North Shore Safety, Ltd.

Industrial Grade – Industrial Tough

Product Offering - A Comprehensive Line of GFCIs and ELCIs

- 15Amps through 60Amps
- 120VAC through 600VAC
- Single, Split and 3-Phase Wiring
- UL and cUL/CSA Listed
- Permanent and Portable Configurations
- Wet-Location Ratings of NEMA 4X and 6P
- Selectable Features and Settings
- Designs Suitable for Rough-Service and Extreme Operating Environments (including Explosion-Proof)

North Shore Safety GFCI/ELCI products are the heaviest duty offered in the industry and are UL/cUL and CSA listed to UL943 and UL1053 standards. Our products have designed-in safety redundancy features that exceed UL requirements and include:

- Electro-magnetic “fail-safe” contact latching
- Largest switching contacts in the industry
- Redundant circuitry for “fail-safe” operation
- Dual indication LEDs
- Availability in automatic or manual reset configurations

North Shore Safety’s GFCI/ELCIs outperform the competition’s because:

- Electro-magnetic latching outperforms troublesome mechanical latching
- They are EMI Resistant
- They have wet-location ratings to NEMA 4X and 6P standards
- They include onboard filtering
- They have a broad ambient operating range (+66degC to –35degC)
- Surge supression/protection is a standard feature

Ground Fault Circuit Interrupter

GFI or GFCI

A device intended for the protection of personnel as well as equipment. It de-energizes a circuit within an established period of time (25 milli-seconds or .025 of a second) when a current to ground (ground-fault leakage) exceeds some pre-determined value (6mA, for Class A personnel protection GFCI) which is less than that required to operate the over-current (overload) protection device (breaker or fuse) of the supply circuit.

Fact Reference

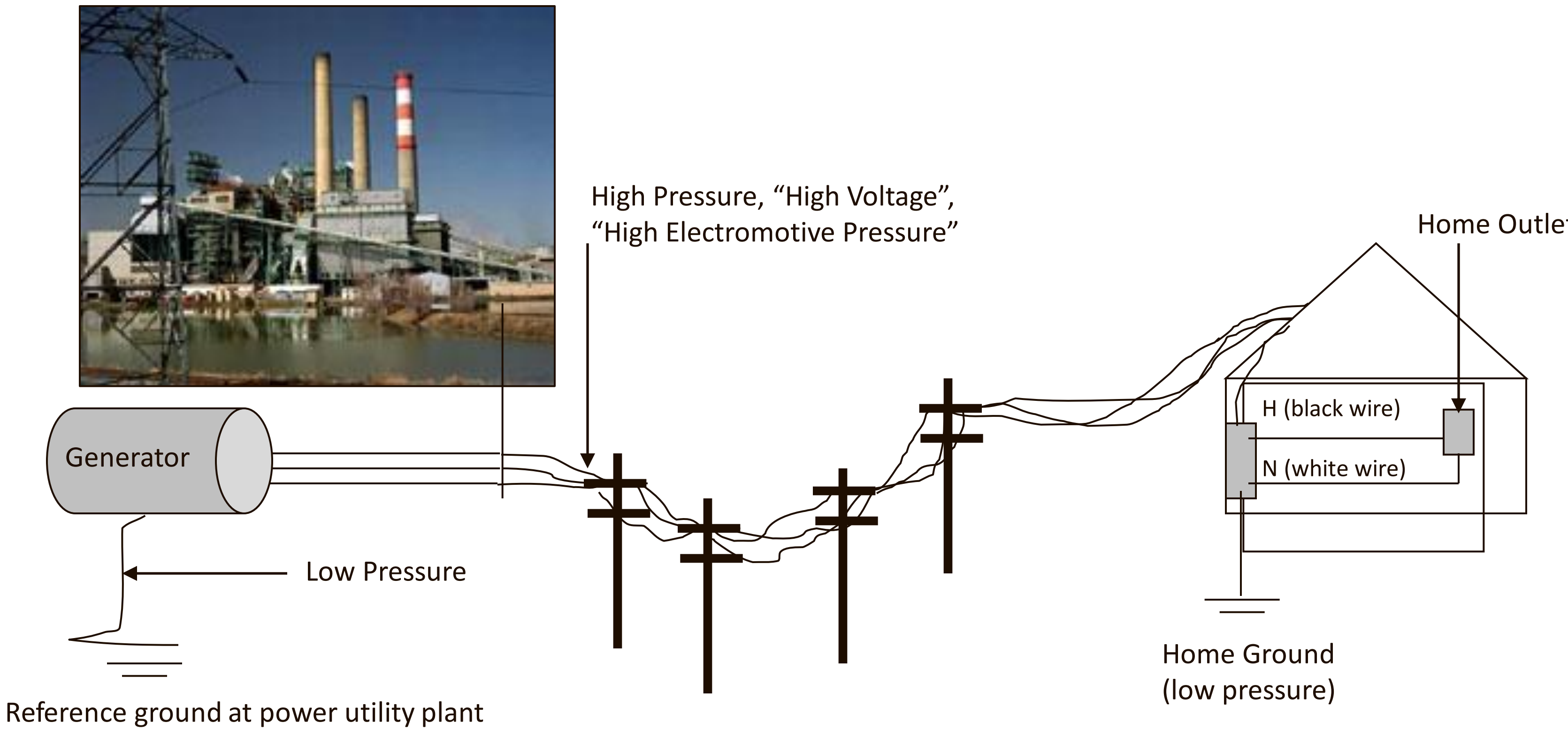
- 0.025 seconds = 1/40th of a second *or* roughly 5 times faster than the time it takes to blink your eye *or* 1 ½ harmonic cycles of a 60Hz electrical system circuit
- 6mA = 0.006 of an Amp…..or in terms of a common household 100-Watt light bulb:
- Watts = Volts X Amps = 100W
- At 120VAC there is 0.833mA. Shock-level perception is 6mA or 138 times less than the power required to energize your household light bulb.

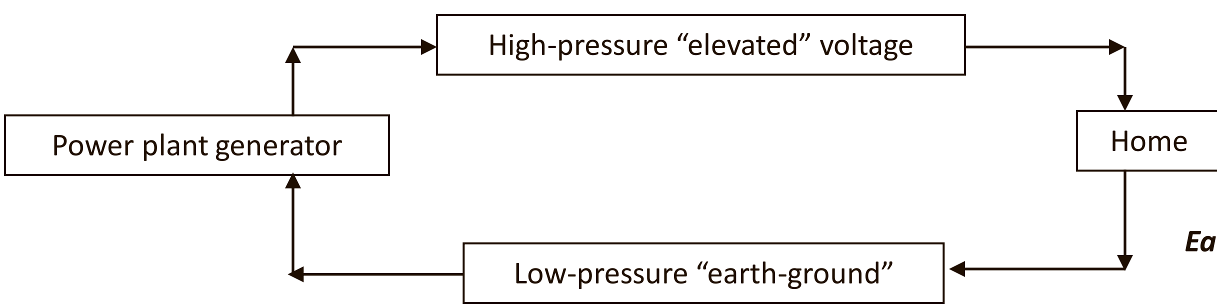
GFCI Defined by UL

Electrical circuit where all current-carrying conductors to ground are 125VAC or less.

- One current-carrying conductor must be referenced to system ground (usually neutral)
- Ground-fault trip point (threshold) setting is less than 6mA but greater than 4mA (trip point setting 4mA<x<6mA)
- Must respond within 25mS (0.025 sec=1/40th of a second) at a 500Ohm (resistance of average human) "ground-fault" short to ground.
- Must detect grounded neutral at load-side of GFCI
- Must have integrated test feature that induces an actual fault for validation of device health
- Must pass all test criteria of UL 943 standard, some of which are as follows:
  - Overload at 6x rated current - 25 cycles
  - Endurance at rated load - 6000 cycles
  - Low resistance ground faulting (shorting through fuse)
  - Extra-low resistance ground faulting (shorting with 2000 Amp supply)
  - Surge immunity
  - EMI withstand
  - Failure mode analysis
  - Environmental pre-conditioning (aging)

