

# **PRODUCT SAFETY: Expanding Markets Mean New Requirements**

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# What You Will Learn About Product Safety

- How to Succeed in the Global Compliance Marketplace
- What Standards and Certification Bodies Mean to You
- The Meaning of All Those Marks
- Safety Concepts, Hazards, and Terms
- Product Classifications
- Safety Design Considerations
- Tools to Find What You Need on *ni.com*



# The Global Compliance Marketplace

- **North America**

- National standards and laws (OSHA)
- NRTL certifications, descriptive reports and N.A. Marks (UL/CSA)
- UL/CSA standards similar to IEC with U.S. deviations

- **European Union**

- EU standards and directives (laws) for CE marking
- Notified Body certification, CB reports and EU Marks (VDE/TUV/Demko)
- European Norms (EN) very similar to IEC standards

- **International**

- Laws and requirements vary between countries
- IEC standards taking over, but cert still required in some countries
- Certification Body (CB) Scheme for mutual recognition of reports

# Success in the Global Marketplace

- U.S. and EU laws tell us “**why**” we must comply
  - Consumer safety and quality, and *use the standards*
  - Fines, withdrawal and jail when not in compliance
- Standards show us “**how**” to comply
  - Tests
  - Safety design
- IEC/EU standards & certification are *de facto* rules for “**success**”
  - N. America adopting IEC standards and schemes
  - Certification is independent proof of compliance

# The Meaning of All Those Marks & markings!



- North American Product Safety



- European Union Product Safety



- North American Hazardous Locations



- European Union Hazardous Locations



- European Union EMC and Safety



- North American EMI



- Australian EMC



- Quality Management System (factory)

# Europe's CE marking

- The “goal” of the CE marking:
  - CE is a mandatory *marking* (symbol) for EMC and safety
  - CE allows products to be *placed on the market* (for sale, free, quantity)
  - CE is the suppliers self-declaration (*not* a certification)
  - CE permits authorities to audit & remove non-compliant products
- What the CE marking “is not”:
  - It is not an approval, certification, or Mark!!!
  - It is not a quality mark
  - It is not for sales or marketing purposes
  - Customers may expect more (e.g., Marks for safety)



[More CE info](http://www.e-insite.net/ednmag/archives/1997/010297/01df_06.htm) > [http://www.e-insite.net/ednmag/archives/1997/010297/01df\\_06.htm](http://www.e-insite.net/ednmag/archives/1997/010297/01df_06.htm)

# Certification Bodies and Safety Marks

- **U.S. “Nationally Recognized Test Laboratory” (NRTL)**

- Valid in U.S. and OSHA sanctioned, listed in *Federal Register*
- U.S. (UL) standards used
- NRTL’s: UL, CSA, others



- **European “Notified Body”**

- National and EU recognition per *Official Journal of the EC (OJ)*
- EN standards used (similar to IEC standards)
- Notified Bodies: VDE, TUV, Demko, others



- **International “Certification Body” (CB) [no mark]**

- CB Scheme on mutual recognition of testing for Marks
- IEC standards used
- CB’s: VDE, TUV, Demko, UL, CSA, others (>50 CB’s)

# Standards Development

## ➤ Things to know

- UL standards applicable in U.S. and similar to IEC
- IEC standards are the basis for EN and others
- EN (European Norm) [standard] required for CE marking
- Europe drove standards in past, now it's the Tech Committee (TC)

## ➤ Standards process

1. IEC standard published (e.g., IEC 61010-1) and used by some
  - Canada CSA C22.2 No 1010.1
  - U.S. UL 61010-1 (future)
2. EN standard ratified and transposed into national standards
  - Germany DIN EN 61010-1
  - Britain BS EN 61010-1
  - France NF EN 61010-1
3. Conflicting national standards withdrawn (DOW) in EU





# Standards for Test and Measurement Equip

Standard	Scope
<b>IEC 61010-1</b> (EN 61010-1)	<b>Safety of Electrical Equipment for use in:</b> <b>1) Test &amp; Measurement, 2) Control, 3) Laboratory</b>  <b><i>“All three in one”!</i></b>
<b>UL 61010B-1 *</b> (was UL 3111-1)	<b>Measurement and Test Equipment</b>
<b>UL 61010C-1 *</b> (was UL 3121-1)	<b>Process Control Equipment</b>
<b>UL 61010A-1 *</b> (was UL 3101-1)	<b>Laboratory Equipment</b>

\* NOTE: UL standards are based on IEC 61010-1:1990, First Edition, with national differences. IEC 61010-1:2001, Second Edition, now in use in many countries. UL standards to become UL 61010-1 in 2004, based on Second Edition.

