# *Surge Protection – Safety Requirements for Surge Protectors and Grounding at the Customer Premises*

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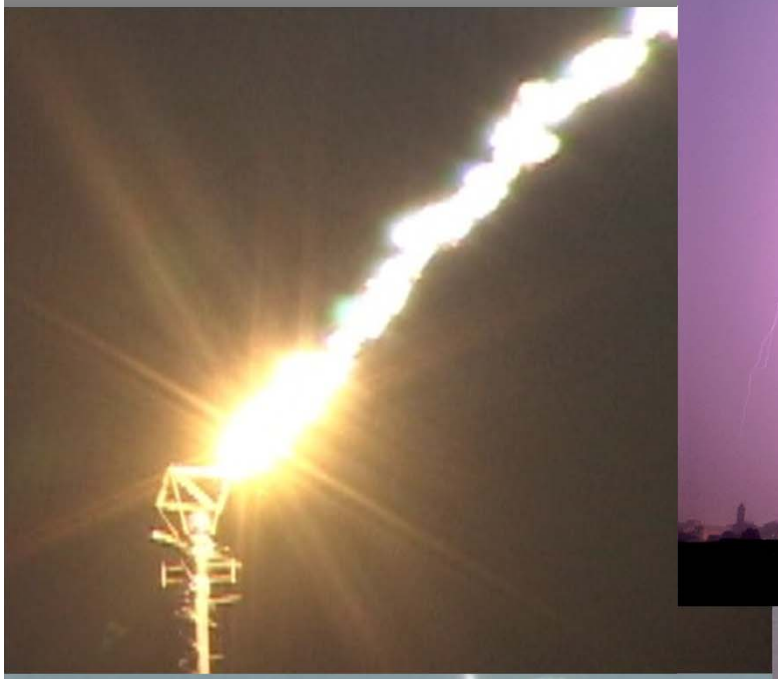
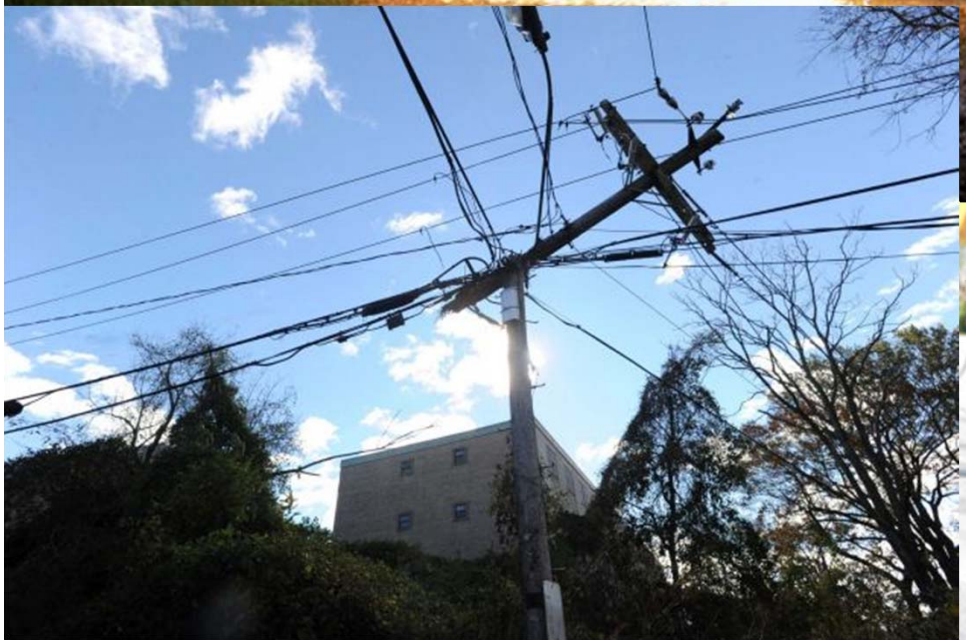
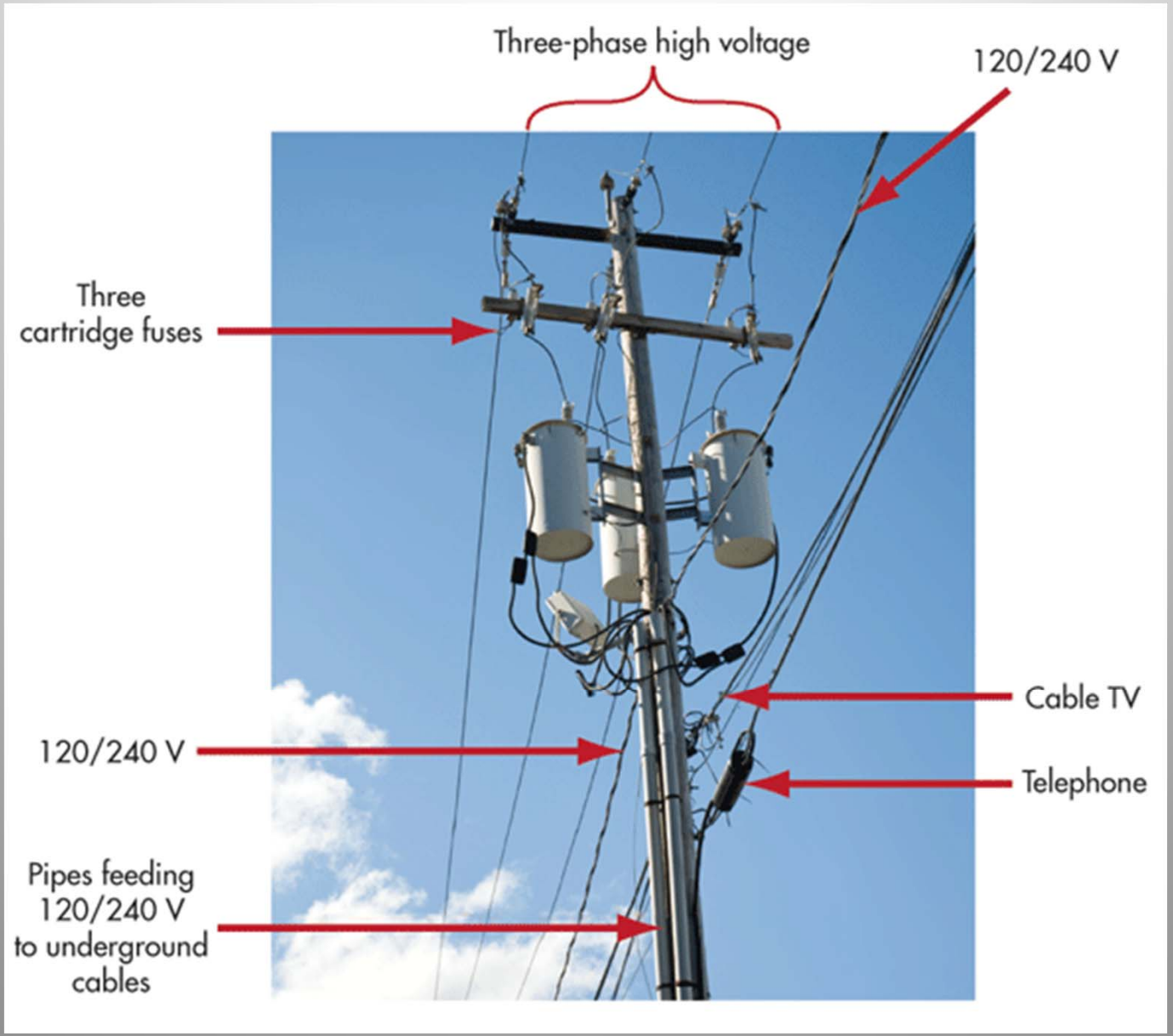
# Lightning Surges