Earth-Grounded Electrical System



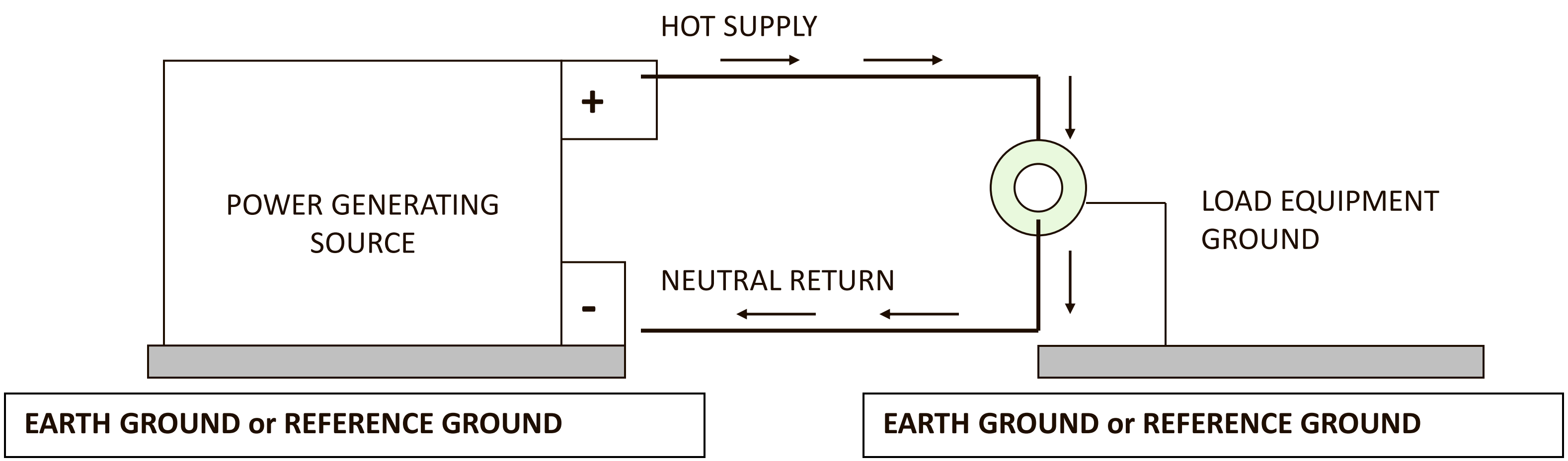


Earth-grounded electrical circuit

Typical Electrical Circuit

Note that for current to flow to an unintended path, this path must represent the lower voltage (lower pressure) reference. This is where the ground contact enters the picture. When power is generated at the origin, the voltage is referenced to a system ground. This becomes the reference point for system voltage. Thus, an elevated voltage from this reference point will represent the high potential for the electrical circuit and the current will flow from high potential (high pressure) to low potential (low pressure ground). Note that in the three-wire system consisting of a hot, neutral and ground that current flows from the power source to the load via the hot wire and then returns to the power source's system low potential via the neutral wire. Neutral and ground are at the same potential at the power source with the neutral wire as the designate conductor to carry the return current to system low potential. It is this arrangement that allows for predictable current flow and safe use of electrical power. Note that the system ground, though at the same low potential as the system neutral, is not the intended return path for return current. It instead serves as an alternative (unintended) path to return current when the hot conductor conducts current to an unintended conductive object (such as a toaster housing).

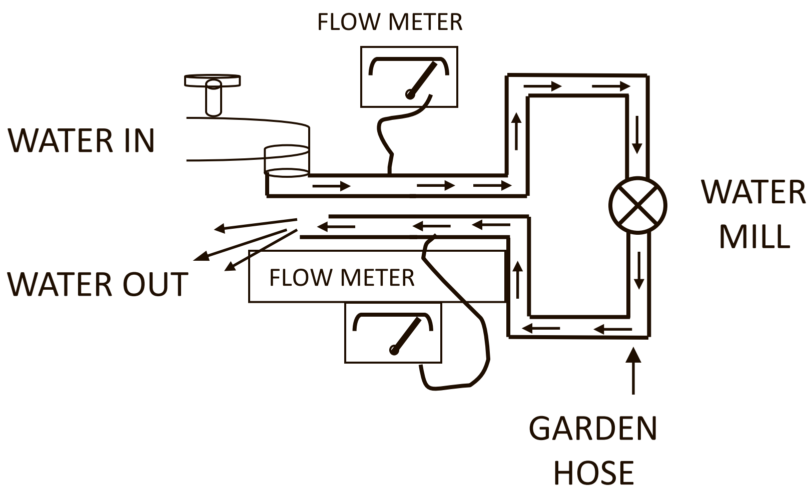
It is often misunderstood by the lay person that the ground-fault device monitors the ground conductor and looks for the presence of current. Instead, the GFCI monitors the balance of current within the acceptable current path (for example, the hot and neutral in a 120-volt system) and would detect a ground-fault condition in the absence of a wired ground.



Ground Fault Analogy

An applicable analogy is one where a garden hose is looped such that the mid-point of the loop is operating a water-mill and the two end-points start and end at the same point. This represents an acceptable electrical circuit where current flows from a power source through the hot lead to power a light bulb and then returns back to the power source via the neutral lead.

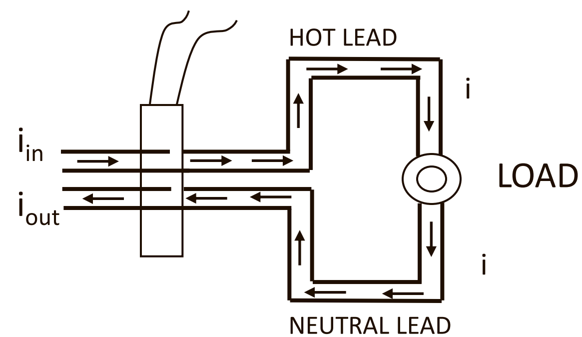
In this hydro-analogy, we can assume there is a leak in the hose if the mass flow rate of water into the system is greater than the mass flow rate of water returning from the system. In an electrical GFCI system the same can be said about current. If the current entering a circuit (through a hot lead) equals the current returning (through a neutral lead) then we have a balanced electrical system with no current leakage (ie. no ground-fault). However, if there is an imbalance in current (greater than 6mA) then we can conclude there must be a current leak through an unintended path. The detection of this leak is sensed by a current transformer (CT torriod) that reacts to a circuit current differential which triggers a switch that feeds power to the GFCI relay or contactor, and breaks the current flow.



$i_{in} = i_{out}$ = No Ground Fault

$i_{in} > i_{out}$ = Ground Fault

Current Transformer (Toroid Sensor)



<u>Notes</u>

Class A GFCI trips when $i_{in} - i_{out} > 6$mA or 0.006A

Class A GFCI does not trip if $i_{in} - i_{out} < 4$mA or 0.004A

Physiological Effects of Electrical Shock

It takes surprisingly little electrical current flowing through the human body to produce physical damage and even death. National electric code in the U.S. states that a ground-fault circuit interrupter shall respond to ground faults as low as 6 milliamps (0.006 amps). This level was determined by analyzing the physiological effects of electrical current on the most prone to shock and physical damage human profile. The NEC determined that this profile is based on a female child of 90 pounds who is well grounded and exposed to electrical current. Thus, the standard as set protects the greatest percentage of the population.

- Testing the physiological effects of electrical shock was originally performed in the late 1950s and early 1960s on pigs as the skin of a pig closely mimics the physiology of a human.
- In the early 1970s UL performed testing on humans to validate earlier testing

Findings:

- Women conduct more than men (body chemistry is more acidic in females than males)
- Muscle conducts more than fat (because of water content of muscle)
- Smaller body structure conducts more than large body structure (lower electrical resistance)

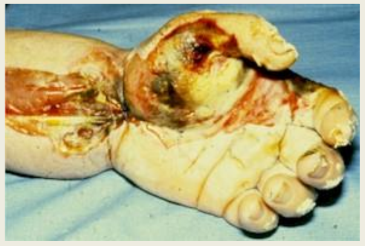
Physical Result

Exit Wound: Current flows through the body from the entrance point, until finally exiting where the body is closest to the ground. This foot suffered massive internal injuries which weren't readily visible, and had to be amputated a few days later.

This worker was shocked by a tool he was holding. The entrance wound and thermal burns from the overheated tool are apparent

Current exited this man at his knees, catching his clothing on fire and burning his upper leg.

Same hand a few days later, when massive subcutaneous tissue damage had caused severe swelling (swelling usually peaks 24-72 hours after electrical shock). To relieve pressure , which would have damaged nerves and blood vessels, the skin on the arm was cut open.



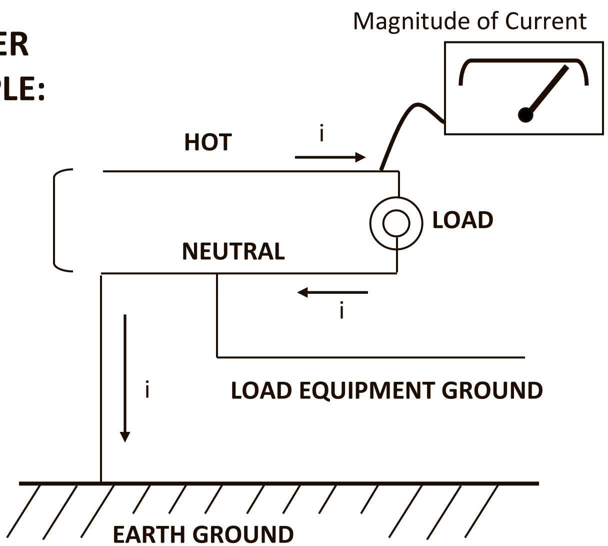
Physical Effects Scale

- 1mA - current perception level
- 6mA - elevated tingling sensation
- 10-30mA - involuntary muscle contractions (at 20mA – 50% of population can't "let go")
- 30-100mA - pain, breathing difficulties
- 100-300mA* - ventricular fibrillation, possible death (greatest point of long term damage)
- X > 300mA - respiratory paralysis, burns, unconsciousness

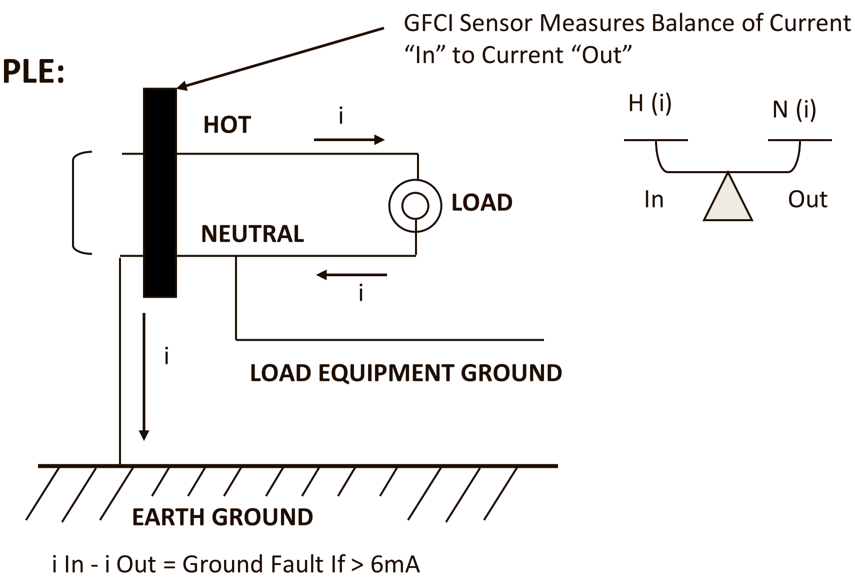
**** Zone of greatest physiological damage due to ventricular fibrillation***

- *Through the findings of the NFPA it was determined that most ground-faults with or without human interface (i.e. human shock versus equipment faulting) occurred at a leakage level well over 100mA and that most faults occur in excess of 0.50 Amps.*
  - ***In Europe, RCCB (residual current circuit breakers) are set at 20mA.***
- Note that the range of effects stated above are far less than 1 amp (1000 mA) and much less than standard home breakers which are typically rated at 15 or 20 amps (15000 or 20000 mA).
- It is important to note that a breaker and a GFCI operate completely different in scope. A breaker measures magnitude of current flowing through a circuit and a GFCI measures balance of current through a circuit.