# General Hazards Addressed by IEC 61010-1

- Electric shock
- Energy
- Fire
- Heat
- Mechanical
- Radiation
- Liberated gases/chemicals
- Sound



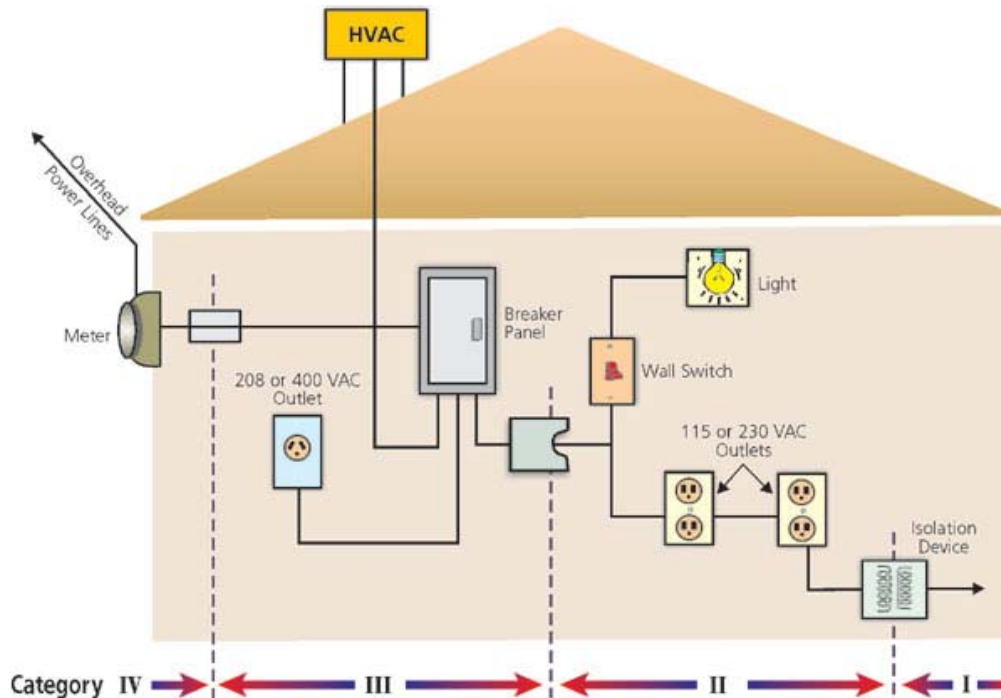
# Safety Terms

- Accessible part
- Mains
- Protective Earth (PE)
- Hazardous Live
- Low Voltage
- Safety Extra-Low Voltage (SELV)
- Normal Condition
- Single Fault Condition
- Basic Insulation
- Supplementary Insulation
- Double/Reinforced Insulation
- Product vs. Component
- Safety-Critical Components
- Comparative Tracking Index (CTI)
- Creepage and Clearance Distance
- Pollution Degree
- Measurement (Installation) Category
- Ingress Protection (IP)
- Operator & Service Access Areas
- Fixed Equipment
- Portable Equipment
- Flammability: V-0, V-1, HB

# Pollution Degree – Environmental Conditions

- Moisture or dust may reduce insulation capability
- Higher degrees = larger distances (PWB's, components)
- Pollution Degrees per IEC 61010-1:
  - 1 – No pollution or only dry, non-conductive (no effect)
  - 2 – Temp conductivity caused by condensation expected
  - 3 – Conductive or dry, non-conductive (harsh environmental)

# Measurement Category – Transient Overvoltage



EE – Evaluation Engineering Nov 2003

## Overvoltage Examples

Working Voltage – CAT	Overvoltage
50V – CAT I	400V
300V – CAT II	2,500V
400V – CAT III	4,000V
600V – CAT IV	8,000V

Values are approximate and vary between standards. Other examples possible. Refer to standard for actual values.