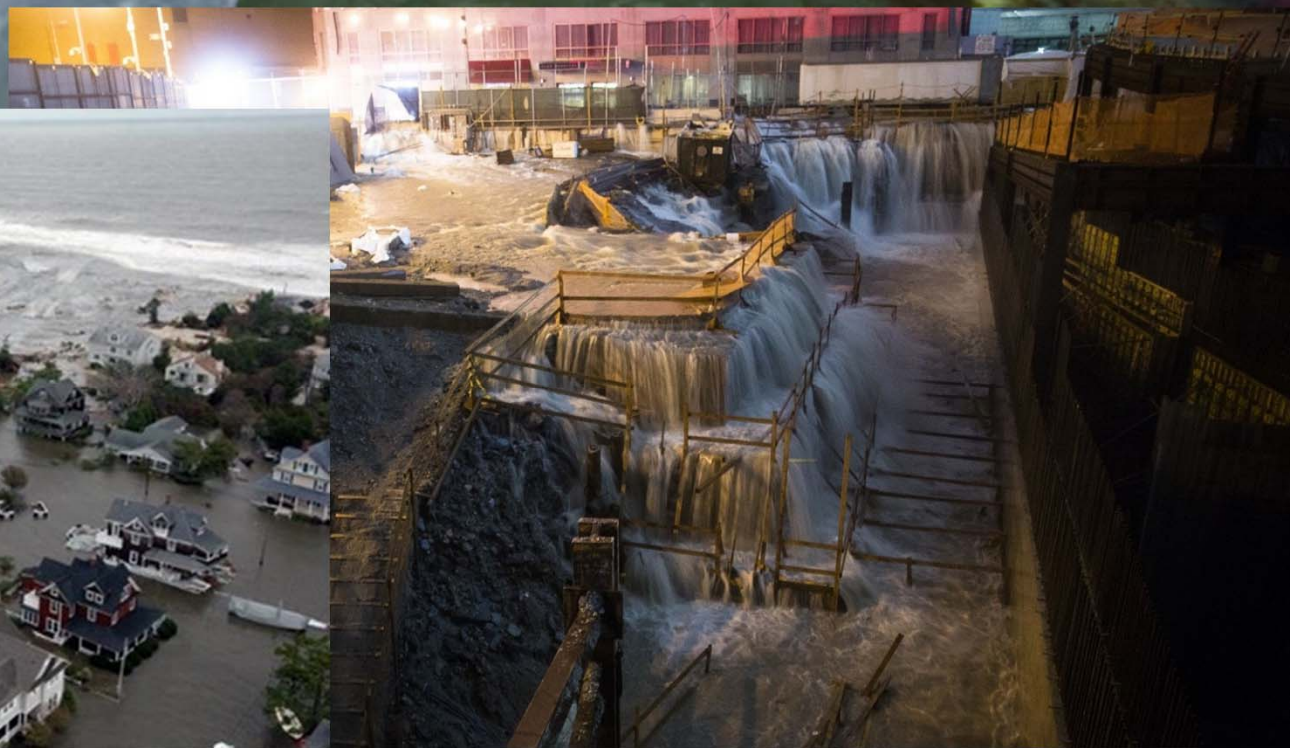
# Surges from Power Line Faults



# Surges from Power Line Faults



# Storm Surge

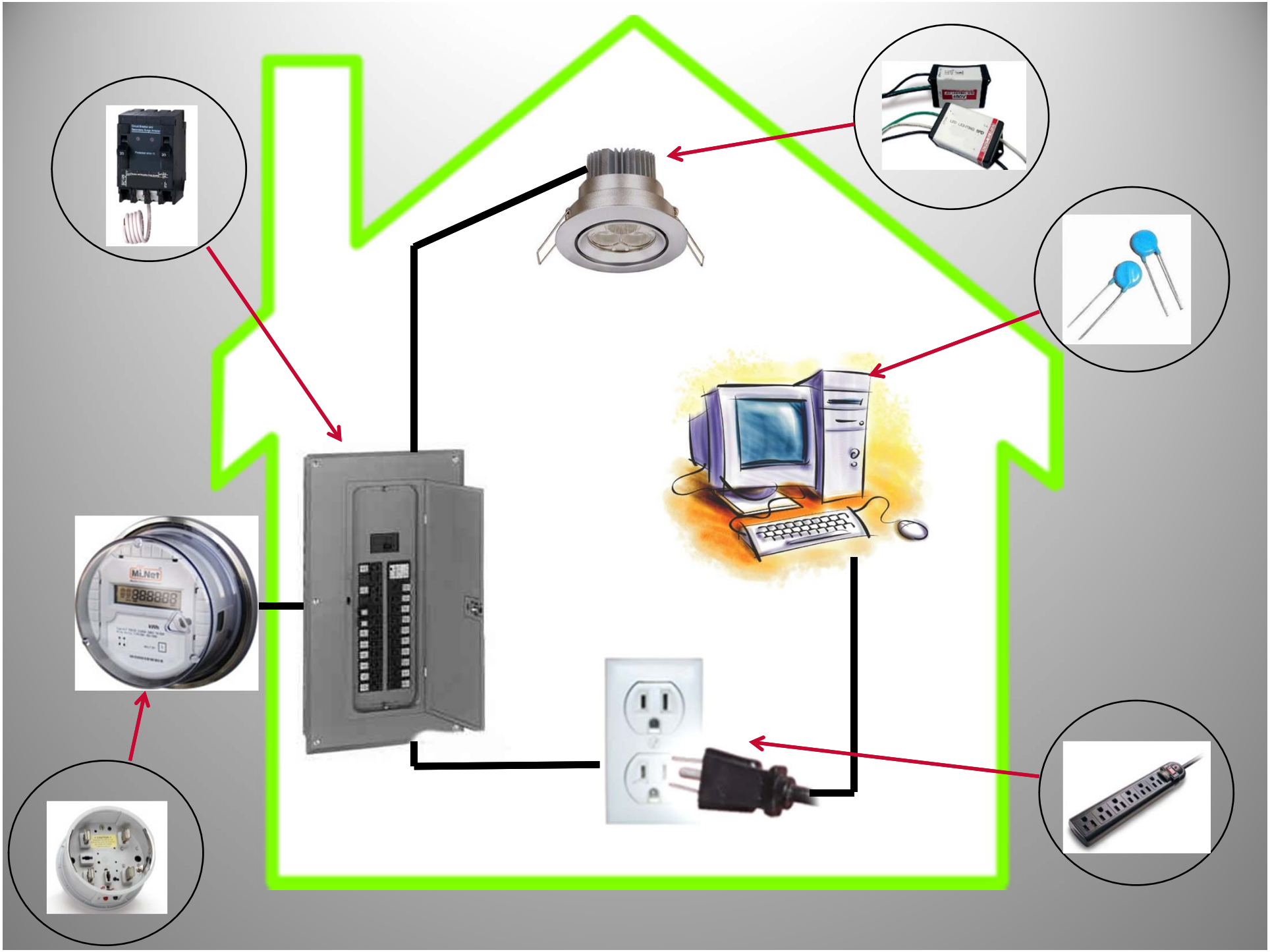



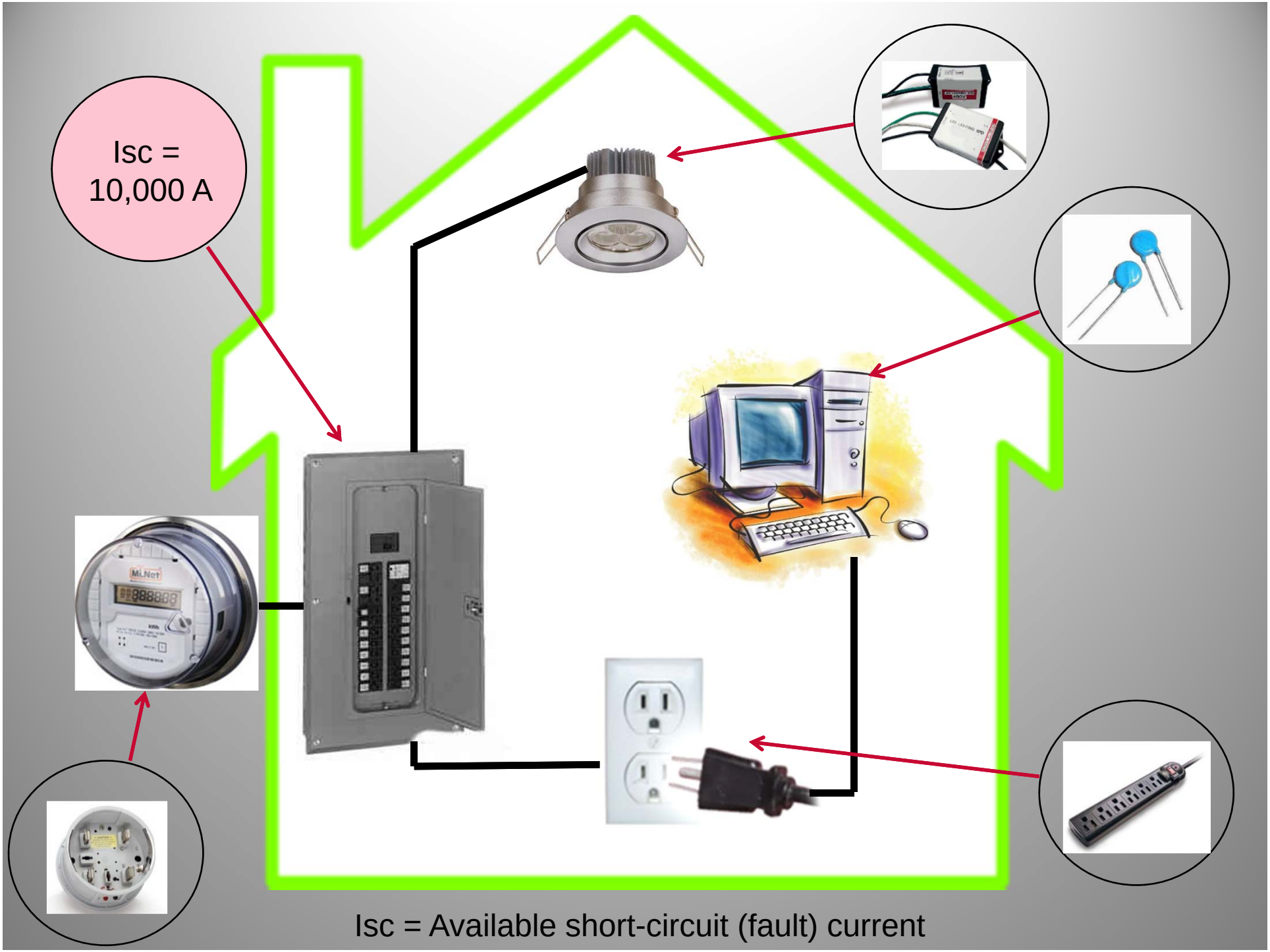

SURGE PROTECTOR
Sandy Relief Ale
A Collaboration to Benefit
Long Island &
Barrier Brewing Co.

