



Comparing Equipment Enclosure Classifications

Selecting UL50 Equipment Enclosures
for IEC 60529 Applications

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Transfer switches are available with distinct types of enclosures designed for indoor or outdoor use. Selecting the most appropriate type helps ensure that a transfer switch will provide reliable performance. This document summarizes the similarities and differences between global enclosure standards.

INDUSTRY STANDARDS

Three standards specify requirements for enclosures used with transfer switch equipment:

1. *International Electrotechnical Commission (IEC) International Standard 60529 — Degrees of Protection Provided by Enclosures* sets forth design and test standards used in many regions of the world, including European, Mideastern, and Asian nations.
2. *National Electrical Manufacturers Association NEMA 250 — Enclosures for Electrical Equipment (1000 Volts Maximum)* sets forth design and test standards that are used in North America, certain countries in Central and South America, and other select locations.
3. *Underwriters Laboratories UL 50 — Enclosures for Electrical Equipment, Non- Environmental Considerations* contains additional testing provisions. It is also used in North America, certain countries in Central and South America, and other select locations.

Topics addressed by all three standards include (1) protection of persons from hazards inside enclosures, (2) protection of equipment from ingress of objects including dust, and (3) protection from water ingress or its effects. NEMA 250 and UL 50 both address environmental characteristics not covered by IEC 60529. The NEMA and UL standards have similar, although not identical, definitions and provisions. These two documents also provide standards for enclosure construction, while IEC 60529 does not. As a result, an IEC 60529 IP code cannot be said to be equivalent to any NEMA 250 or UL 50 Type. The scope of each standard is compared in Table 1.

Table 1: Scope of Enclosure Standards

Characteristic	IEC 60529	NEMA 250	UL 50
Protection from Human Contact	X	X	X
Protection from Solids Ingress	X	X	X
Protection from Water Ingress	X	X	X
Environmental Requirements			
Design Requirements		X	X
Construction Requirements		X	X
Mechanical Impact		X	X
Sheet Metal Thickness		X	X
Gasket Aging		X	X
Oil Resistance		X	X
Materials/Finishes/Corrosion Resistance		X	X
Third-Party Oversight			
Third-Party Laboratory Testing			X
Third-Party Factory Inspection			X

While the scopes of NEMA 250 and UL 50 are similar, they differ in testing requirements. NEMA 250, like IEC 60529, does not require equipment manufacturers to obtain independent testing services but allows for manufacturers to self-declare compliance. As a result, manufacturers may interpret and implement aspects of the standards differently.

UL 50 requires testing of equipment and periodic factory inspections directly by UL or a UL-approved laboratory or representative. Consequently, UL listings leave fewer matters to interpretation by manufacturers. ASCO supplies UL 50-listed enclosures because they are subject to third-party testing and inspection requirements.

IEC 60529 PROTECTION CODES

IEC 60529 addresses protection from ingress of solid objects and water. Classification codes are thus comprised of the letters “IP” (Ingress Protection) plus two numerals. These numerals represent degrees of protection against entry of solid objects and water into an enclosure, as shown in Figure 1. Where applicable, “X” can be used to designate one of the two code fields as unassigned. Additional letters can be appended for specific characteristics.

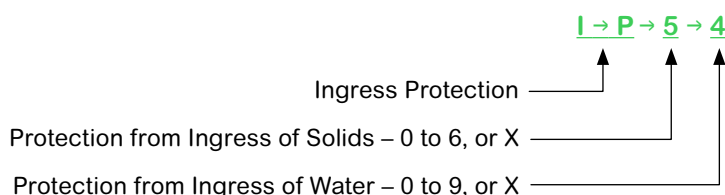


Figure 1: IP Code Key

First Numeral – Solids

The first IP code numeral indicates the extent to which equipment is protected from both solid objects and persons. Definitions for the first numeric position, which designates a level of protection against ingress of solids, are shown in Table 2.

Table 2: Key to First IP Character Protection Against Ingress of Solid Foreign Objects and Hazardous Parts		
Numeral	Meaning	Specification
0	Not Protected	–
1	≥ 50 mm dia.	An access probe sphere of 50 mm dia. shall not penetrate and shall have adequate clearance for hazardous parts
2	≥ 12.5 mm dia.	An access probe sphere of 12.5 mm dia. shall not penetrate and shall have adequate clearance for hazardous parts
3	≥ 2.5 mm dia.	An access probe sphere of 2.5 mm dia. shall not penetrate and shall have adequate clearance for hazardous parts
4	≥ 1 mm dia.	An access probe sphere of 1 mm dia. shall not penetrate and shall have adequate clearance for hazardous parts
5	Dust-Protected	Ingress of dust not totally prevented, but dust shall not interfere with operation or impair safety
6	Dust-Tight	No ingress of dust

Second Numeral – Water

The second numeral indicates the extent to which equipment is protected from water ingress. Definitions for the second IP numeric position are shown in Table 3.