✓ *Like Poll Degree, higher CAT's also mean larger distances & components!*

**CAT I** – For measurements not directly connect to the Mains, such as telecom, electronic, etc

**CAT II** – For measurements that may be connected to Mains voltages (115/230Vac)

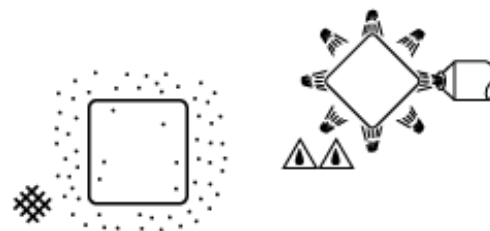
**CAT III** – For measurements in building distribution such as fixed installation, circuit breakers

**CAT IV** – For measurements on the primary overhead electrical supply lines (<1,000V)

# Enclosure Rating Systems – Objects & Moisture

## IEC 60529 Ingress Protection (IP) System

1 <sup>st</sup> digit	Protection from solid objects	2 <sup>nd</sup> digit	Protection from moisture
0	Non-protected	0	Non-protected
1	Protected against solid objects greater than 50mm	1	Protected against dripping water
2	Protected against solid objects greater than 12mm	2	Protected against dripping water when tilted up to 15°
3	Protected against solid objects greater than 2.5mm	3	Protected against spraying water
4	Protected against solid objects greater than 1.0mm	4	Protected against splashing water
5	Dust protected	5	Protected against water jets
6	Dust tight	6	Protected against heavy seas
-	-	7	Protected against the effects of immersion
-	-	8	Protected against submersion



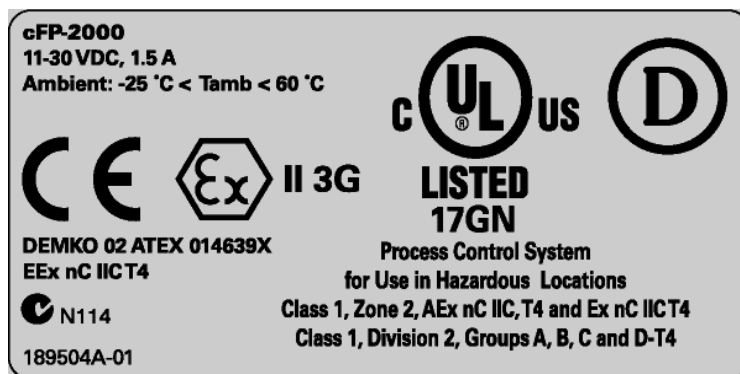
*IP 54 min typical for industrial area*

## NEMA to IEC Rating\*

NEMA Type	IEC Class
3	IP54
3R	IP54
3S	IP54
4 and 4X	IP56
5	IP52
6 and 6P	IP67
12 and 12K	IP52

\* Cannot be used to convert IEC to NEMA.

# Hazardous Locations – U.S. and Europe



Temperature  
Codes:

T1 (450°C)

T2 (300°C)

T3 (200°C)

T4 (135°C)

T5 (100°C)

T6 (85°C)

- **“Source” of ignition:**
  - **Arcs and sparks** in operation of product, like motors, contactors, switching, plug/unplug comp’s
  - **High temperatures** from lamps and lighting fixtures can ignite hazardous materials
  - **Electrical failure** like, burnt out lamp socket or terminal short
- **“Class” defines the type of hazard (location examples):**
  - **Class I** – Flammable gases, vapors, and liquids (gas refineries, dry cleaners, spray painting)
  - **Class II** – Combustible dusts (grain elevators, flour/feed mills, Mg/Al plants, spice/coal manuf)
  - **Class III** – Ignitable fibers and flyings (textile and cotton mills, wood processing)
- **“Division” defines severity of hazard (Ex Zone similar to U.S. Division; Class I):**
  - **Div I** – Exists all or some of the time under normal operating conditions (greater than 10hr/yr)
  - **Div II** – Not likely to exist under normal operating conditions (1-10 hr/yr)