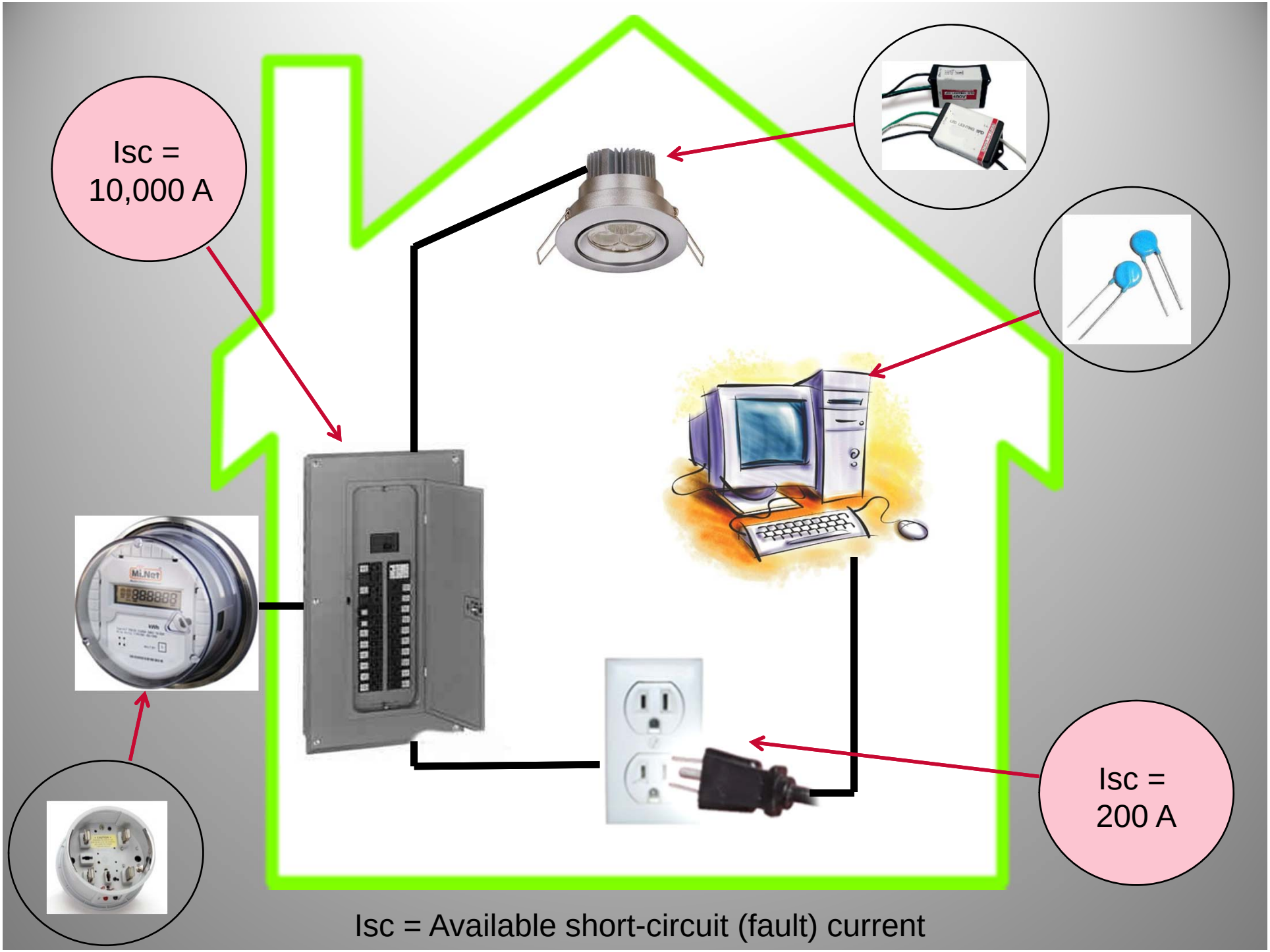
# This Presentation Will Cover …

- Surge Protective Devices for AC Power
- Protectors for Communications and Signaling Circuits
- Grounding

- **Surge Protective Devices for AC Power**
- **Protectors for Communications and Signaling Circuits**
- **Grounding**


Mi.Net


Isc =
10,000 A
Mi.Net
Isc = Available short-circuit (fault) current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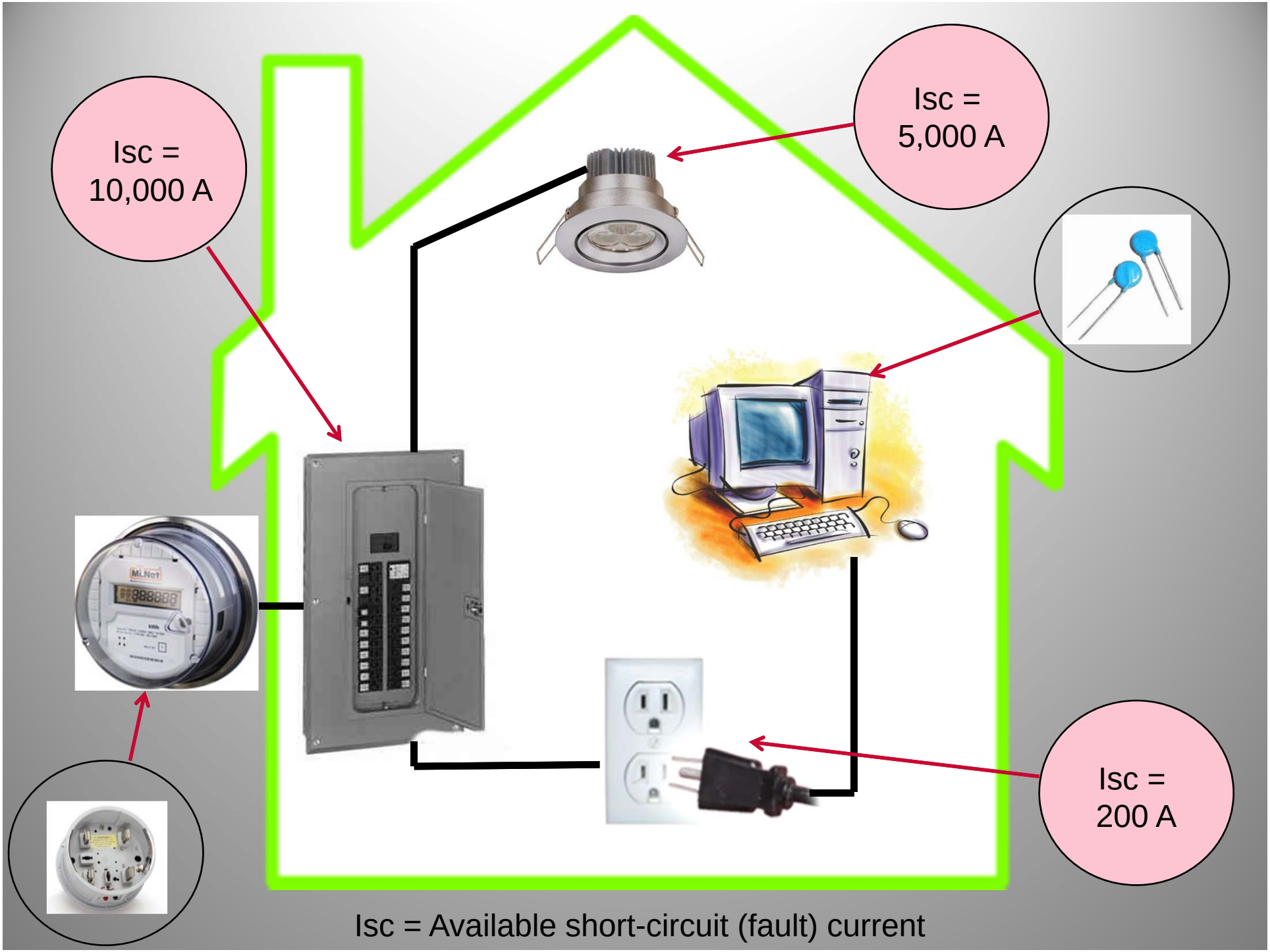
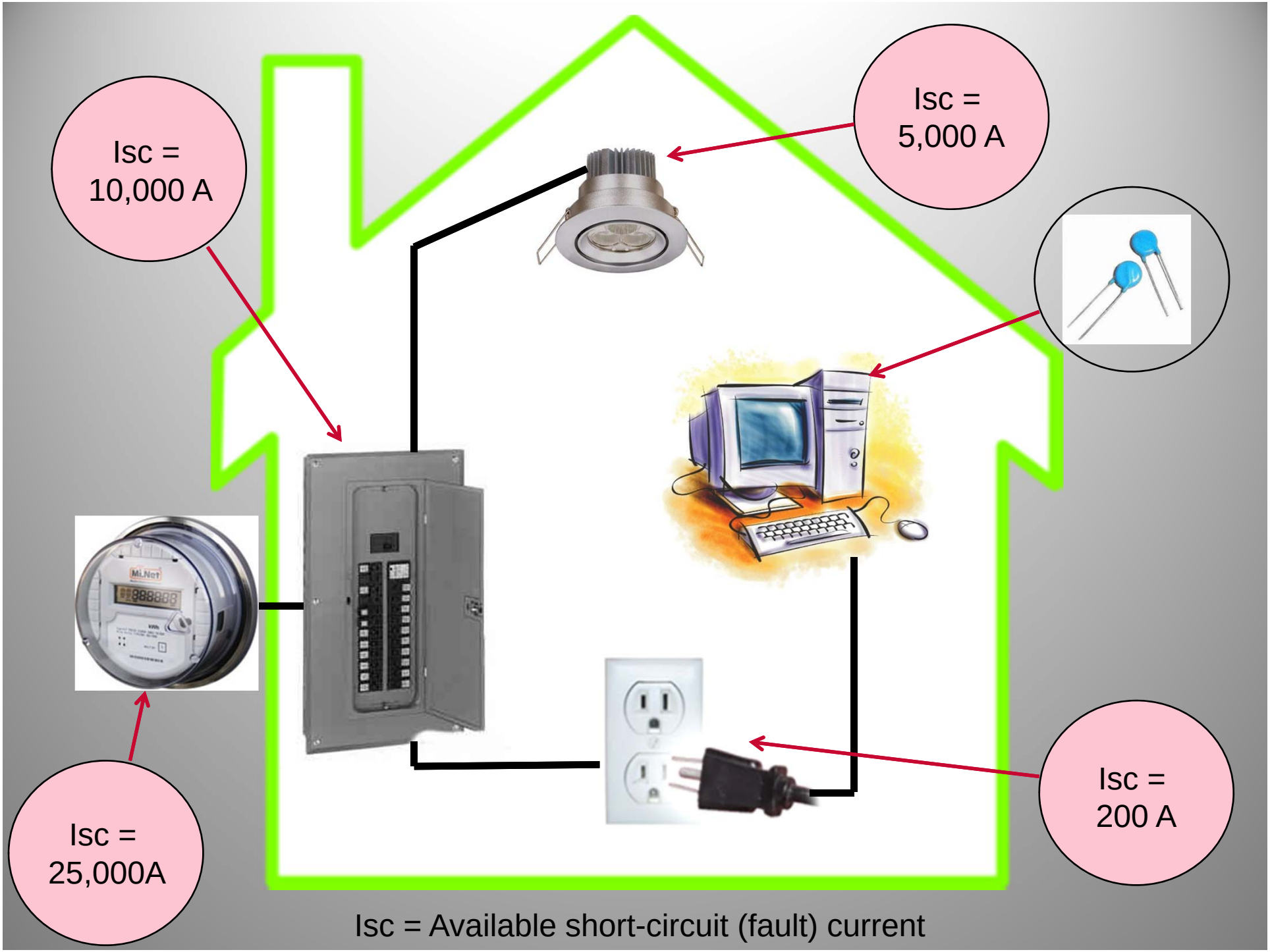
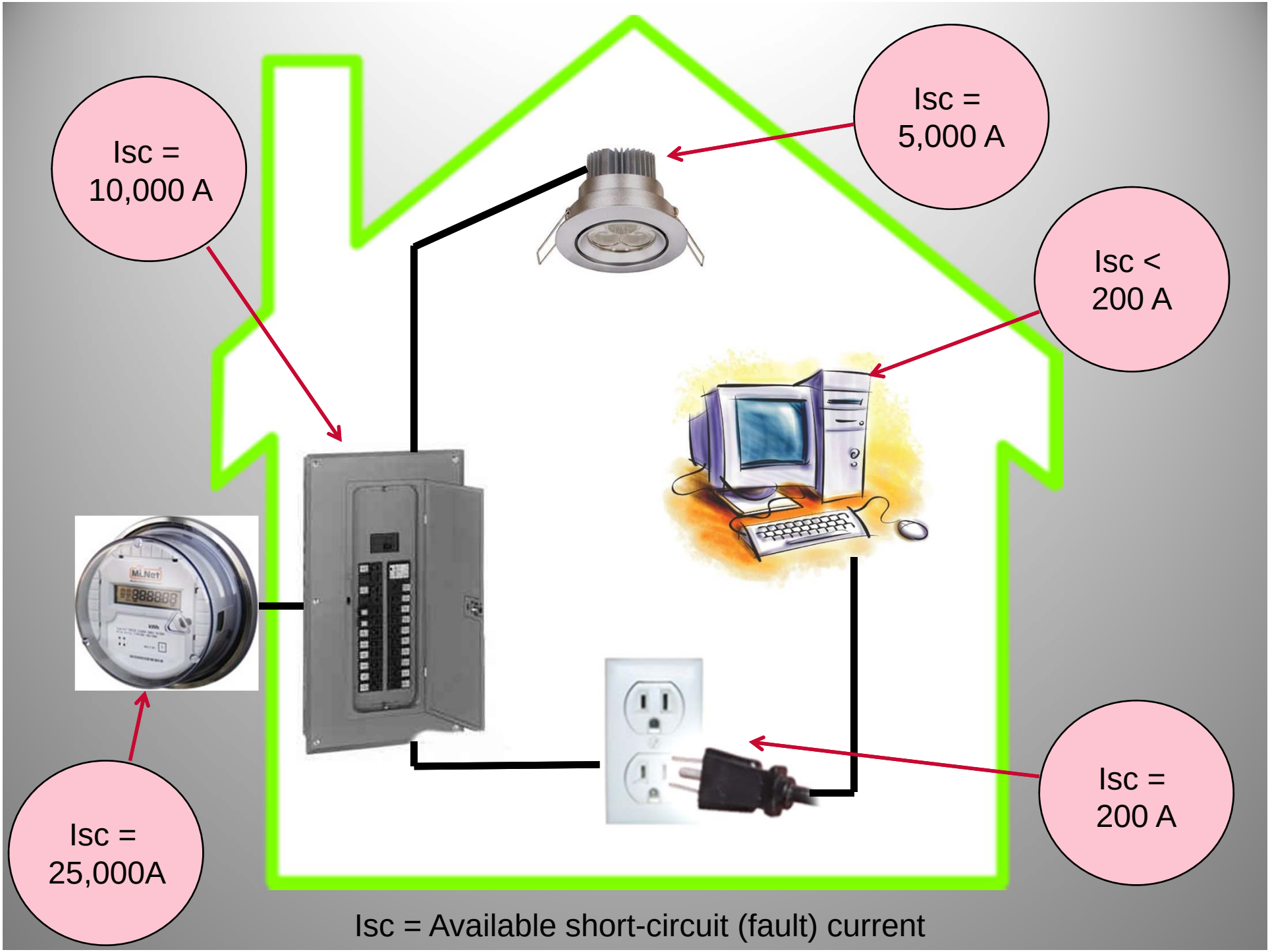
Isc =
200 A
Isc = Available short-circuit (fault) current