Table 3: Key to Second IP Character
Protection of Equipment Against Ingress of Water

Numeral	Meaning	Specification
0	Not Protected	–
1	Vertically Dripping	Vertically falling drops shall have no harmful effects
2	Dripping	Vertically falling drops shall have no harmful effects when the enclosure is tilted at any angle up to 15 degrees on either side of vertical
3	Spraying	Water sprayed at an angle of up to 60 degrees on either side of vertical shall have no harmful effects
4	Splashing	Water splashed against the enclosure from any direction shall have no harmful effects
5	Jetting	Water projected in jets from any direction against the enclosure shall have no harmful effects
6	Powerful Jetting	Water projected in powerful jets from any direction against the enclosure shall have no harmful effects
7	Temporary Immersion	Ingress of water in quantities causing harmful effects shall not be possible when the enclosure is temporarily immersed in water under standardized conditions of pressure and time
8	Continuous Immersion	Ingress of water in quantities causing harmful effects shall not be possible when the enclosure is continuously immersed in water under conditions that shall be agreed to between the manufacturer and user, but which are more severe than numeral 7
9	High Pressure and Temperature Jetting	Water projected at high pressure and high temperature against the enclosure from any direction shall not have harmful effects

The IEC standard further provides test methods and conditions. Manufacturers may use the results to self-declare an IP code for an enclosure, indicating distinct first and second characters to describe protections from solids and water, respectively.

UL 50 AND NEMA 250 ENCLOSURE TYPES

UL 50 defines “Types” to classify the protective characteristics of enclosures. Every UL Type provides “a degree of protection” against ingress of solids and inadvertent human contact with hazardous equipment components. A Type is assigned following testing by UL or in a UL-authorized laboratory. The solids and water ingress protections of UL 50 enclosure types are shown in Table 4, which presents the Types commonly used for transfer switch equipment. UL 50 Type definitions are closely similar to those for NEMA 250 Types. Consequently, the NEMA 250 definitions are not redundantly presented here.

Table 4: UL 50 Type Definitions

Type	Definition
1	Enclosures constructed for indoor use to provide a degree of protection to personnel against access to hazardous parts and to provide a degree of protection against ingress of solid objects (falling dirt).
3R, 3RX*	Enclosures constructed for indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection against ingress of foreign solid objects (falling dirt); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, and snow); and that will be undamaged by the external formation of ice on the enclosure.
4, 4X*	Enclosures constructed for indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection against ingress of solid objects (falling dirt and windblown dust); provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow, splashing water, and hose-directed water) and that will be undamaged by the external formation of ice on the enclosure.
12	Enclosures constructed (without knockouts) for indoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection against ingress of solid objects (falling dirt and circulating dust, lint, fibers, and flyings); provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (dripping and light splashing); and to provide a degree of protection against light splashing and subsequent seepage of oil and non-corrosive coolants.

Note: “X” suffix indicates a degree of protection against corrosion.

Of the various UL 50 types, Type 1 and Type 12 enclosures are used most often for indoor applications, and Types 3R, 3RX, 4, and 4X are prevalent in outdoor use. These are the enclosure types that ASCO offers for its UL 1008-listed transfer switches. Their key characteristics are summarized in Table 5.

Table 5: Attributes of Commonly Used UL 50 Types

Environmental Condition	1	3R	3RX	4	4X	12
Incidental Contact	X	X	X	X	X	X
Rain, Snow, Sleet	-	X	X	X	X	-
Falling Dirt	X	X	X	X	X	X
Windblown Dust	-	-	-	X	X	-
Dripping Liquid, Light Splashing	-	-	-	-	-	X
Ice	-	X	X	X	X	-
Dust, Lint, Fibers, Flyings	-	-	-	X	X	X
Splashing Water	-	-	-	X	X	-
Hose-Directed Water	-	-	-	X	X	
Oil and Coolant Seepage	-	-	-	-	-	X
Corrosive Agents	-	-	X	-	X	-

COMPARING UL TYPES TO IP CODES

As noted, UL 50 and NEMA 250 identify characteristics not addressed or tested under IEC 60529. Consequently, an IP-coded product cannot be used to comply with requirements of a specific UL 50 or NEMA 250 Type, but a UL 50 or NEMA 250 Type enclosure may be used to provide similar protection offered by an IP-coded product. Based on Table A-1 in the NEMA 250 standard, Table 6 below shows how NEMA Types meet or exceed specific IP code protections. Provided for informational purposes only, Table 6 is not intended to demonstrate full compliance between each detail presented in the respective standards.

Table 6: NEMA 250 – IP Comparison Overview

IP 1 st Character	NEMA Enclosure Type								IP 2 nd Character
	1		3R, 3RX		4, 4X		12		
IP 0_									IP _0
IP 1_									IP _1
IP 2_									IP _2
IP 3_									IP _3
IP 4_									IP _4
IP 5_									IP _5
IP 6_									IP _6
	A	B	A	B	A	B	A	B	

Notes:
A = A shaded block in the “A” column indicates that the NEMA Enclosure Type exceeds the requirements for the respective ANSI/IEC 60529 IP First Character Designation for protection against access to hazardous parts and solid foreign objects.
B = A shaded block in the “B” column indicates that the NEMA Enclosure Type exceeds the requirements for the respective ANSI/IEC 60529 IP Second Character Designation for protection against the ingress of water.