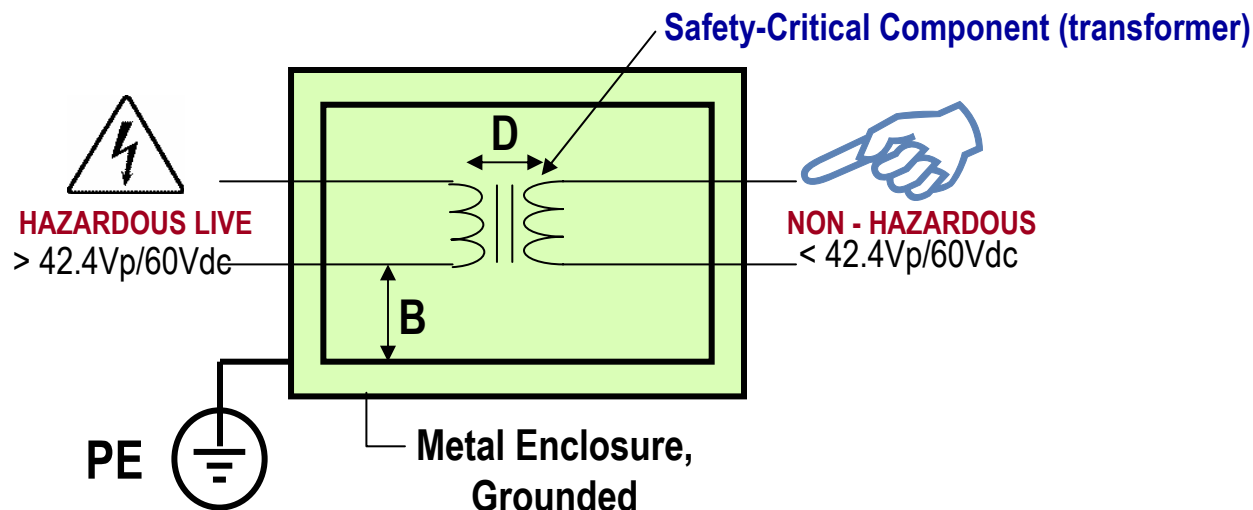
# Safety Concept – Voltage Limits and Insulation

- Safe Voltage Limits (Non-Hazardous):

- U.S:  $30V_{rms}$  and  $42.4V_p$  or  $60V_{dc}$  max

- Europe (U.S. in future):  $33V_{rms}$  and  $46.7V_p$  or  $70V_{dc}$  max

- Basic vs. Double/Reinforced Insulation:



D = Double insulation  
B = Basic insulation  
PE = Protective Earth



# U.S. and EU Safety Differences

Safety focus differs between experts in the U.S. and Europe, which may result in differing interpretations of the same standard.

Product Rating Example; EU: **230V, 3A** vs. U.S.: **115V, 6A**

**High Voltage in Europe → "SHOCK" Hazard!**  
**High Current in U.S. → "FIRE" Hazard!**

## EU Safety Focus, in order:

1. Component approval "Marks"\* - *testing in end-product discouraged*
2. Construction and design
3. Testing

## U.S. Safety Focus, in order:

1. Testing & plastics (flammability)
2. Component "Marks"\* or testing in end product
3. Construction and design

\* NOTE: UL and IEC "component standards" are not harmonized in most cases! Hence, 2 marks may be required.

# Fire Enclosure Tests

- Dangerous Flame Test for Bottom Openings:



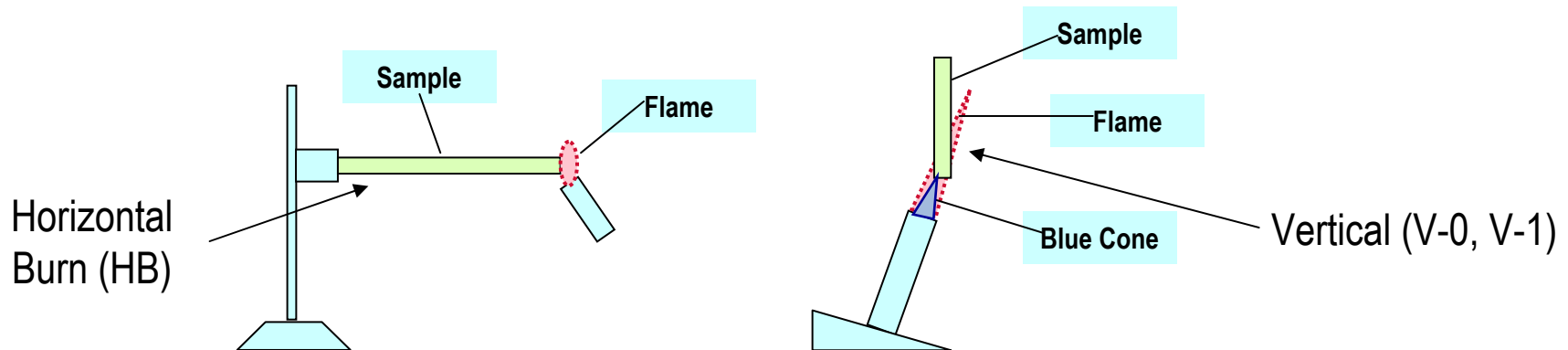
See > <http://www.conformity.com/0211dangerous.pdf>



**UL's Infamous:**

**“Hot Flaming Oil Test”**

- Flame Tests for Plastic Materials:



# Design – Safety Design Priorities

## 1. Safety Critical Components

- Opto's, relays, xfrm's, fuses, DC/DC conv's
- PWB's, connectors
- Others



## 2. Construction and Design

- PWB spacings and layout
- Enclosures and materials
- Labels and documentation



## 3. Testing

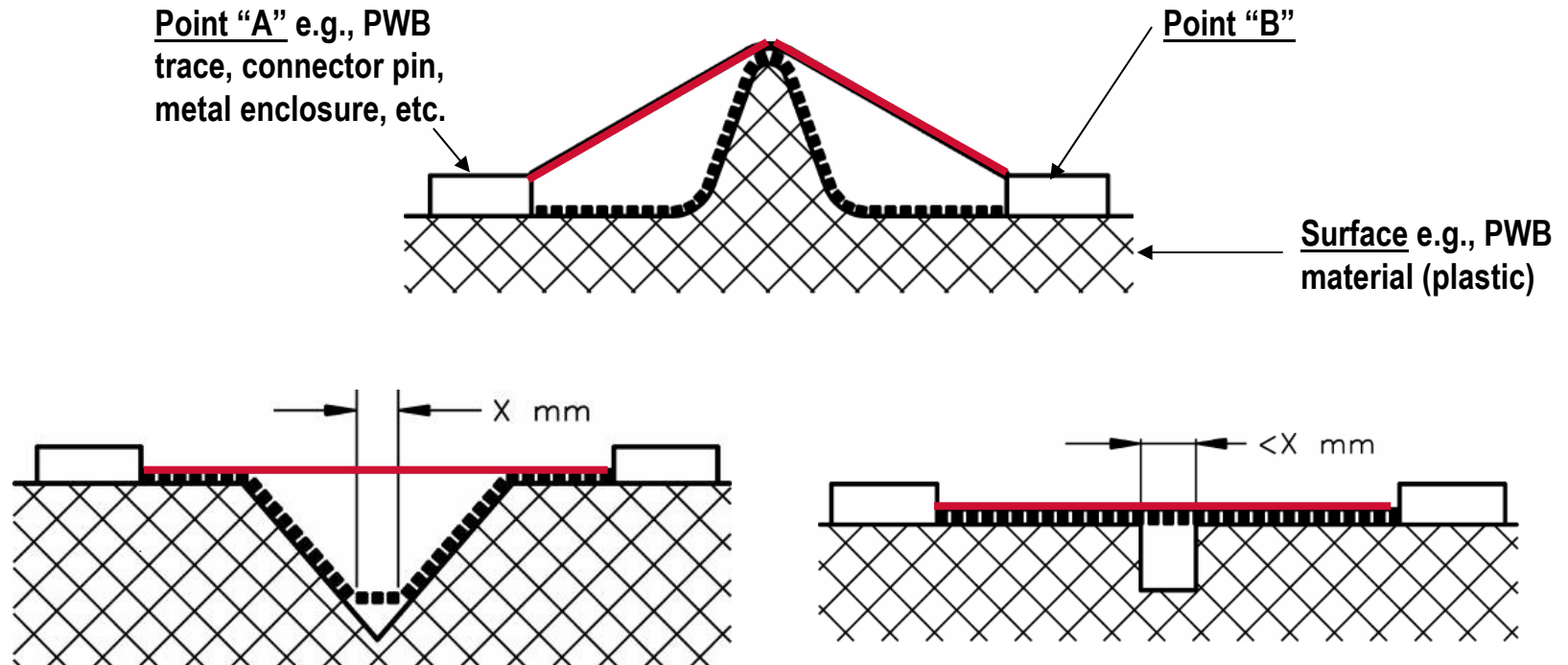
- Dielectric (hi-pot)
- Temperature
- Abnormal's (shorts, blocked fans), others



# Design – Safety Critical Components

- **What's a Safety Critical Component?**
  - Working voltage (hazardous) >42.4Vp and bridges hazardous to SELV
  - Hazardous working voltage and user accessible
  - Circuit/thermal protection and others affecting safety
- **What do we need?**
  - Two approval marks (usually): 1) UL and 2) VDE (IEC)/other (**UL ≠ IEC**)
  - Used within ratings and meets end-product standards
  - Copy of certificate to verify standard/s, ratings and part number
- **What are the pitfalls?**
  - Spec says it is “approved” but it is “not marked” with UL and VDE
  - Accepting non-approved component for test in end product
  - Spec says it's “designed to meet” or has “CE”

# Design – Creepage and Clearance



- Dotted line = Creepage (distance along a surface)
- Solid line = Clearance (distance through air)
- $X = 1.0\text{mm}$  for Pollution Degree 2
- Groove width  $<X$ , ignore groove