Isc =
10,000 A
Isc =
5,000 A
Isc =
200 A
Isc = Available short-circuit (fault) current


Isc =
10,000 A
Isc =
5,000 A
Isc =
25,000A
Isc =
200 A
Isc = Available short-circuit (fault) current


Isc = 10,000 A
Isc = 5,000 A
Isc < 200 A
Isc = 25,000A
Isc = 200 A
Isc = Available short-circuit (fault) current

# Surge Protective Devices for AC Power
# Types of Protectors

Type 1 – Permanently connected SPDs (Line Side)

Type 2 – Permanently connected SPDs (Load Side)

Type 3 – Point of utilization SPDs

Types 1, 2 and 3 – Component Assemblies

Type 4 – Component Assemblies

Type 5 – Discrete component surge suppressors

# Surge Protective Devices for AC Power
# Types of Protectors

Type 1 – Permanently connected SPDs (Line Side)

Type 2 – Permanently connected SPDs (Load Side)

Type 3 – Point of utilization SPDs

**Types 1, 2 and 3 – Component Assemblies**

**Type 4 – Component Assemblies**

**Type 5 – Discrete component surge suppressors**

**Legacy Designation:**

**Type 4 – Component SPDs, including discrete components as well as component assemblies**

# Surge Protective Devices for AC Power
# Types of Protectors

**NEC Article 100 - Definitions**

**Surge-Protective Device (SPD).** A protective device for limiting transient voltages by diverting or limiting surge current; it also prevents continued flow of follow current while remaining capable of repeating these functions and is designated as follows:

- references UL1449
- 2011 NEC specifies legacy Type designations
- 2014 NEC will also likely specify legacy Type designations

# Surge Protective Devices for AC Power
# Types of Protectors

## NEC ARTICLE 285

## Surge-Protective Devices (SPDs), 1 kV or Less

### 285.3 Uses Not Permitted

- an SPD shall not be installed where the rating of the SPD is less than the maximum continuous phase-to-ground power frequency voltage available at the point of application

### 285.5 Listing

- an SPD (surge arrester or TVSS) shall be a listed device.