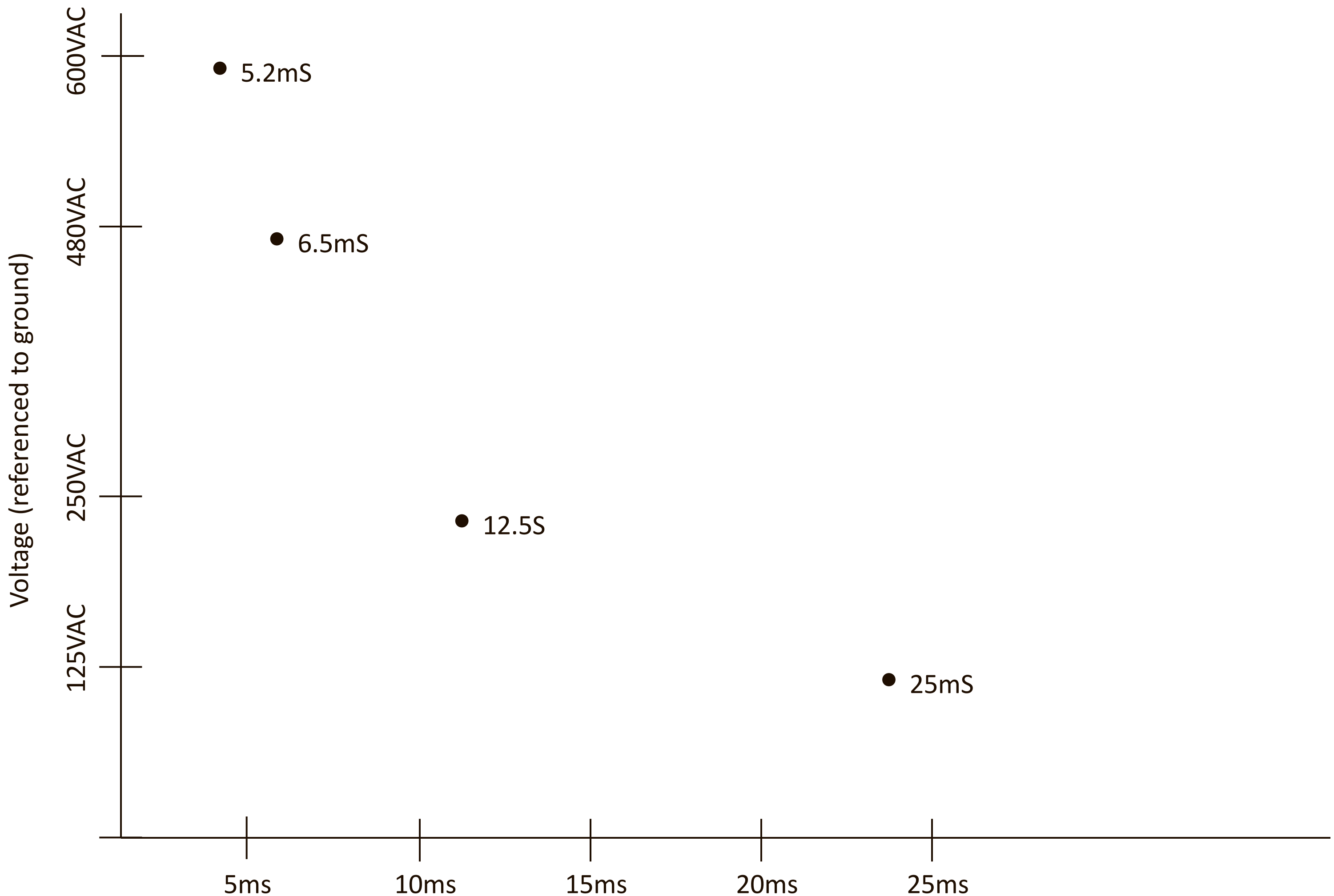
BREAKER EXAMPLE:



GFCI EXAMPLE:



Voltage versus Trip Time Analysis



Trip Time response requirement of GFCI/ELCI based on voltage to mitigate physiological damage or injury

GFCI vs. ELCI

GFCIs and ELCIs are functionally identical. However, a GFCI designation is usually reserved for a device that provides the utmost personal protection and meets the lowest threshold for human exposure to electrical current. This is quantified by NEC/OSHA/UL standards as 6mA.

On the other hand an ELCI is a device that offers a great deal of personal protection, but due to the inherent electrical requirement of an electrical circuit, it's current leakage threshold is set somewhat higher than 6mA. This threshold is usually 10mA or 30mA. The need for a higher threshold is based on the inherent leakage (by design) of some equipment. An example of a leaking device is that of an open armatured motor. Some current is leaked capacitive by air to the motor housing. This acceptable leak is seen by the ground-fault device as a ground-fault. If this leakage is large enough it may cause the GFCI to trip. If this condition happens with frequency, it is often referred to as "nuisance-tripping".

Nuisance Trip

GFCI/ELCI fault-trip caused by conditions other than those for which the device is intended to respond.

GFCI – Ground-Fault Circuit Interrupter (personnel protection) - UL 943 listed

ELCI – Equipment Leakage Circuit Interrupter (equipment/personnel protection) – UL 1053 compliant.

Typically, ELCIs target higher amperage/higher voltage applications prone to inherent equipment leakage. Keep in mind that trip thresholds of 10mA and 30mA offer a high level of protection and represent a better scenario than the alternative of no protection. Note also that with some applications there may be no alternative other than an ELCI with its higher trip thresholds.

ELCIs – (UL 1053)

Moreover, ELCIs are reserved for those circuits where voltage from any one current carrying conductor to ground exceeds the UL 943 requirement of 125 VAC or less. As seen from the previous graph; trip times for higher voltages can be far less than 25mS and are beyond current technologies for ground-fault detection and interruption.

GFCI versus ELCI Overview

- GFCIs are limited to 125VAC or less from all current-carrying conductors to system ground
- GFCIs require a trip time of 25mS or less at a 500Ohm ground-fault to system ground
- GFCIs must trip between 4 and 6mA
- ELCIs are designated for electrical circuits where voltages from current-carrying conductors to ground exceed 125VAC
- ELCIs are designated for electrical systems where higher trip thresholds are required due to inherent baseline leakage associated with system design

Variables That May Create Need for Higher Trip Thresholds

- Capacitive leakage associated with VFDs (variable frequency drives)
- Capacitive leakage associated with long load side circuit runs (metal conduit)
- Multiple loads with inherent baseline leakage
- Rapid switching and/or switch arcing
- Chaotic start-ups of multiple devices on a circuit
- Major differences in phase loading (although a GFCI/ELCI does not require balanced loading between phases)
- Large inrush of current on highly inductive loads (i.e.: inductive motors)
- Wet location environments where load side apparatus are influenced by moisture

Electrical Circuits Defined

- Single Phase
- Split Phase (dual voltage)
- Three Phase **Y** (Wye)
- Three Phase **Δ** (Delta)

Single-Phase Circuits (ground not shown for clarity)

120VAC

Hot

Neutral

120VAC *GFCI*

240VAC – 2-120VAC
Conductors to ground 180º
out of phase

L1

Ground

L2

240VAC *GFCI*

240VAC Elevated

Hot

Neutral

240 elevated from ground
neutral *ELCI*

(Europe)

Single-Phase Circuits (ground not shown for clarity) – cont.

277VAC elevated

Hot

Neutral

277 elevated from ground neutral

ELCI

(Usually single leg to ground conductor of a 277/480VAC 3-Ph circuit)

347VAC elevated

Hot

Neutral

347 elevated from ground neutral

ELCI

(Usually single leg to ground conductor of a 347/600VAC 3-Ph circuit)

Split-Phase (dual-voltage)

120/240VAC – 2-120VAC
Conductors out of phase
and referenced to neutral
180º out of phase