# Design – Insulation Values

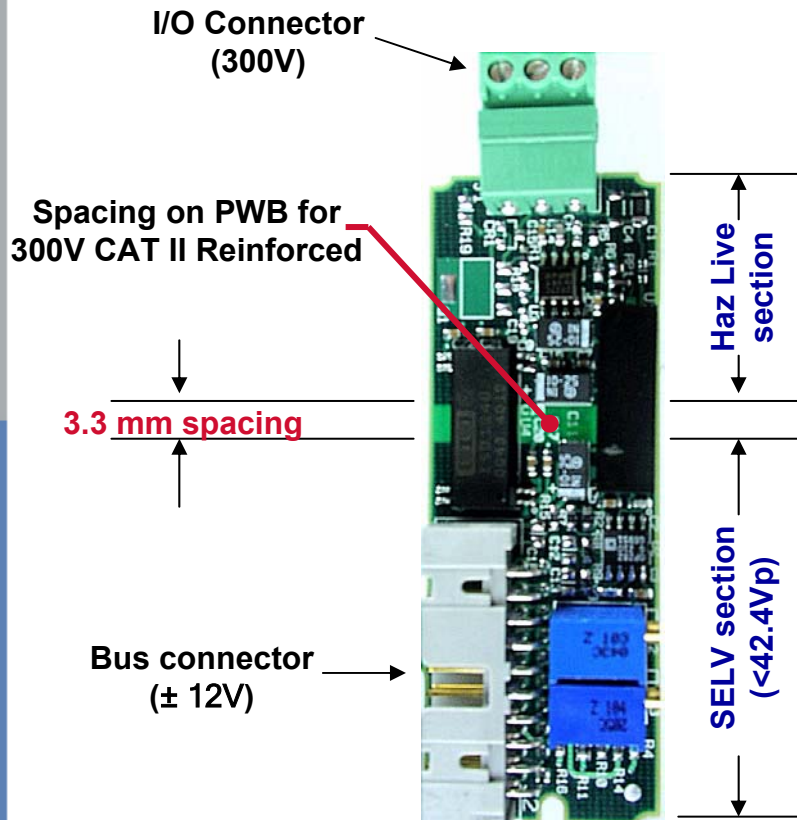
Creepage and Clearance Distances per IEC 61010-1							
<u>BASIC</u> Insulation Pollution Degree 2, Installation Category II				<u>DOUBLE</u> or <u>REINFORCED</u> Insulation Pollution Degree 2, Installation Category II			
Working Voltage rms or dc up to:	Clearance	Creepage in Equip CTI>100	Creepage on PWB CTI>175	Working Voltage rms or dc up to:	Clearance	Creepage in Equip CTI>100	Creepage on PWB CTI>175
50	0.2	1.2	0.2	50	0.2	2.4	0.4
100	0.2	1.4	0.2	100	0.4	2.8	0.4
150	0.5	1.6	0.5	150	1.6	3.2	1.6
300	1.5	3.0	1.5	300	3.3	6.0	3.3
600	3.4	6.0	3.0	600	6.5	12.0	6.5
1000	5.5	10.0	5.5	1000	11.5	20.0	11.5

**300V spacings on PWB and In Equipment (components, etc)**

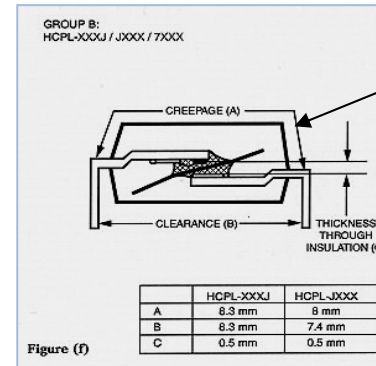
Interpolation of creepage is permissible. Creepage shall always be at least as large as clearance. PWB conformal coatings do not reduce creepage. All distances in mm and PWB not coated. IEC 61010-1:1990 1<sup>st</sup> edition values above. See standards for other insulation tables and to verify values.