# NFPA 70 – National Electrical Code
# Article 285; Types of Protectors

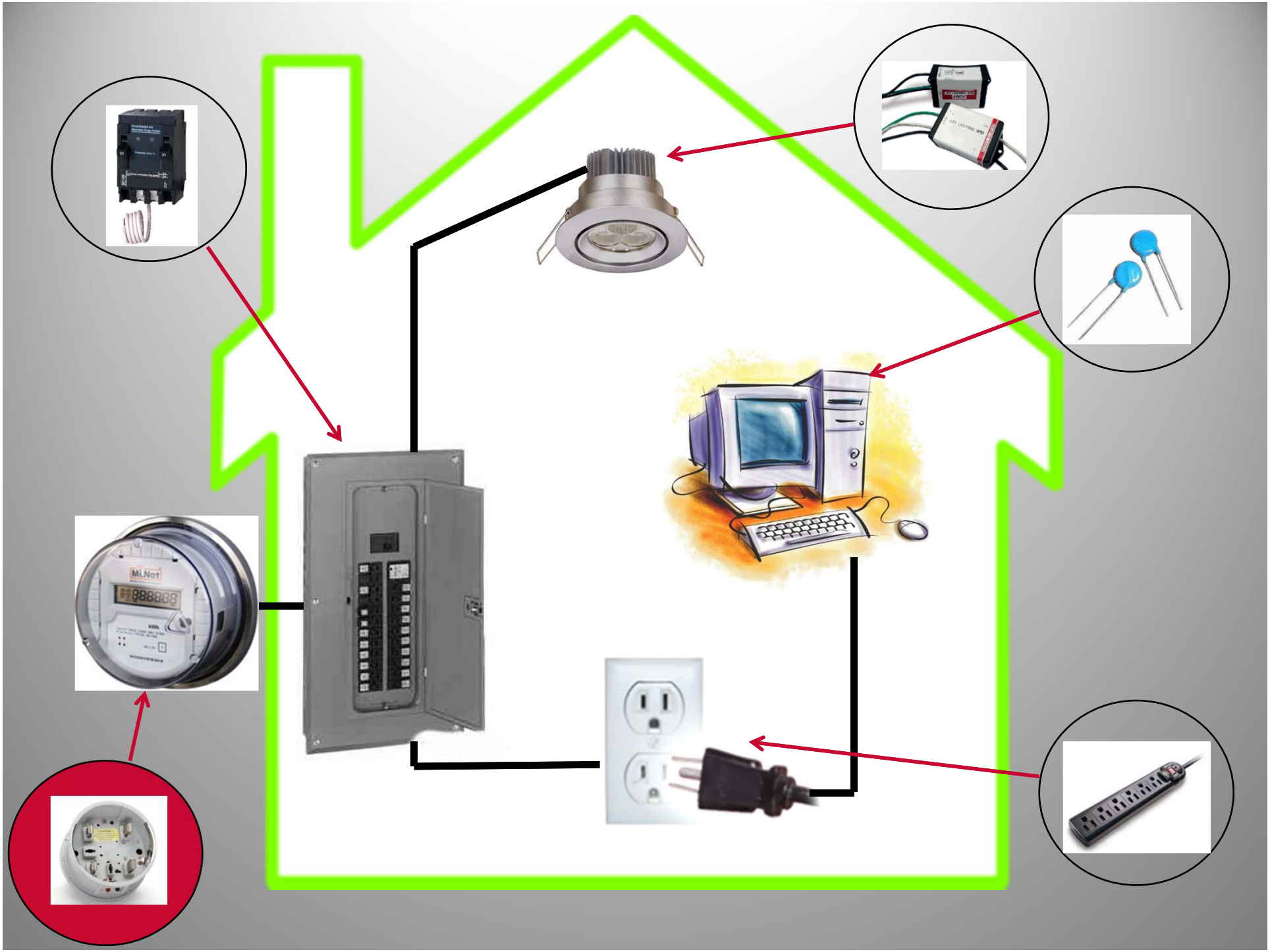
## 285.23 - Type 1

- permitted to be connected to the supply side of the service disconnect
- also permitted on load side

# UL1449, Standard for Surge Protective Devices Types of Protectors

Type 1 – Permanently connected SPDs

- line side of the service equipment overcurrent device
- includes watt-hour meter socket enclosures
- intended to be installed without an external overcurrent protective device
- load side of the service equipment overcurrent device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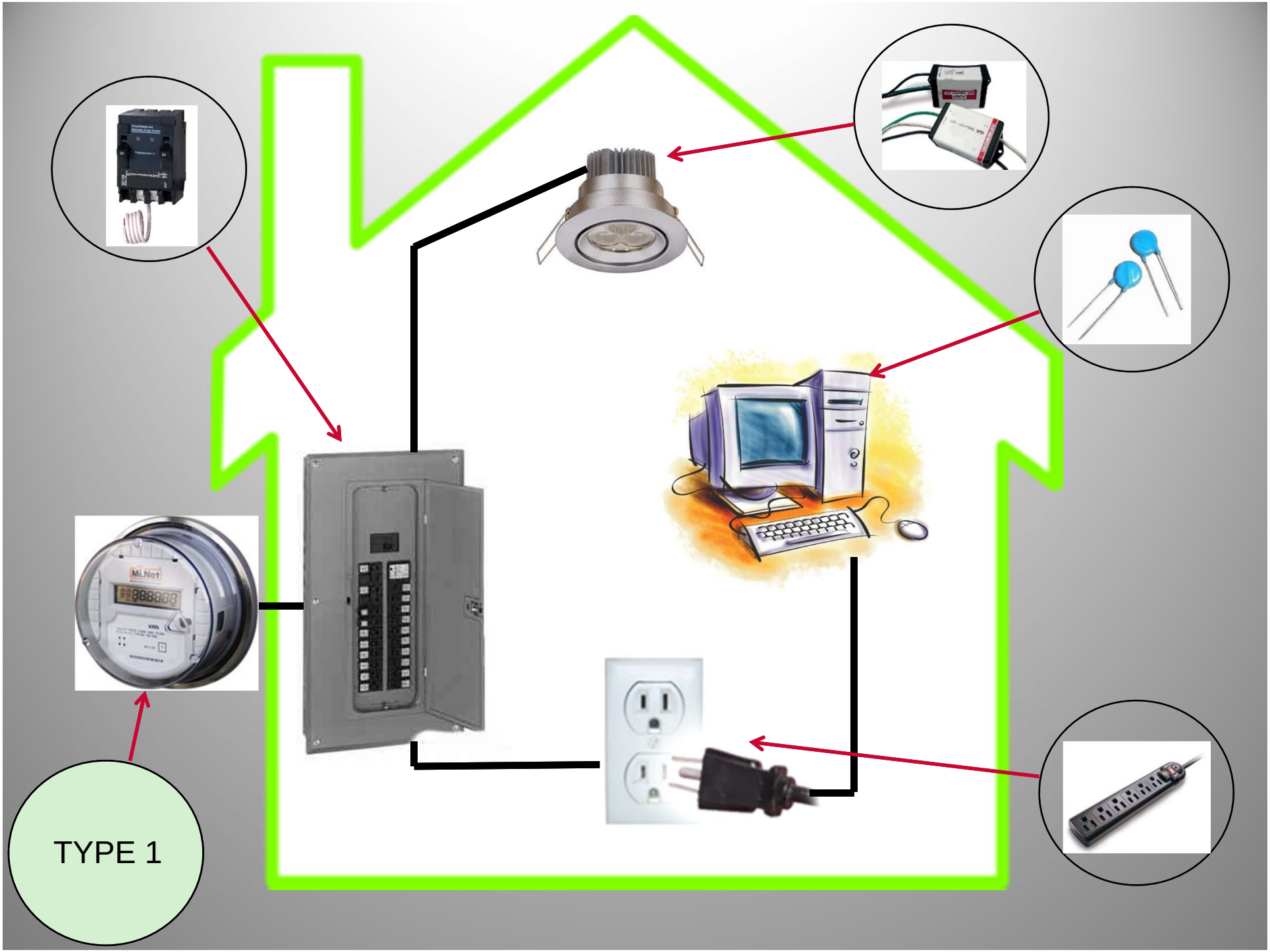
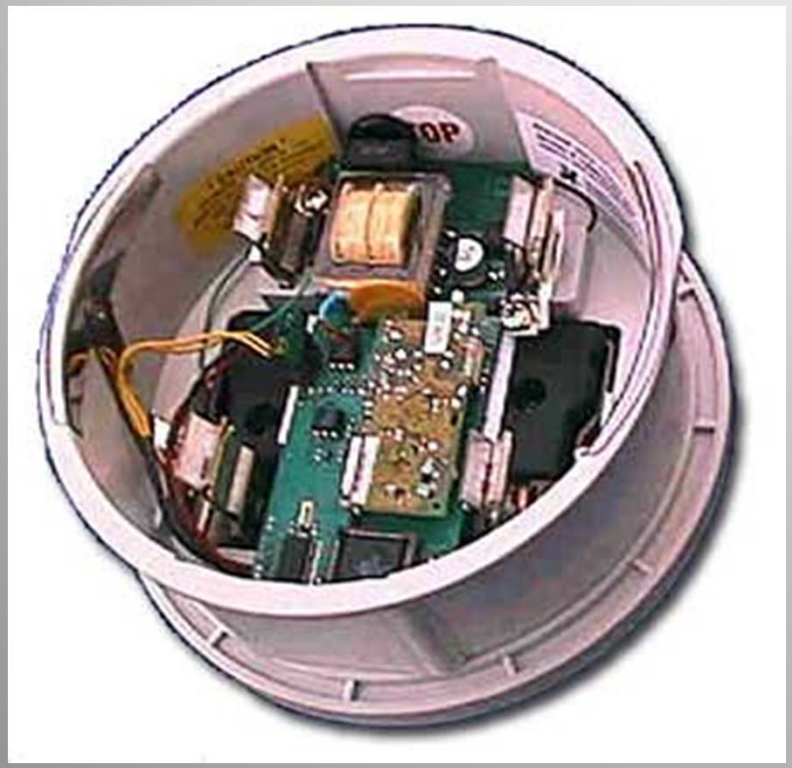
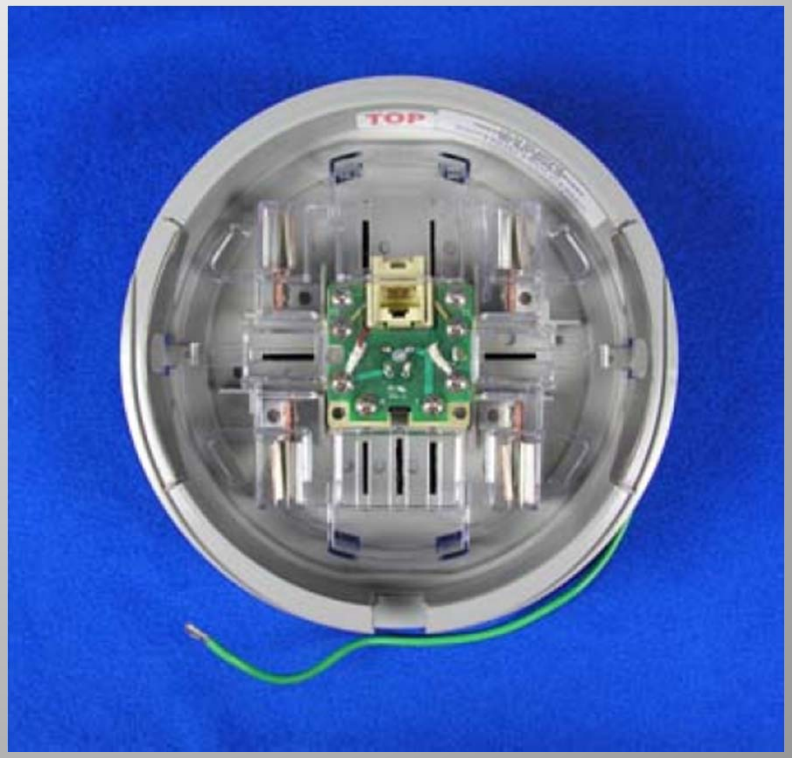

Mi.Net
TYPE 1


Isc =
20-200 kA
Isc = Available short-circuit (fault) current

# Are Type 1 SPDs provided ???






(And are other components suitable for this environment as well?)