L1

Neutral

L2

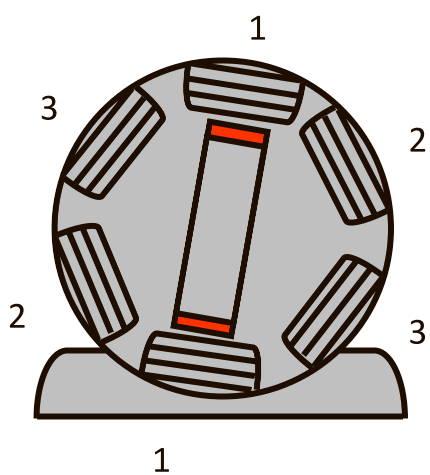
120VAC

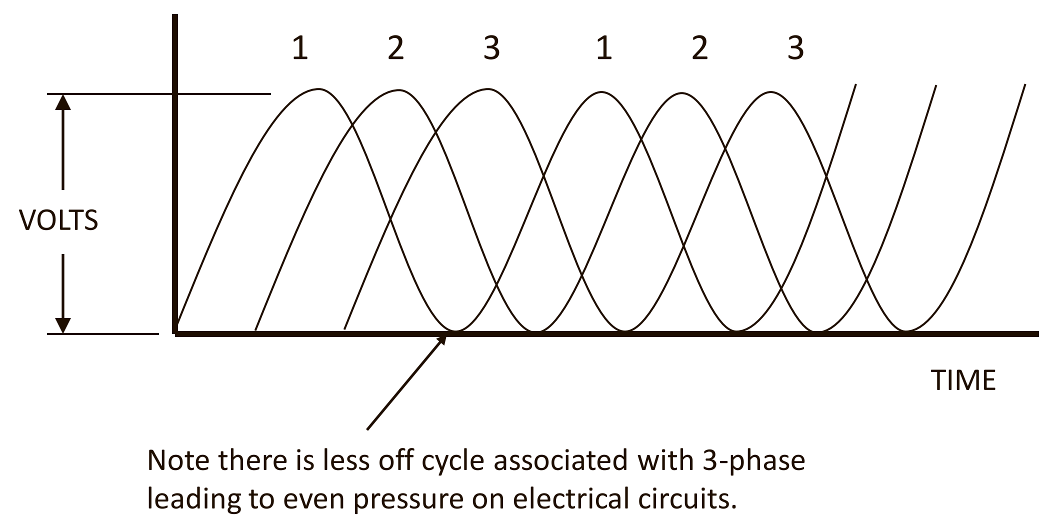
240VAC

Typical home power

3 - PHASE POWER

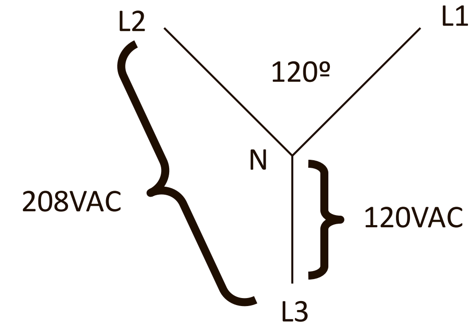
AC power has decided practical advantages over DC power in generation, transmission and distribution. Its one major drawback is the oscillatory nature of the instantaneous power flow in a single phase circuit. This oscillation can create pulsating strains on both generation and load type equipment. To reduce this strain, power is available through our utility grid in a 3-phase format. As a further bonus for power transmission, a balanced three-phase system delivers more watts per kilogram of conductor than a single phase system. For these reasons, almost all bulk electric power generation takes place in three-phase circuits (think of it as 3 conductors delivering power 120° out of phase)





3-Phase Y (WYE) (ground not shown for clarity)

Example of a 3-ph 120/208



120/208 3-ph

L1
L2
L3
Neutral

208VAC between any two legs

120VAC between any one leg & neutral (neutral is optional)

GFCI

277/480VAC 3-ph

L1
L2
L3
Neutral

480VAC between any two legs

277VAC between any one leg & neutral (neutral is optional)

ELCI

347/600VAC 3-ph

L1
L2
L3
Neutral

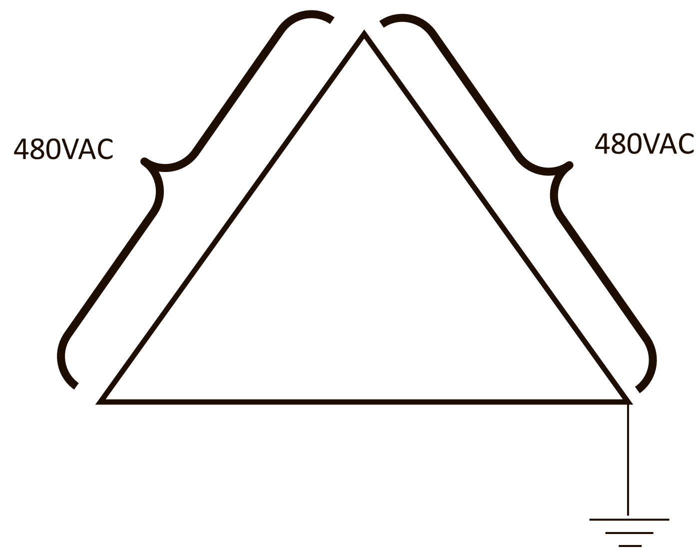
600VAC between any two legs

347VAC between any one leg & neutral (neutral is optional)

ELCI

3-Phase Δ (Delta) (ground not shown for clarity)

Example



480VAC 3-ph

L!
L2
L3

480VAC between any two legs

ELCI

600VAC 3-ph

L!
L2
L3

600VAC between any two legs

ELCI

Where GFCIs are Needed

- Power use in wet locations
- Rough service portable power
- High impedance ground systems (lengthy pathways)
- Confined-space power usage (code mandated)
- High human interface with electrical power
- Equipment protection (safeguards)
- Protect equipment from unsafe failure modes
- Where mandated by NEC and OSHA

North Shore Safety's GFCIs

North Shore Safety offers a comprehensive line of GFCIs and ELCIs in either a portable or permanent use configuration.

Portable use – A GFCI integrated to a portable power cord (protecting the electrical cord downstream of its placement).

Permanent use – A GFCI integrated to a fixed electrical circuit (hardwired). GFCI protects the circuit downstream of its placement.

North Shore Safety offers GFCIs and ELCIs ranging from 15 amps to 60 amps, from 120 volts AC through 600 volts AC in single, split and 3-phase.

From NEC - 2011 Edition:

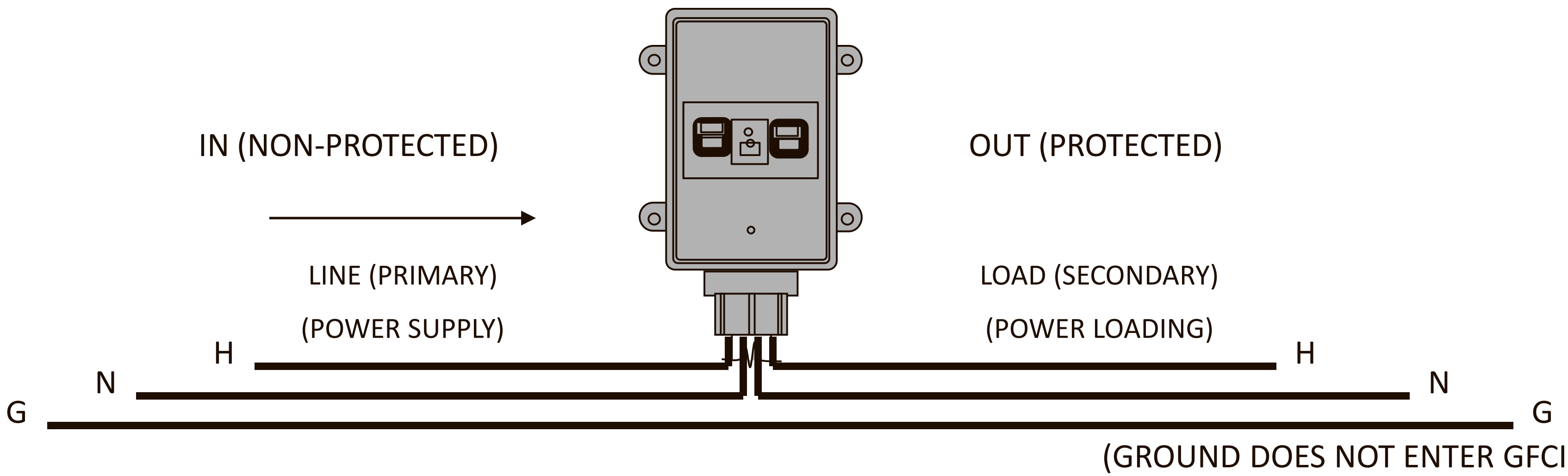
Article 590.6 – Ground-Fault Protection for Personnel. Ground-fault protection for personnel for all temporary wiring installations shall be provided to comply with 590.6(A) and (B). This section shall apply only to temporary wiring installations used to supply temporary power to equipment used by personnel during construction, remodeling, maintenance repair, or demolition of buildings, structures, equipment, or similar activities. This section shall apply to power derived from an electric utility company or from an on-site-generated power source.

OSHA 29 CFR 1926.404(b)(ii) Ground-Fault Circuit Interrupters:

Ground-fault circuit interrupters. All 120-volt, single-phase, 15- and 20-ampere receptacle outlets on construction sites, which are not a part of the permanent wiring of the building or structure and which are in use by employees, shall have approved ground-fault circuit interrupters for personal protection. Receptacles on a two-wire, single-phase portable or vehicle-mounted generator rated not more than 5 kW, where the circuit conductors of the generator are insulated from the generator frame and all other grounded surfaces, need not be protected with ground-fault circuit interrupters.

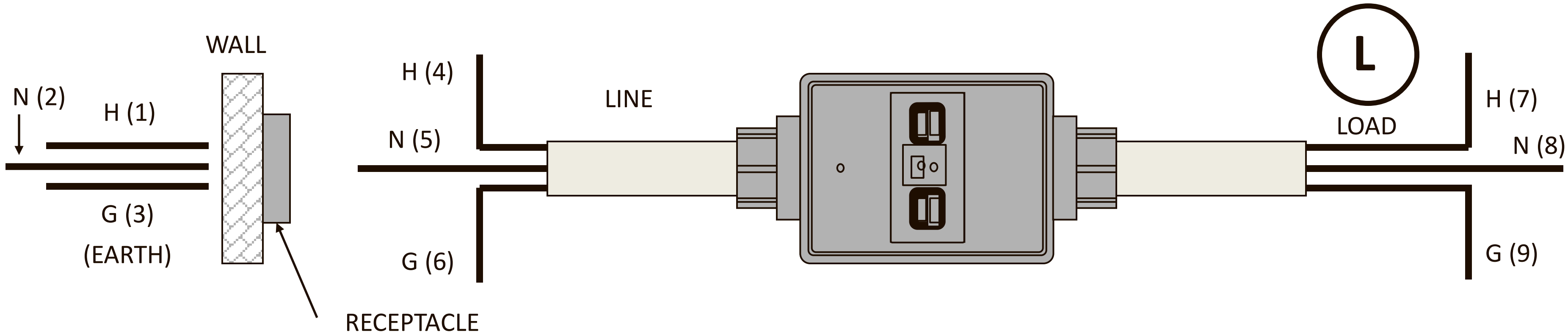
Examination of GFCI Capabilities

Definition of line and load of GFCI – Line and Load is also referred to as primary and secondary or power supply and power loading.