# Design – Insulation Distance Examples

## 1) On Printed Wiring Board:

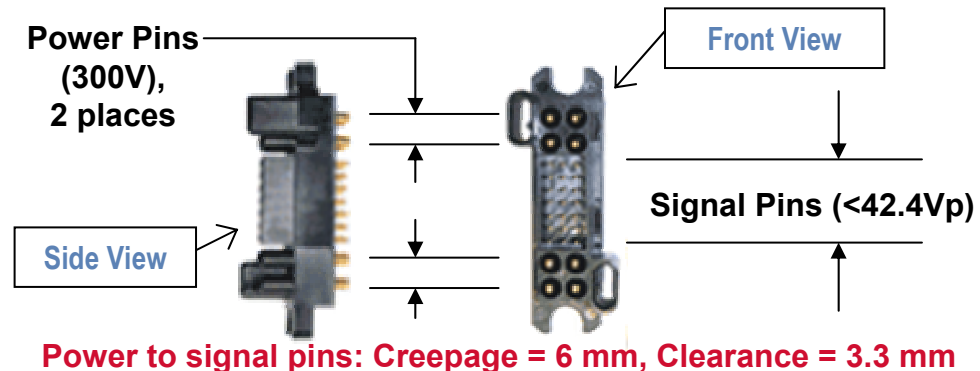


## 2) Opto In Equipment:



6.0 mm creepage across opto surface, input to output pins

## 3) Power/Signal connector In Equipment:



# Design – Safety Tests

- **Type Tests**

- Dielectric withstand
- Ground continuity
- Input power consumption
- Voltage limits
- Capacitor discharge
- Stability and impact
- Earth leakage
- Temperature rise
- Abnormal and fault Conditions
- Special tests e.g., HazLoc

- **Routine Tests (production)**

- Dielectric withstand
- Ground continuity



Note: Other tests may be required.



# Product Certification on *ni.com* ([www.ni.com/hardref.nsf](http://www.ni.com/hardref.nsf))

## Access NI Product Certifications:

- 1) “Support” tab (top), then “Product Reference” (side bar) and then “Product Certification,” or type ‘Product Certification’ into “Search” box and click “Go”
- 2) Now search for product certification by Model Number or Product Line or Table

**Product Certification**

National Instruments (NI) products comply with the applicable International requirements for product safety, electromagnetic compatibility (EMC), quality, and for use in hazardous locations. Look for the Mark's on the product label for verification of certification.

[Search All Products \(by Model Number\)](#) | [Browse All Products \(by Product Line\)](#)

Symbol	Title
CE	European Union EMC and Safety
FCC	North American EMI
C-Tick	Australian EMC
UL	North American Product Safety
Derko or VDE	European Union Product Safety
UL	North American Hazardous Locations
Ex	European Union Hazardous Locations
ISO 9002	Quality Management System

**Additional Product Certification Information**  
[Detailed Product Certification Descriptions](#)  
[NI Product Safety Certification and Standards Reference Table](#)  
[NI Product HardLoc Certification and Standards Reference Table](#)  
[NI Product EMC Standards and Doc's Reference Table](#)

# Product Certification – cFP-2000 Example

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- Top Hardware Solutions
- Product Reference
  - Drivers and Updates
  - Manuals
  - Hardware Conformity and Schematics
    - Declarations of Conformity
    - Dimensional Drawings
  - Year 2000 Compatibility Archive
  - Troubleshooting
  - Support Utilities
- Request Support from an engineer

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## cFP-2000 - Product Certification

This product meets the following certifications and standards:

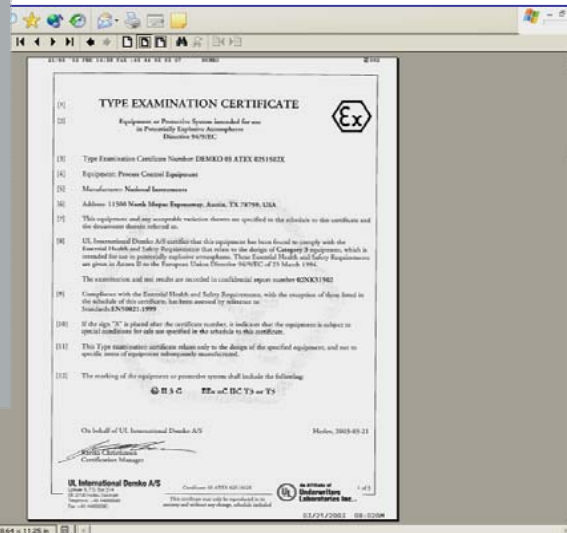
Symbol	Description	Certification
CE	<a href="#">CE - European Union EMC and Safety Compliance</a> The CE marking and Declaration of Conformity (DoC) is NI's statement assuring compliance to the European Union directives and standards for electromagnetic compatibility (EMC) and product safety.	<a href="#">View (1.25 MB PDF)</a>
FCC	<a href="#">FCC - North American EMI Verification</a> The Federal Communications Commission (FCC) enacted electromagnetic-interference (EMI) regulations for various electronic equipment. NI products comply with U.S. and Canadian EMI Class A requirements. (FCC Mark not applicable for Class A products)	
C-Tick	<a href="#">C-Tick - Australian EMC Compliance</a> The Australian Communications Authority (ACA) regulations require EMC compliance for electronic products. NI products bear the C-Tick Mark, which indicates compliance with Australian EMI standards.	
UL	<a href="#">UL - North American Product Safety Certification</a> The UL Mark on a product means that it has been safety tested and meets UL requirements. The cULus Listed Mark indicates compliance with Canadian and U.S. safety standards, and gives consumers the safety assurance they expect.	<a href="#">View the UL Cert</a>
Demko or VDE	<a href="#">Demko or VDE - European Union Product Safety Certification</a> Notified Bodies are accredited in Europe for product safety testing and certification according to European Norms (EN) with the goal to protect the health of the consumer. Notified Body Marks such as, VDE, TUV and Demko, provide independent EU support for the supplier CE marking	<a href="#">View (1.25 MB PDF)</a>
UL	<a href="#">UL - North American Hazardous Locations</a>	<a href="#">View the UL Cert</a>