# NFPA 70 – National Electrical Code
# Article 285; Types of Protectors

## 285.24 – Type 2

- permitted only on load side of a service disconnect or as part of listed equipment per 230.82(8)

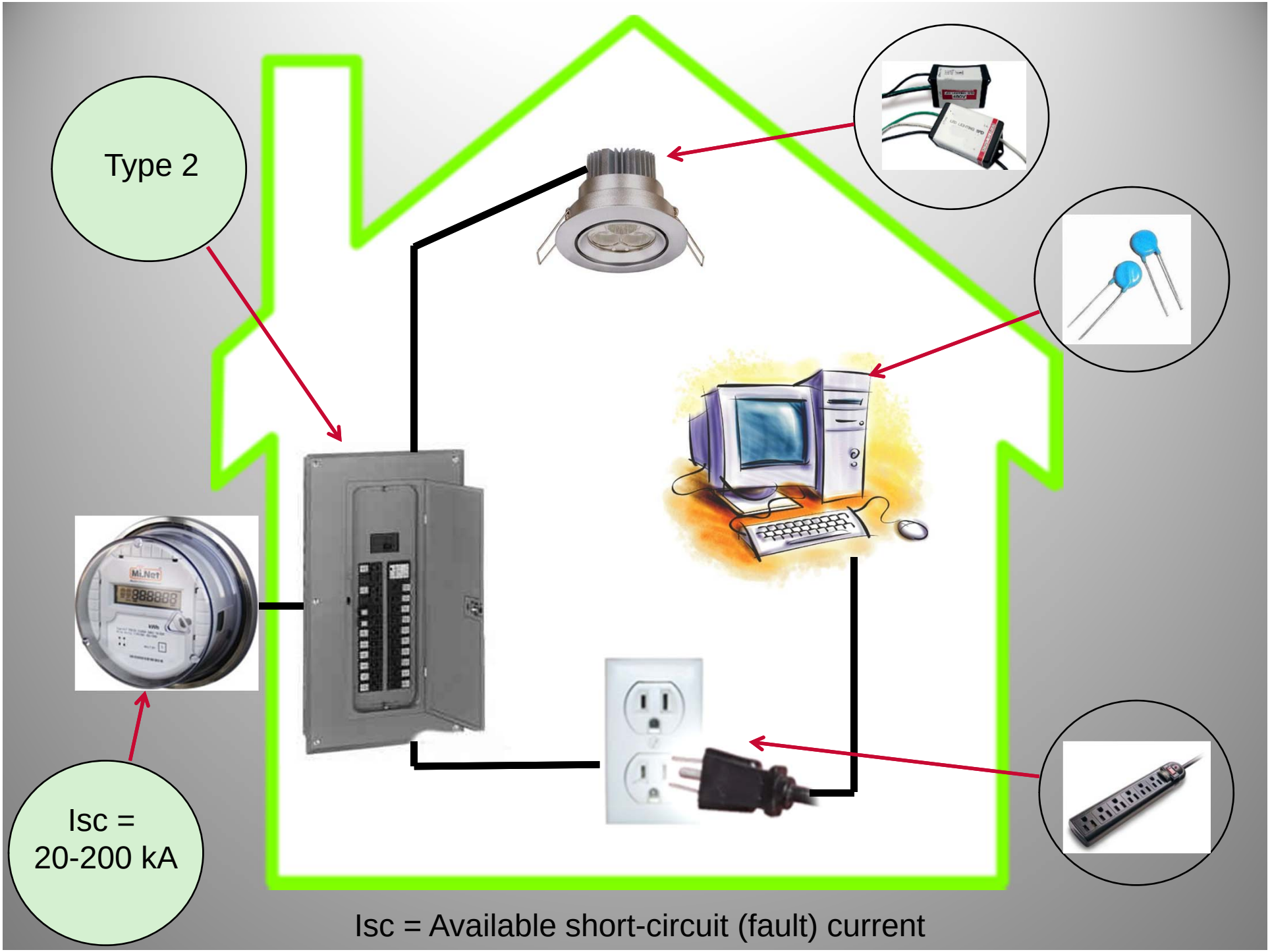
# UL1449, Standard for Surge Protective Devices Types of Protectors

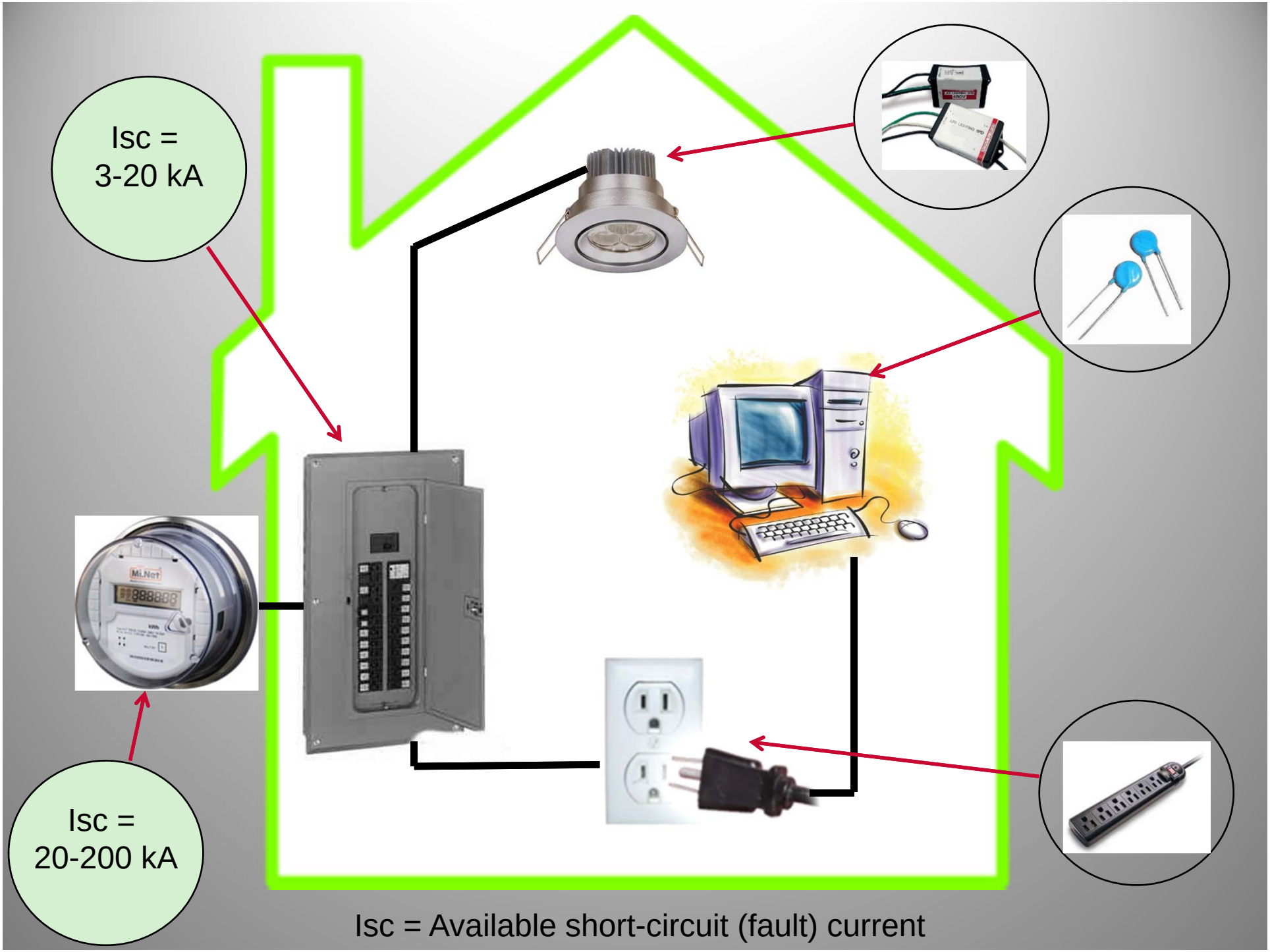
Type 2 – Permanently connected SPDs

- load side of the service equipment overcurrent device
- including SPDs located at the branch panel