Note: GFCI only protects downstream of installation (i.e. GFCI protection on load side only).

Examination of GFCI Capabilities

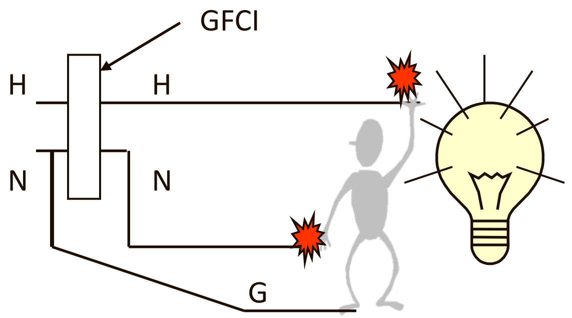


<u>Case and Results:</u>

- Disconnect#1…………………no power to RECEPTACLE
- Disconnect#2…………………no power to RECEPTACLE
- Disconnect#3…………………ungrounded system (GFCI still works)
- Disconnect#4…………………no power to GFCI
- Disconnect#5…………………no power to GFCI
- Disconnect#6…………………disconnected ground (GFCI still works)
- Disconnect#7…………………GFCI powers-up with no power to load side equipment
- Disconnect#8…………………GFCI powers-up with no power to load side equipment
- Disconnect#9…………………load side open ground (GFCI still works and will respond when ground is connected via contact by a person).
- Connect#7 to #8……………Danger – Direct short (GFCI will not respond) – GFCI sees this as an infinite load. Circuit breaker will blow.
- Connect#7 to #9……………Danger – Direct short (GFCI will race the circuit breaker in trip time. GFCI should prevail.. Personnel are protected.
- Connect#8 to #9……………Grounded neutral – GFCI sees current through ground conductor and the current imbalance imposed on the toroid will cause the GFCI to trip.

What a GFCI can not do:

- Will not protect line side (circuit before GFCI)
- Will not protect you when touching two current carrying conductors of opposite polarity (GFCI sees this as a load)
- Will not protect you when touching a line of another circuit (i.e. hot leg from unprotected circuit and neutral of protected circuit)
- Will not detect overcurrent



GFCI sees contact with "H" and "N" as a load or Bob becomes the lightbulb

How can you create a better shock prevention system?

- Use a GFCI to detect a ground-fault condition (especially in wet locations)
- Incorporate a good grounding system for your equipment
- Insulate all electrical components
- Create physical isolation from electrical componentry

How to Determine Power Requirements for a GFCI

Amperage Rating

Ampacity or amperage capacity of the device. This rating represents the maximum current that the device can safely carry. Note that any current level lower than this rating is acceptable in application.

When defining a current (amperage) load, it is normally defined in terms of in-rush level and an in-use level.

In-rush

The instantaneous demand or flow of current at load device startup (i.e. pump startup draws more current initially). This in-rush is due to the device having low resistance initially (prior to circuit saturation). An analogy is the garden hose transporting water initially through an empty hose. Typically, an electrical device can handle 150% of its in-use rated Ampacity.

In-use

The running or saturated demand and flow of current at load device. Typically, this is the rated electrical Ampacity of the device.

Voltage Requirement

This rating dictates the voltage (or electrical pressure) at which the circuit will be operating. Note that this is not a voltage capacity but a discrete point of voltage.

Phase Requirement

The electrical scheme used to supply power to the load side device. Includes the number of conductors supplying power and how these conductors are referenced to each other and system ground.

Examples of circuit rating requirements
- Defined by amperage, voltage and phase -

- 30 amp (45 amp in-rush), 120 volt, single-phase
- 40 amp (60 amp in-rush), 240 volt, 3 -phase
- 30 amp (45 amp in-rush), 120/240, volt split-phase

A GFCI is further defined by its reset feature which indicates how the device powers up with the initiation of supply-side power. There are two reset types available: automatic and manual

Automatic reset

A GFCI that powers up automatically upon plug-in or after power restoration in the absence of a ground-fault. Note, however, that a user must press the reset button in the event of a ground-fault to restore power regardless of the reset type selected. Typically, automatic reset units are selected in unmanned applications where automatic device power-up would not pose an unsafe condition. Such applications include unmanned pumps, battery chargers, etc..

Manual reset

A GFCI that requires the user to press the reset button upon plug-in or primary power restoration to prevent accidental equipment startups (this is also called “safe-start”). This requirement is necessary after each and every occurrence of primary power restoration. Typically, manual reset units are specified where accidental startups after primary power restoration could pose physical harm. Examples include: table saws, drain cleaners, etc.

Electrical Formulas

Ohms Law

Ohms = Volts/Amperes
Amperes = Volts/Ohms
Volts = Amperes X Ohms

Power

Watts = Amperes X Volts
Amperes = Watts/Volts
Horsepower = (Volts X Amperes X Efficiency)/746
Power Factor = Watts/(Amperes X Volts)
3-Phase Kilowatts = (Volts X Amperes X Power Factor X 1.732)/746
3-Phase Amperes = (756 X HP)/(1.732 X Volts X Efficiency X Power Factor)
3-Phase Volt – Amperes = Volts X Amperes X 1.732
Single-Phase Kilowatts = (Volts X Amperes X Power Factor)/1000
Single-Phase Amperes = (746 X HP)/(Volts X Efficiency X Power Factor)

Typical Conductor Designations (Color of Individual Wires)

Hot Conductor (Colors)

- **Black**
- **Red**
- **Orange**
- **Yellow**

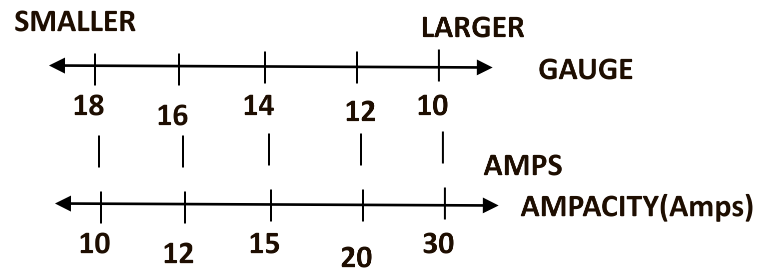
Neutral Conductor (Colors)

- **White**
- **Grey**

Ground Conductor (Colors)

- **Green**

What Defines Conductors?



- Gauge Size (AWG)
- Color (see previous slide)
- Voltage Rating - Dielectric Withstand 300 Volt or 600 Volt
- Temperature Rating - (i.e. 90°C or 105°C)
- Insulation Material - (Flame, Chemical withstand, Abrasion)
- No. of Strands - (More strands = higher flexibility = higher cost)
- Agency Listing - (U.L. - Underwriters Laboratory, CSA - Canadian Standards Association)

Defining Power (Multi-Conductor) Cord (Cable)

- Number of Conductors
- Color or Conductors
- Gauge (AWG-American Wire Gauge) of Conductors
- Insulation Withstand (Outer Jacket, Inner Jacket)
- Chemical Oil Withstand (Outer Jacket, Inner Jacket)
- U.L./CSA Agency Ratings

PLASTIC vs. ELASTOMERIC vs. RUBBER

SJTW	SJEOW	SJOW
Good	**Better**	**Best**
(Plastic, General Purpose)	**(Elastomeric)**	**(Rubber, Specialized Industrial)**

Cable Designations (See Table X & Y)

S J T O O W

S — Hard Service

J — Junior Jacket
J=300 Volt
(Blank if 600 Volt)

T — T= Thermoplastic
E= Elastomeric
Blank=Rubber

O — Oil Resistant Outer Jacket

O — Oil Resistant Conductor Insulation

W — Rated for Outdoor Use

Cable Designations

- S - Hard Service - Cable is rated for portable hard service use
- Senior vs. Junior Jacket (Blank vs. J)
    - Represents voltage withstand or insulation rating of cable (Voltage Pressure withstand):
        - J = 300 Volt Rating
        - Blank = 600 Volt Rating
    - Note: 600 Volt Rating typically means thicker insulation which additionally equates to better abrasion characteristics in application

T vs. E vs. Blank

- T = Thermoplastic Insulated Jacket - Good for general purpose indoor use. Not good for environments of elevated service such as cold temperature, wet locations, chemical exposure, U.V. exposure high abrasion or weld/grinding splash environments
- E = Elastomeric (Plastic / Elastomer Blended) Insulated Jacket - Adequate for most applications. Better flexibility than thermoplastic cables in cold temperatures and much better withstand to chemical exposure and U.V. exposure than that of thermoplastic. However, still not suited for welding or grinding environments or extreme chemical exposure
- Rubberized (Chlorinated Polyethylene - Synthetic Rubber) Insulated Jacket - Outstanding flexibility in cold weather, excellent withstand to chemicals especially petro-chemicals and most alkaline. In addition, insulation material is self extinguishing and will not promote burn through during welding or grinding applications (i.e. Potential ground fault source)

Cable Designations (continued)

- First "O" – Designates resistance to oil impregnation of the outer cable jacket. However, it does not constitute equivalency among different cable types (i.e. SO cord performs better than ST cord types).

- Second "O" – Designates resistance to oil impregnation of conductor insulation.

- "W" – Designates that cable is suitable for indoor or outdoor wet location use.

