCoupler* products, ADI is able to offer isolators with smaller form factors without compromising isolation capability.