cFP-2000 product certification links

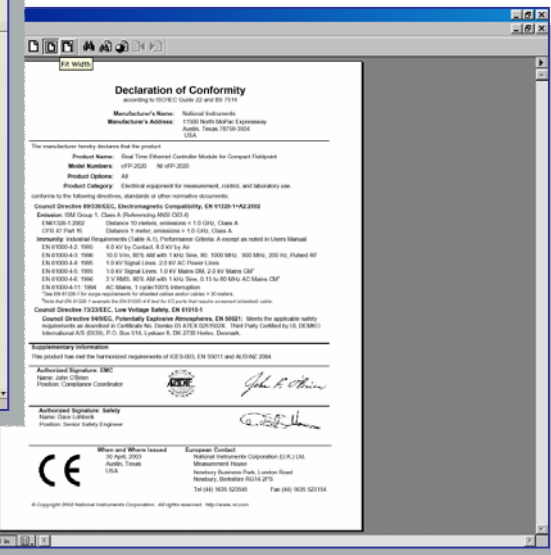
# Product Certification – Examples



## UL Certificate



## Ex HazLoc Certificate



## CE Declaration

# Product Certification and Standards Descriptions

The screenshot shows the 'Product Certification and Standards Descriptions' page on the National Instruments website. The page has a search bar at the top and a sidebar on the left with navigation links. The main content area is titled 'Product Certification and Standards Descriptions' and contains a paragraph about NI products and their compliance with international standards. Below this, there are sections for 'CE', 'FCC', 'C-Tick', 'UL', 'Dema', 'UL', 'Ex', and 'ISO 9002', each with a brief description and a link to 'more info'. At the bottom, there is a section for 'EMC' with a link to 'more info'.

The screenshot shows the 'Product Safety' section on the National Instruments website. It contains three main sections: 'UL - North American Product Safety Certification', 'Dema or VDE - European Union Product Safety Certification', and 'UL - North American Hazardous Locations Certification'. Each section provides a brief description of the certification and a link to 'more info'. At the bottom, there is a section for 'Ex - European Union Hazardous Locations Certification' with a link to 'more info'.

The screenshot shows the 'Standards and Certification' section on the National Instruments website. It contains a paragraph about standards and certification, followed by a table titled 'Product Safety Standards' and a table titled 'EMC Standards'.

International <sup>1</sup>	Europe <sup>2</sup>	U.S., Canada <sup>3,4</sup>
Measurement		
IEC 61010-1	EN 61010-1	UL 3111-1 UL 61010B-1 CSA C22.2 No. 1010.1
Control		
IEC 61010-1	EN 61010-1	UL 3121-1 UL 61010C-1 CSA C22.2 No. 1010.1
Laboratory		
IEC 61010-1	EN 61010-1	UL 3101-1 UL 61010A-1 CSA C22.2 No. 1010.1

International	Europe	U.S./Canada
IEC 61326	EN 61326	FCC Part 15
CISPR 11	EN 55011	ICES-003

This page describes NI Product Certifications and Standards with links to more info. Access from links to the right of Marks or from link at bottom of Product Certification page.

# Questions and Answers



**FOR MORE INFORMATION SEE:**

**[www.ni.com/hardref.nsf](http://www.ni.com/hardref.nsf)**