Cable Conductor Identification

Cable is further defined by gauge and number of conductors. Examples are as follows:

14/3 = 14 gauge/3-conductor

6/4 = 6 gauge/4-conductor

Example of typical cable description - 14/3 SJOOW

Conductor colors defined accordingly:

Hot Wires	Neutral Wires	Ground Wires
Black	**White**	**Green**
Red	**Grey**	
Orange		
Yellow		

UL CORD TYPE DESIGNATIONS

S	SERVICE (600 VOLT) RUBBER (CPE)
SO	SERVICE (600 VOLT) RUBBER (CPE) WITH OIL-RESISTANT JACKET
SOO	SERVICE (600 VOLT) RUBBER (CPE) WITH OIL-RESISTANT INSULATION & JACKET
SOOW	SERVICE (600 VOLT) RUBBER (CPE) WITH OIL-RESISTANT INSULATION & JACKET, INDOOR/OUTDOOR USE
SJ	SERVICE JUNIOR (300 VOLT) RUBBER (CPE)
SJO	SERVICE JUNIOR (300 VOLT) RUBBER (CPE) WITH OIL-RESISTANT JACKET
SJOO	SERVICE JUNIOR (300 VOLT) RUBBER (CPE) WITH OIL-RESISTANT INSULATION & JACKET
SJOOW	SERVICE JUNIOR (300 VOLT) RUBBER (CPE) WITH OIL-RESISTANT INSULATION & JACKET, INDOOR/OUTDOOR USE
SE	SERVICE (600 VOLT) ELASTOMER
SEO	SERVICE (600 VOLT) ELASTOMER WITH OIL-RESISTANT JACKET
SEOO	SERVICE (600 VOLT) ELASTOMER WITH OIL-RESISTANT INSULATION & JACKET
SEOOW	SERVICE (600 VOLT) ELASTOMER WITH OIL-RESISTANT INSULATION & JACKET, INDOOR/OUTDOOR USE
SJE	SERVICE JUNIOR (300 VOLT) ELASTOMER
SJEO	SERVICE JUNIOR (300 VOLT) ELASTOMER WITH OIL-RESISTANT JACKET
SJEOO	SERVICE JUNIOR (300 VOLT) ELASTOMER WITH OIL-RESISTANT INSULATION & JACKET
SJEOOW	SERVICE JUNIOR (300 VOLT) ELASTOMER WITH OIL-RESISTANT INSULATION & JACKET, INDOOR/OUTDOOR USE
ST	SERVICE (600 VOLT) THERMOPLASTIC
STO	SERVICE (600 VOLT) THERMOPLASTIC WITH OIL-RESISTANT JACKET
STOO	SERVICE (600 VOLT) THERMOPLASTIC WITH OIL-RESISTANT INSULATION & JACKET
STOOW	SERVICE (600 VOLT) THERMOPLASTIC WITH OIL-RESISTANT INSULATION & JACKET, INDOOR/OUTDOOR USE
SJT	SERVICE JUNIOR (300 VOLT) THERMOPLASTIC
SJTO	SERVICE JUNIOR (300 VOLT) THERMOPLASTIC WITH OIL-RESISTANT JACKET
SJTOO	SERVICE JUNIOR (300 VOLT) THERMOPLASTIC WITH OIL-RESISTANT INSULATION & JACKET
SJTOOW	SERVICE JUNIOR (300 VOLT) THERMOPLASTIC WITH OIL-RESISTANT INSULATION & JACKET, INDOOR/OUTDOOR USE

UL CORD DIAMETER RANGES

	AWG SIZE 18-2	AWG SIZE 16-2	AWG SIZE 14-2	AWG SIZE 12-2	AWG SIZE 10-2	AWG SIZE 18-3	AWG SIZE 16-3	AWG SIZE 14-3	AWG SIZE 12-3	AWG SIZE 10-3
S	0.340-0.385	0.365-0.410	0.495-0.550	0.565-0.625	0.615-0.685	0.360-0.400	0.385-0.430	0.520-0.575	0.590-0.655	0.650-0.720
SO	0.340-0.385	0.365-0.410	0.495-0.550	0.565-0.625	0.615-0.685	0.360-0.400	0.385-0.430	0.520-0.575	0.590-0.655	0.650-0.720
SOO	0.340-0.385	0.365-0.410	0.495-0.550	0.565-0.625	0.615-0.685	0.360-0.400	0.385-0.430	0.520-0.575	0.590-0.655	0.650-0.720
SOOW	0.340-0.385	0.365-0.410	0.495-0.550	0.565-0.625	0.615-0.685	0.360-0.400	0.385-0.430	0.520-0.575	0.590-0.655	0.650-0.720
SJ	0.280-0.315	0.305-0.340	0.335-.0375	0.405-0.455	0.540-0.605	0.300-0.335	0.325-0.360	0.360-0.395	0.425-0.475	0.565-0.635
SJO	0.280-0.315	0.305-0.340	0.335-.0375	0.405-0.455	0.540-0.605	0.300-0.335	0.325-0.360	0.360-0.395	0.425-0.475	0.565-0.635
SJOO	0.280-0.315	0.305-0.340	0.335-.0375	0.405-0.455	0.540-0.605	0.300-0.335	0.325-0.360	0.360-0.395	0.425-0.475	0.565-0.635
SJOOW	0.280-0.315	0.305-0.340	0.335-.0375	0.405-0.455	0.540-0.605	0.300-0.335	0.325-0.360	0.360-0.395	0.425-0.475	0.565-0.635
SE	0.340-0.385	0.365-0.410	0.495-0.550	0.565-0.625	0.615-0.685	0.360-0.400	0.385-0.430	0.520-0.575	0.590-0.655	0.650-0.720
SEO	0.340-0.385	0.365-0.410	0.495-0.550	0.565-0.625	0.615-0.685	0.360-0.400	0.385-0.430	0.520-0.575	0.590-0.655	0.650-0.720
SEOO	0.340-0.385	0.365-0.410	0.495-0.550	0.565-0.625	0.615-0.685	0.360-0.400	0.385-0.430	0.520-0.575	0.590-0.655	0.650-0.720
SEOOW	0.340-0.385	0.365-0.410	0.495-0.550	0.565-0.625	0.615-0.685	0.360-0.400	0.385-0.430	0.520-0.575	0.590-0.655	0.650-0.720
SJE	0.280-0.315	0.305-0.340	0.335-.0375	0.405-0.455	0.540-0.605	0.300-0.335	0.325-0.360	0.360-0.395	0.425-0.475	0.565-0.635
SJEO	0.280-0.315	0.305-0.340	0.335-.0375	0.405-0.455	0.540-0.605	0.300-0.335	0.325-0.360	0.360-0.395	0.425-0.475	0.565-0.635
SJEOO	0.280-0.315	0.305-0.340	0.335-.0375	0.405-0.455	0.540-0.605	0.300-0.335	0.325-0.360	0.360-0.395	0.425-0.475	0.565-0.635
SJEOOW	0.280-0.315	0.305-0.340	0.335-.0375	0.405-0.455	0.540-0.605	0.300-0.335	0.325-0.360	0.360-0.395	0.425-0.475	0.565-0.635
ST	0.340-0.385	0.365-0.410	0.495-0.550	0.565-0.625	0.615-0.685	0.360-0.400	0.385-0.430	0.520-0.575	0.590-0.655	0.650-0.720
STO	0.340-0.385	0.365-0.410	0.495-0.550	0.565-0.625	0.615-0.685	0.360-0.400	0.385-0.430	0.520-0.575	0.590-0.655	0.650-0.720
STOO	0.340-0.385	0.365-0.410	0.495-0.550	0.565-0.625	0.615-0.685	0.360-0.400	0.385-0.430	0.520-0.575	0.590-0.655	0.650-0.720
STOOW	0.340-0.385	0.365-0.410	0.495-0.550	0.565-0.625	0.615-0.685	0.360-0.400	0.385-0.430	0.520-0.575	0.590-0.655	0.650-0.720
SJT	0.280-0.315	0.305-0.340	0.335-.0375	0.405-0.455	0.540-0.605	0.300-0.335	0.325-0.360	0.360-0.395	0.425-0.475	0.565-0.635
SJTO	0.280-0.315	0.305-0.340	0.335-.0375	0.405-0.455	0.540-0.605	0.300-0.335	0.325-0.360	0.360-0.395	0.425-0.475	0.565-0.635
SJTOO	0.280-0.315	0.305-0.340	0.335-.0375	0.405-0.455	0.540-0.605	0.300-0.335	0.325-0.360	0.360-0.395	0.425-0.475	0.565-0.635
SJTOOW	0.280-0.315	0.305-0.340	0.335-.0375	0.405-0.455	0.540-0.605	0.300-0.335	0.325-0.360	0.360-0.395	0.425-0.475	0.565-0.635

Cordset Description (Component Designation)

- Cordsets – A cord set is defined not only by its cable type but also by the wiring devices (i.e. plug and connector) integrated to the cable.

- Plug – A device with male contacts which when inserted into a receptacle, establishes connection between the conductors of the attached flexible cord and the conductors connected to the receptacle.

- Connector – A female contact device used in making a detachable electrical connection to an electrical attachment plug or a flanged electrical power inlet.

- Receptacle – A device with female contacts which is primarily installed at a structure or in a piece of equipment and is intended to establish electrical connection with an inserted plug.