Isc =
20-200 kA
Isc = Available short-circuit (fault) current


Type 2
Isc =
20-200 kA
Isc = Available short-circuit (fault) current


Isc =
3-20 kA
Isc =
20-200 kA
Isc = Available short-circuit (fault) current

# NFPA 70 – National Electrical Code
# Article 285; Types of Protectors

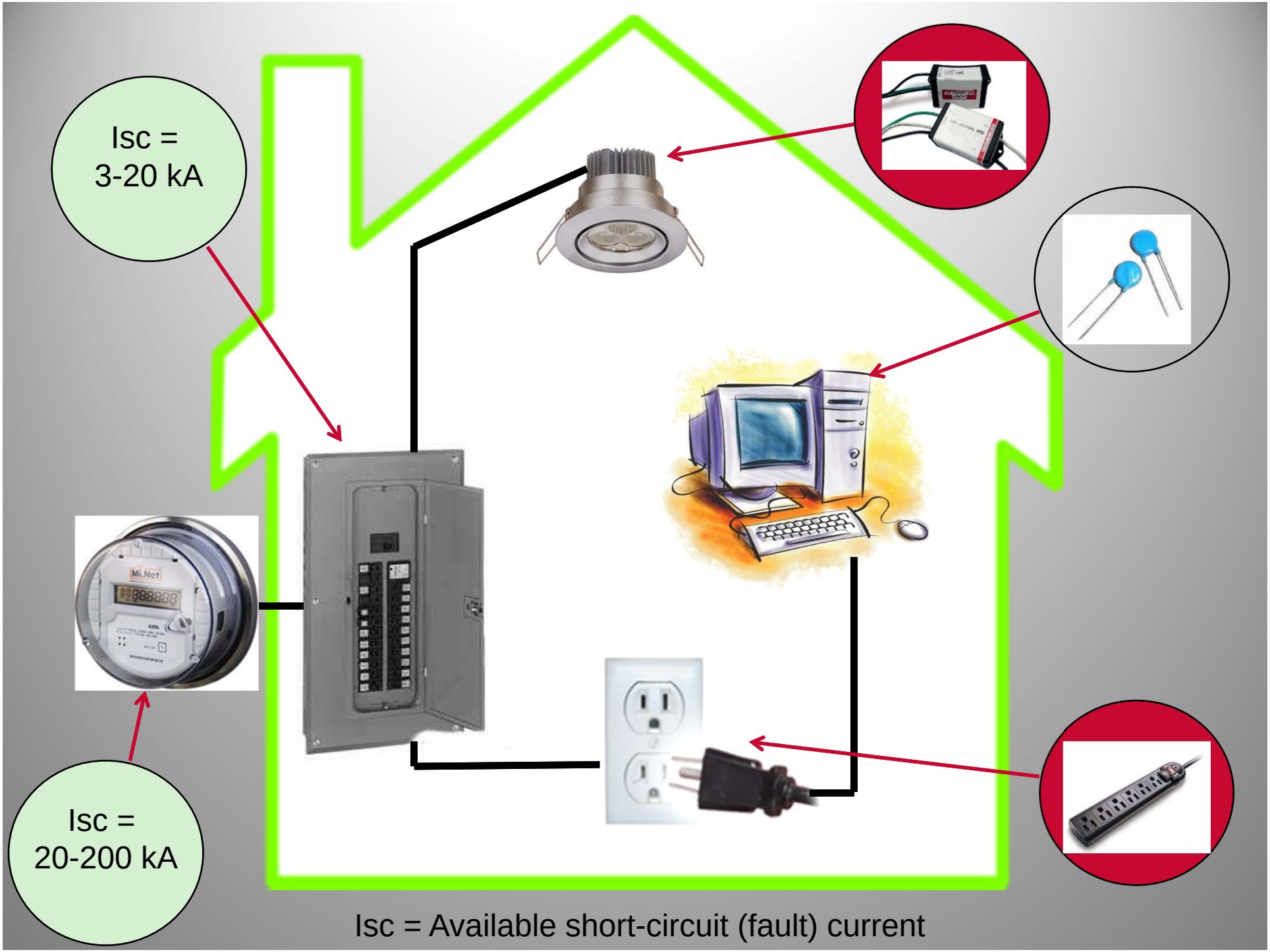
**285.6 Short-Circuit Current Rating**

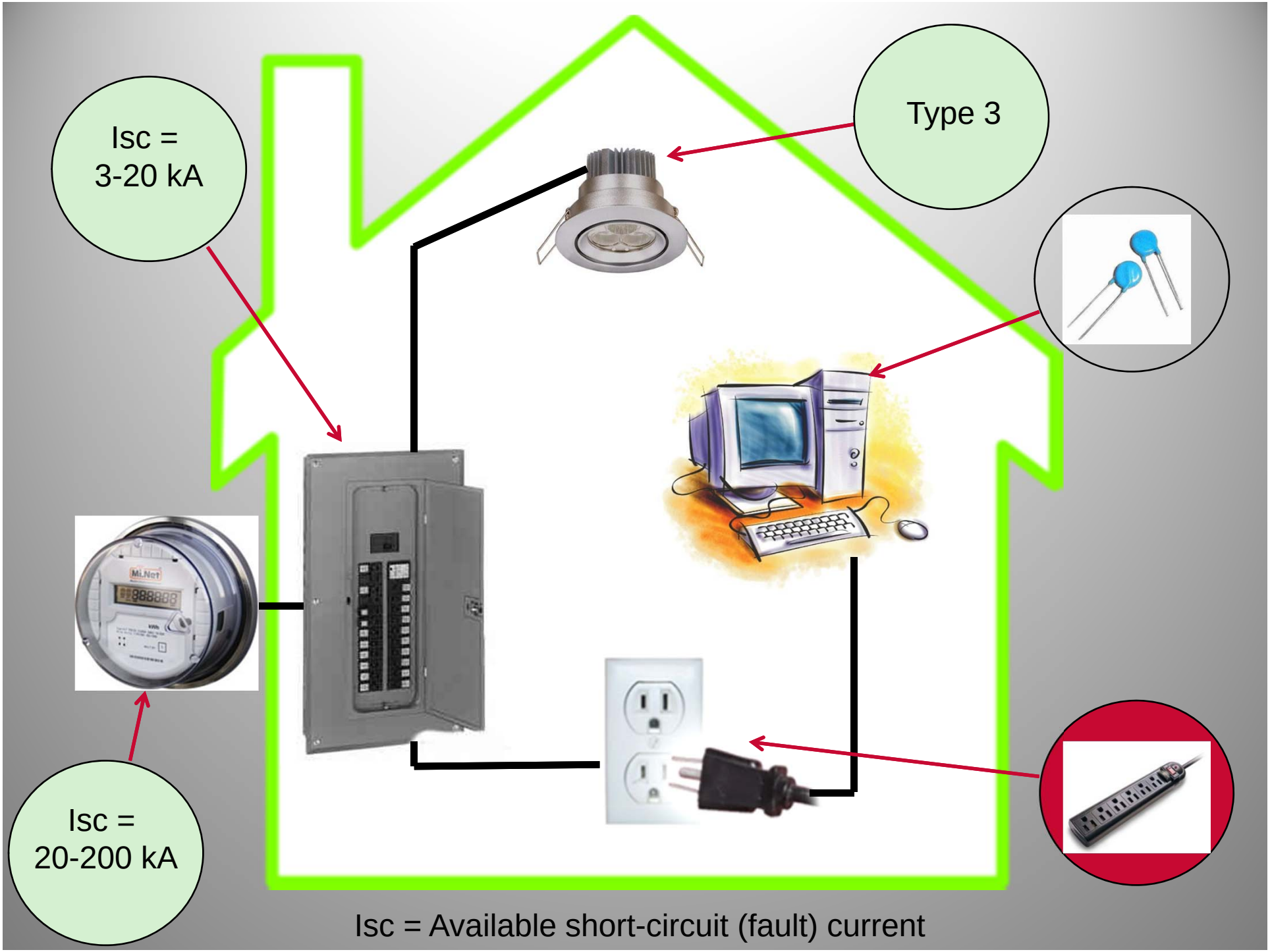
- the SPD shall be marked with a short-circuit current rating and shall not be installed at a point on the system where the available fault current is in excess of that rating

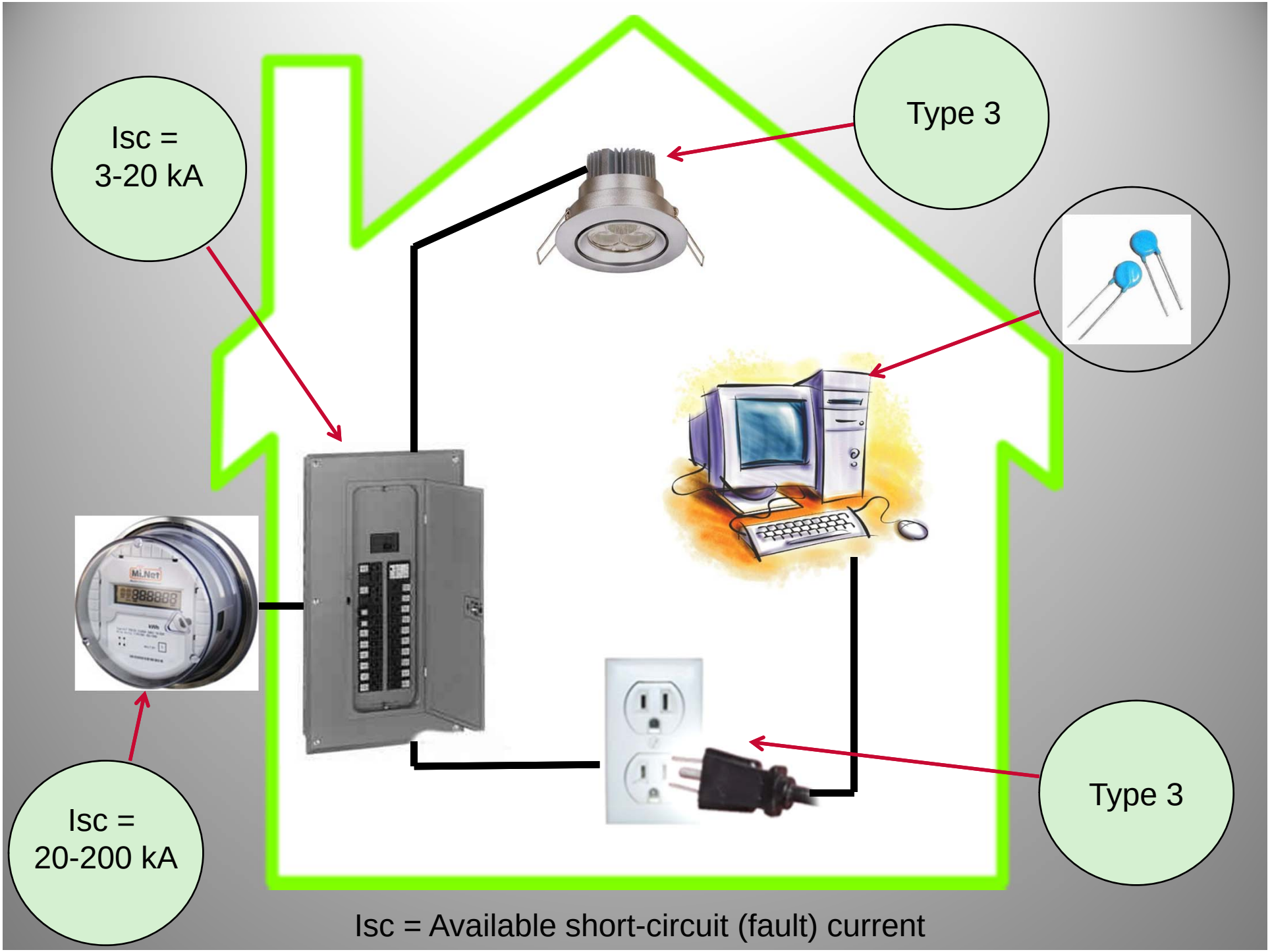
# UL1449, Standard for Surge Protective Devices Types of Protectors