Because the UL 50 and NEMA 250 Type definitions are nearly identical, it is reasonable to extend the comparisons in Table 6 to UL 50 Types. This produces the comparable IP codes shown in Table 7, which presents the enclosure types most used for transfer switching equipment.

Table 7: Enclosure Classification Comparison^{1,2}

Each row shows how a UL 50/NEMA 250 Type may meet or exceed an IP Classification.
This information cannot be used to demonstrate that an IP Classification meets NEMA 250/UL 50 requirements.

UL 50 TYPE - Independently Tested NEMA 250 TYPE - Manufacturer-Declared		ANSI/IEC 60529 IP CLASSIFICATION Manufacturer-Declared	
1	Indoor ³ Incidental Contact Falling Dirt	20	Objects ≥ 50 mm dia.
3R, 3RX⁴	Indoor or outdoor Incidental contact Falling dirt Rain, sleet, snow, and effects from external formation of ice	24	Objects ≥ 12.5 mm dia. Splashing Water
4, 4X	Indoor or outdoor Incidental contact Falling dirt and windblown dust Rain, sleet, snow, splashing water, hose-directed water, and effects from external formation of ice Indoor or outdoor	66	Dust-tight Water jets
12	Indoor Incidental contact Falling dirt and circulating dust, lint, fibers, and flyings Dripping and light splashing of water; and effects of seepage of oil and noncorrosive coolants	54	Dust-protected Splashing Water

Notes:

1 Based on Table A-1 in the NEMA 250 standard

2 Each cell contains language summarized from UL 50, NEMA 250, or IEC 60529 as appropriate. Always refer to the latest version of the source standards for up-to-date definitions.

3 In the source publications, every UL 50 and NEMA 250 description begins with the phrase, "Provides a degree of protection against...".

4 "X" suffix indicates a degree of protection against corrosion.

APPLICATION NOTES

Materials

The enclosure types in Table 7 address most transfer switching applications. Nevertheless, manufacturers may offer enclosures constructed of alternative materials. While cold-rolled steel is suited for several enclosure types, Type 3RX and Type 4X enclosures are available in Type 304 or Type 316 grade stainless steel for added corrosion resistance. The less expensive Type 304 steel is suited for many outdoor applications. Type 316 stainless steel can provide better protection when equipment is set in coastal marine environments, at sites near roadways where seasonal deicing salts are used, and at facilities where corrosive chemicals are present.

Some enclosures are available in aluminum, fiberglass, or other materials. These offer various levels of resistance to solvents, alkalis, and acids, and may be suitable for facilities where such substances are used.

Ventilation

High-ampacity transfer switches may generate heat in amounts that require ventilated enclosures. However, adding vents may compromise the protection offered by an enclosure type. In some instances, additional protective measures may be warranted such as placing the equipment in a shed or other protective shelter. Consult a qualified manufacturer's representative when evaluating enclosures for high-amperage equipment or applications subject to elevated ambient temperatures.

Placement in Lineups

Connecting enclosures in rows can reduce enclosure protection because connecting hardware and associated holes could allow particulate and water ingress. Without further protective measures, connective features could render outdoor-rated enclosures noncompliant with their type definitions. Consequently, equipment lineups are typically constructed where UL 50 Type 1 enclosures can be used.

Secure Enclosures

When transfer switches are deployed outdoors, exposure to sunlight and its associated heat gain are sometimes overlooked. For equipment with single-door construction, displays and controls can be degraded by ultraviolet radiation from sunlight and by other environmental effects. In addition, unprotected displays and controls present a security risk from vandals. Specifying locking “door-over-door” enclosures can limit environmental exposures and reduce risks of inadvertent contact, unauthorized operation, and vandalism. Learn more in the ASCO white paper entitled [Selecting Secure Enclosures to Protect Equipment from Ultraviolet Radiation](#).

SUMMARY

IEC 60529, NEMA 250, and UL 50 each address the protection of persons from hazards inside enclosures as well as the protection of equipment from ingress of objects and water. Because UL 50 and NEMA 250 Types apply criteria not included by IP Codes, IP codes are not directly equivalent to any NEMA 250 or UL 50 Type. Nevertheless, the protection offered by specific NEMA and UL Types may meet or exceed the protection offered by specific IP codes, as shown in Table 7 of this document. Notably, only the UL 50 standard requires independent verification of the performance of enclosures.

REFERENCES

International Electrotechnical Commission, *International Standard 60529 - Degrees of Protection Provided by Enclosures*, Edition 2.2, 2013-08

National Electrical Manufacturers Association, *A Brief Comparison of NEMA 250 Enclosures for Electrical Equipment (1000 Volts Maximum) and IEC 60529 Degrees of Protection Provided by Enclosures (IP Code)*, 2021

Underwriters Laboratories, *UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations*, 14th Edition, 2024



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