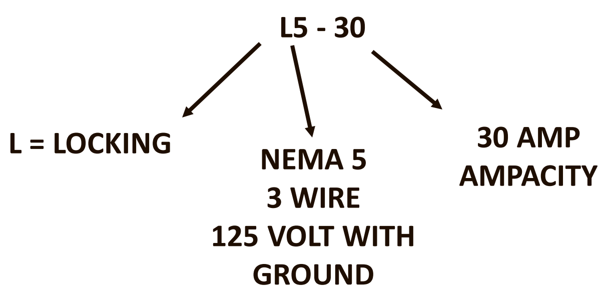
Wiring devices are defined by their NEMA configurations

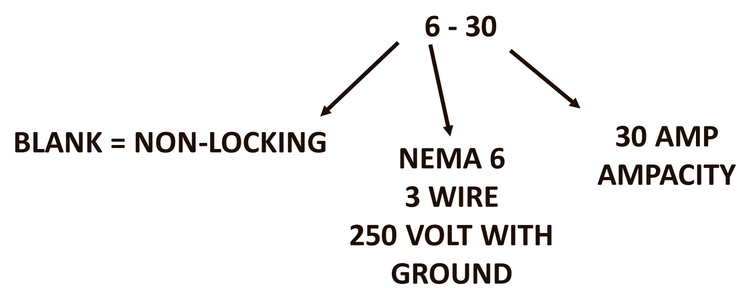
NEMA (National Electrical Manufacturers Association) – NEMA is the voice of the electrical industry, and through its standards, electrical products are formulated. Generally, these standards promote interchangeability between products of one manufacturer with like products made by another manufacturer.

Wiring devices are by NEMA standards defined by:

- Voltage
- Number of conductors
- Amperage
- Mechanical connection (locking or non-locking)

Some examples are as follows:





Note: Some manufacturers will follow the NEMA designation with P, C, or R to define a plug, connector or receptacle respectively (see Table W for complete NEMA listings).

North Shore Safety
Safety Through Innovation

NEMA Configuration Chart
Straight Blade Devices

			15 AMPERE		20 AMPERE		30 AMPERE		50 AMPERE		60 AMPERE	
			RECEPTACLE	PLUG	RECEPTACLE	PLUG	RECEPTACLE	PLUG	RECEPTACLE	PLUG	RECEPTACLE	PLUG
2-POLE 2-WIRE	1	125V	1-15R C73.10	1-15P C73.10								
	2	250V		2-15P	2-20R C73.21	2-20P C73.21	2-30R	2-30P				
	3	277V				(RESERVED FOR FUTURE CONFIGURATIONS)						
	4	600V				(RESERVED FOR FUTURE CONFIGURATIONS)						
2-POLE 3-WIRE GROUNDING	5	125V	5-15R C73.11	5-15P C73.11	5-20R C73.12	5-20P C73.12	5-30R C73.45	5-30P C73.45	5-50R C73.46	5-50P C73.46		
	6	250V	6-15R C73.20	6-15P C73.20	6-20R C73.51	6-20P C73.51	6-30R C73.52	6-30P C73.52	6-50R C73.53	6-50P C73.53		
	7	277V AC	7-15R C73.28	7-15P C73.28	7-20R	7-20P	7-30R	7-30P	7-50R	7-50P		
	24	347V AC	24-15R	24-15P	24-20R	24-20P	24-30R	24-30P	24-50R	24-50P		
	8	480V AC				(RESERVED FOR FUTURE CONFIGURATIONS)						
	9	600V AC				(RESERVED FOR FUTURE CONFIGURATIONS)						
3-POLE 3-WIRE	10	125/ 250V			10-20R C73.23	10-20P C73.23	10-30R C73.24	10-30P C73.24	10-50R C73.25	10-50P C73.25		
	11	3 250V	11-15R	11-15P	11-20R	11-20P	11-30R	11-30P	11-50R	11-50P		
	12	3 480V				(RESERVED FOR FUTURE CONFIGURATIONS)						
	13	3 600V				(RESERVED FOR FUTURE CONFIGURATIONS)						
3-POLE 4-WIRE GROUNDING	14	125/250V	14-15R	14-15P	14-20R	14-20P	14-30R C73.16	14-30P C73.16	14-50R C73.17	14-50P C73.17	14-60R C73.18	14-60P C73.18
	15	3 250V	15-15R	15-15P	15-20R	15-20P	15-30R C73.60	15-30P C73.60	15-50R C73.61	15-50P C73.61	15-60R C73.62	15-60P C73.62
	16	3 480V				(RESERVED FOR FUTURE CONFIGURATIONS)						
	17	3 600V				(RESERVED FOR FUTURE CONFIGURATIONS)						
4-POLE 4-WIRE	18	3Y 120/208V	18-15R	18-15P	18-20R C73.26	18-20P C73.26	18-30R C73.47	18-30P C73.47	18-50R C73.48	18-50P C73.48	18-60R C73.27	18-60P C73.27
	19	3Y 277/480V				(RESERVED FOR FUTURE CONFIGURATIONS)						
	20	3Y 347/600V				(RESERVED FOR FUTURE CONFIGURATIONS)						
4-POLE 5-WIRE GRDG	21	3Y 120/208V				(RESERVED FOR FUTURE CONFIGURATIONS)						
	22	3Y 277/480V				(RESERVED FOR FUTURE CONFIGURATIONS)						
	23	3Y 347/600V				(RESERVED FOR FUTURE CONFIGURATIONS)						

Indicates page number where devices are located.
NEMA Number
ANSI Number

North Shore Safety

Safety Through Innovation

NEMA Configuration Chart Locking Devices

			15 AMPERE		20 AMPERE		30 AMPERE	
			RECEPTACLE	PLUG	RECEPTACLE	PLUG	RECEPTACLE	PLUG
2-POLE 2-WIRE	125V	ML1	ML-1R	ML-1P				
	125V	L1	L1-15R C73.31	L1-15P C73.31				
	250V	L2			L2-20R C73.31	L2-20P C73.32		
2-POLE 3-WIRE GROUNDING	125V	ML2	ML-2R	ML-2P				
	125V	L5	L5-15R C73.42	L5-15P C73.42	L5-20R C73.72	L5-20P C73.72	L5-30R C73.73	L5-30P C73.73
	250V	L6	L6-15R C73.74	L6-15P C73.74	L6-20R C73.75	L6-20P C73.75	L6-30R C73.76	L6-30P C73.76
	277V AC	L7	L7-15R C73.43	L7-15P C73.43	L7-20R C73.77	L7-20P C73.77	L7-30R C73.78	L7-30P C73.78
	480V AC	L8			L8-20R C73.79	L8-20P C73.79	L8-30R C73.80	L8-30P C73.80
	600V AC	L9			L9-20R C73.81	L9-20P C73.81	L9-30R C73.82	L9-30P C73.82
	28V DC	FSL1					FSL1	FSL1
	400Hz 120V	FSL2					FSL2	FSL2
3-POLE 3-WIRE	125/250V	ML3	ML-3R	ML-3P				
	125/250V	L10			L10-20R C73.96	L10-20P C73.96	L10-30R C73.97	L10-30P C73.97
	3 250V	L11	L11-15R C73.98	L11-15P C73.98	L11-20R C73.99	L11-20P C73.99	L11-30R C73.100	L11-30P C73.100
	3 480V	L12			L12-20R C73.101	L12-20P C73.101	L12-30R C73.102	L12-30P C73.102
	3 600V	L13					L13-30R C73.103	L13-30P C73.103
3-POLE 4-WIRE GROUNDING	125/250V	L14			L14-20R C73.83	L14-20P C73.83	L14-30R C73.84	L14-30P C73.84
	3 250V	L15			L15-20R C73.85	L15-20P C73.85	L15-30R C73.86	L15-30P C73.86
	3 480V	L16			L16-20R C73.87	L16-20P C73.87	L16-30R C73.88	L16-30P C73.88
	3 600V	L17					L17-30R C73.89	L17-30P C73.89
	400Hz 3 120V	FSL3					FSL3	FSL3
4-POLE 4-WIRE	3Y 120/208V	L18			L18-20R C73.104	L18-20P C73.104	L18-30R C73.105	L18-30P C73.105
	3Y 277/480V	L19			L19-20R C73.106	L19-20P C73.106	L19-30R C73.107	L19-30P C73.107
	3Y 347/600V	L20			L20-20R C73.108	L20-20P C73.108	L20-30R C73.109	L20-30P C73.109
4-POLE 5-WIRE GROUNDING	3Y 120/208V	L21			L21-20R C73.90	L21-20P C73.90	L21-30R C73.91	L21-30P C73.91
	3Y 277/480V	L22			L22-20R C73.92	L22-20P C73.92	L22-30R C73.93	L22-30P C73.93
	3Y 347/600V	L23			L23-20R C73.94	L23-20P C73.94	L23-30R C73.95	L23-30P C73.95
	400Hz 3Y 120/208V	FSL4					FSL4	FSL4

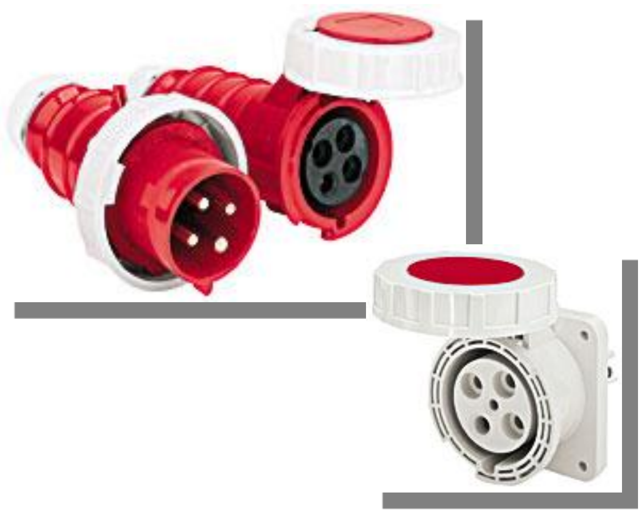
Indicates page number where devices are located.
NEMA Number
ANSI Number

Alternate Wiring Devices (Primarily International)

- In addition to NEMA configured wiring devices (which are of blade type) there are also international devices that are configured in a pin and sleeve format listed under IEC 309 standard.

- IEC (International Electrotechnical Commission) – A worldwide standards organization with 43 member countries. The U.S. is represented in this commission by the American National Standards Institute (ANSI). The IEC produces many standards covering all aspects of the electrical and electronics industry worldwide.

- IEC-309 - Devices much like the NEMA devices are defined by voltage, amperage and number of conductors (see Table F).



North Shore Safety
Safety Through Innovation

Watertight Pin & Sleeve Devices

UL CSA NOM IP67 CE

WATERTIGHT

20 AMP/30 AMP 60 AMP

North American Ratings

AMPS	POLES AND WIRES	CONFIGURATION Recep. Conn.	Plug/ Inlet	VOLTAGE
20	2P 3W			125V AC
	2P 3W			250V AC
	2P 3W			480V AC
	3P 4W			125/250V AC
	3P 4W			3˜250
	3P 4W			3˜480
	3P 4W			3˜600
	4P 5W			3˜Y120/208
	4P 5W			3˜Y277/480
30	2P 3W			125V AC
	2P 3W			250V AC
	2P 3W			480V AC
	3P 4W			125/250V AC
	3P 4W			3˜250
	3P 4W			3˜480
	3P 4W			3˜600
	4P 5W			3˜Y120/208
	4P 5W			3˜Y277/480
60	2P 3W			125V AC
	2P 3W			250V AC
	2P 3W			480V AC
	3P 4W			125/250V AC
	3P 4W			3˜250
	3P 4W			3˜480
	3P 4W			3˜600
	4P 5W			3˜Y120/208
	4P 5W			3˜Y277/480
	4P 5W			3˜Y347/600

UL CSA NOM IP67 CE

WATERTIGHT

100 AMP

North American Ratings

AMPS	POLES AND WIRES	CONFIGURATION Recep. Conn.	Plug/ Inlet	VOLTAGE
100	2P 3W			250V AC
	2P 3W			480V AC
	3P 4W			125/250V AC
	3P 4W			3˜250
	3P 4W			3˜480
	3P 4W			3˜600
	4P 5W			3˜Y120/208
	4P 5W			3˜Y277/480

ÖVE CE NOM IP67

WATERTIGHT

16 AMP/32 AMP/63 AMP/125 AMP

International Ratings

AMPS	POLES AND WIRES	CONFIGURATION Recep. Conn.	Plug/ Inlet	VOLTAGE
16	2P 3W			100-130
	2P 3W			200-250
	3P 4W			380-415
	4P 5W			200/346 240/415
32	2P 3W			100-130
	2P 3W			200-250
	3P 4W			380-415
	3P 4W			380V 50Hz 440V 60Hz
	4P 5W			200/346 240/415
63	2P 3W			200-250
	3P 4W			380-415
	4P 5W			200/346 240/415
125	3P 4W			380-415
	4P 5W			200/346 240/415

Wiring Device Attachment to Cord

When attaching a field wiring device to cable of multiple conductors (black, white, red, green, etc.), the following wiring scheme is used in the absence of a formalized wiring instruction. Note that a typical wiring device will have one or more of the following designations to define orientation of conductor installation.

Contact Screws: Gold or Black = Hot or Multiple-Hot Legs
Silver = Neutral
Green = Ground

Contact Designations: X = Hot or L1
Y = L2
Z = L3
N = Neutral
G = Ground

Wiring Devices – Custom

Note that North Shore Safety can manufacture custom cords that include wiring terminals on conductors or bulkhead cable glands on the cable.

Watertight or Non-watertight Wiring Devices or Enclosures

Electrical equipment such as enclosures, panels, switches, wiring devices and lighting indicators are rated by a performance scale that designates permeability of the device's enclosure to dust, dirt, rain, submersion or arc and flame containment. Performance scales are sponsored by two organizations; the first, and most recognized in the U.S. is the NEMA scale. The second is the IEC sponsored scale (primarily international, which is the IP or Ingress Protection scale). However, there is a reasonable correlation between these two performance scales (shown on attachment P).

<u>Watertight Wiring Devices</u>
When specifying wiring devices for a cord set, take note that North Shore Safety can supply these cords with a higher performance wiring device that can withstand wet-location use. Typically, these devices will carry a NEMA 4X or an IP66 rating. These higher-performing devices offer a greater level of shock protection in wet locations. (See table on NEMA/IP rating)

NEMA Ratings

NEMA 1
Type 1 enclosures are intended for indoor use primarily to provide a degree of protection against contact with the enclosed equipment or locations where unusual service conditions do not exist.

NEMA 2
Type 2 enclosures are intended for indoor use primarily to provide a degree of protection against limited amounts of falling water and dirt.

NEMA 3
Type 3 enclosures are intended for outdoor use primarily to provide a degree of protection against windblown dust, rain, and sleet; and that be undamaged by the formation of ice on the enclosure.

NEMA 3R
Type 3R enclosures are intended for outdoor use primarily to provide a degree of protection against falling rain; and that be undamaged by the formation of ice on the enclosure.

NEMA 4
Type 4 enclosures are intended for indoor or outdoor use primarily to provide a degree of protection against windblown dust and rain, splashing water, and hose directed water; and the be undamaged by the formation of ice on the enclosure.

NEMA 4X
Type 4X enclosures are intended for indoor and outdoor use primarily to provide a degree of protection against corrosion, windblown dust and rain, splashing water, and hose-directed water; and to be undamaged by the formation of ice on the enclosure.

NEMA Rating Cont.

NEMA 6

Type 6 enclosures are intended for indoor or outdoor use primarily to provide a degree of protection against the entry of water during temporary submersion at a limited depth; and to be undamaged by the formation of ice on the enclosure.

NEMA 6P

Type 6P enclosures are intended for indoor or outdoor use to provide a degree of protection to the personnel against incidental contact with the enclosed equipment; to provide a degree of protection against falling dirt; against hose-directed water & the entry of water during prolonged submersion at a limited depth; & that will be undamaged by the external formation of ice on the enclosure.

NEMA 7

Type 7 enclosures are for indoor use in locations classified as Class I, Groups A, B, C, or D, as defined in the National Electric Code. Type 7 enclosures shall be capable of withstanding the pressures resulting from an internal explosion of specified gases, and contain such an explosion sufficiently that an explosive gas-air mixture existing in the atmosphere surrounding the enclosure will not be ignited. Enclosure heat generating devices shall not cause external surfaces to reach temperature capable of igniting explosive gas-air mixtures in the surrounding atmosphere. Enclosures shall meet explosion, hydrostatic, and temperature design tests.

NEMA 9

Type 9 enclosures are intended for indoor use in locations classified as Class II, Groups E, F, or G, as defined in the National Electric Code. Type 9 enclosures shall be capable of preventing the entrance of dust. Enclosed heat generating devices shall not cause external surfaces to reach temperatures capable of igniting or discoloring dust on the enclosure or igniting dust-air mixtures in the surrounding atmosphere. Enclosures shall meet dust penetration and temperature design tests, and aging of gaskets (if used).

NEMA 12

Type 12 enclosures are intended for indoor use primarily to provide a degree of protection against dust, falling dirt, and dripping noncorrosive liquids.

NEMA 13

Type 13 enclosures are intended for indoor use primarily to provide a degree of protection against dust, spraying of water, oil, and noncorrosive coolant.

NEMA ratings and IP ratings

NEMA ratings and IP ratings.
What do they mean?

In the United States and Canada, NEMA, UL, and CSA are the organizations generally recognized. Their ratings are based on similar application descriptions and expected performance. UL and CSA both require the enclosure to be tested in their labs. Both organizations can also send site inspectors to ensure that the manufacturer is conforming to the correct manufacturing methods and material specifications. NEMA does not require testing, and the responsibility is with the manufacturer to ensure the products meet the NEMA ratings.

IP Ratings.

The first number defines the level of protection against penetration of solid objects into the housing.
The second number defines the level of protection against penetration of liquids into the housing.

Additional information can be found in the 1976 IEC Publication, Classification of Degrees of Protection Provided by Enclosures.

Numeric Format – IPXY

IP = Ingress Protection
X = level of protection against penetration of solid objects into the housing.
Y = level of protection against penetration of liquids into the housing.

IP Table

Number X	Degree of Protection	Number Y	Degree of Protection
0	No protection against contact or entry of solids.	0	No protection.
1	Protection against accidental contact by hand, but not deliberate contact. Protection against large objects. (greater than 50mm)	1	Protection against drops of condensed water. Condensed water falling on housing shall have no effect.
2	Protection against contact by fingers. Protection against medium-size foreign objects. (greater than 12mm)	2	Protection against drops of liquid. Drops of falling liquid shall have no effect when housing is tilted to 15 degrees from vertical.
3	Protection against contact by tools, wire, etc. Protection against small foreign objects. (greater than 2.5mm)	3	Protection against rain. No harmful effect from rain at angle less than 60 degrees from vertical.
4	Protection against contact by small tools and wires. Protection against small foreign objects. (greater than 1mm)	4	Protection against splashing from any direction.
5	Complete protection against contact with live or moving parts. Protection against harmful deposits of dust.	5	Protection against water jets from any direction.
6	Complete protection of live or moving parts. Protection against penetration of dust.	6	Protection against conditions on ships' decks. Water from heavy seas will not enter.
		7	Protection against immersion in water. Water will not enter under stated conditions of pressure and time.
		8	Protection against indefinite immersion in water under a specified pressure.

Comparing NEMA versus IP enclosure ratings

This is a cross reference for comparing NEMA and IP enclosure ratings. This comparison is only approximate, and it is the responsibility of the user to verify the enclosure rating necessary for the given application.

Enclosure type	IP23	IP30	IP32	IP55	IP64	IP65	IP66	IP67
1	◆							
2		◆						
3					◆			
4							◆	
4X							◆	
6								◆
12				◆		◆		
13						◆		