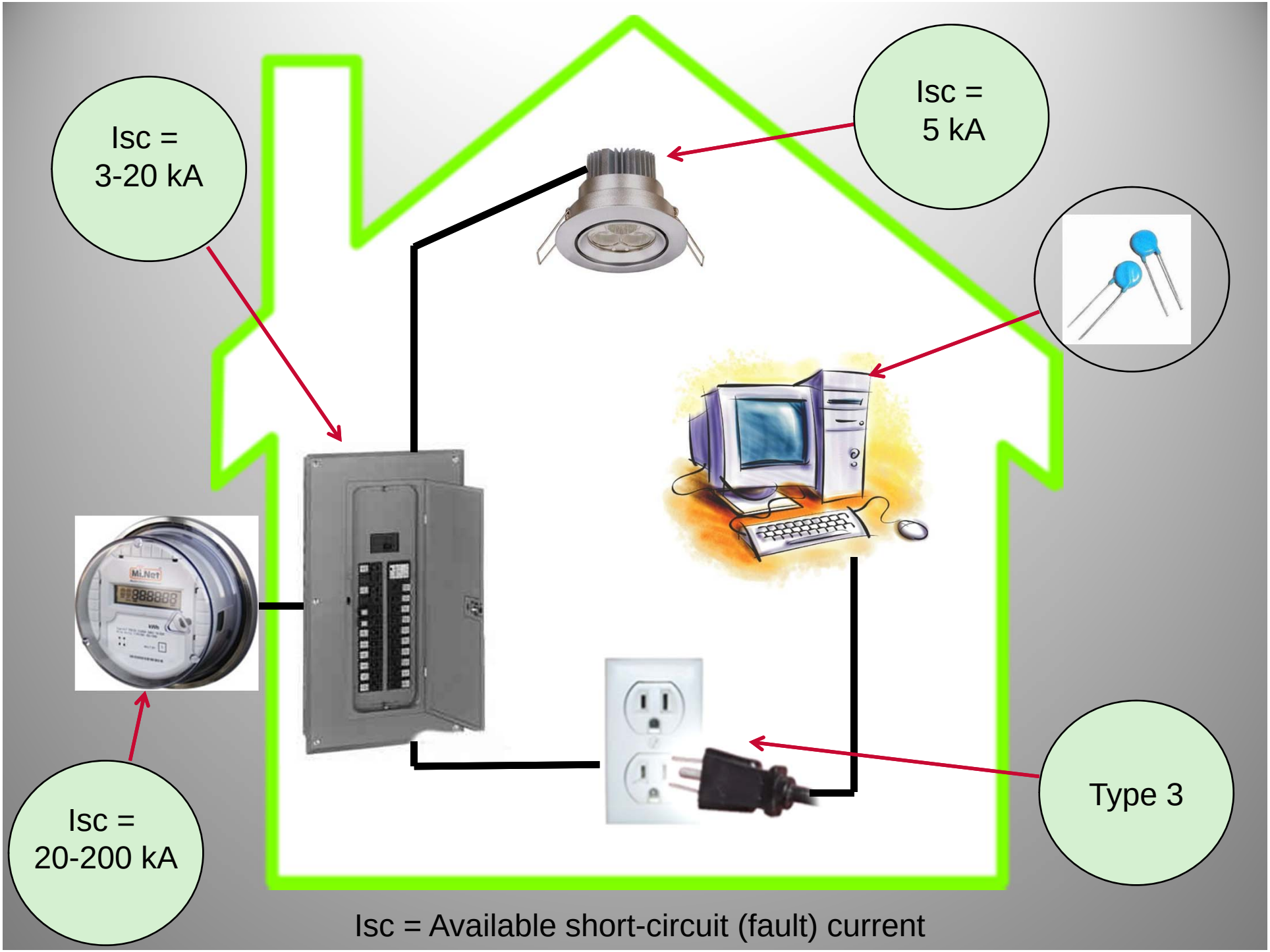
Type 3 – Point of utilization SPDs

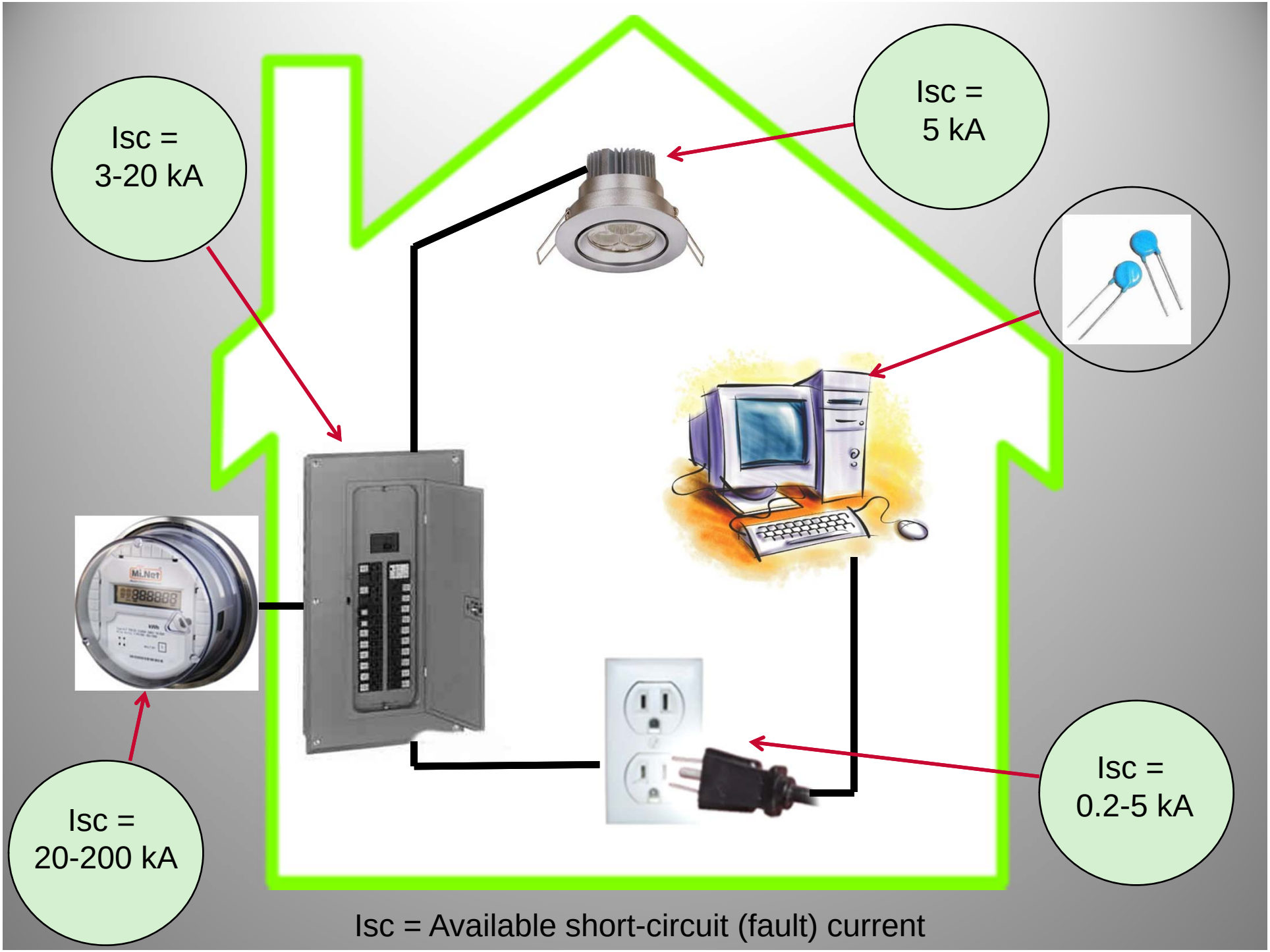
- installed at a minimum conductor length of 10 meters (30 feet) from the electrical service panel to the point of utilization, for example cord connected
- direct plug-in, receptacle type and SPDs installed at the utilization equipment being protected



Isc =
3-20 kA
Isc =
20-200 kA
Isc = Available short-circuit (fault) current

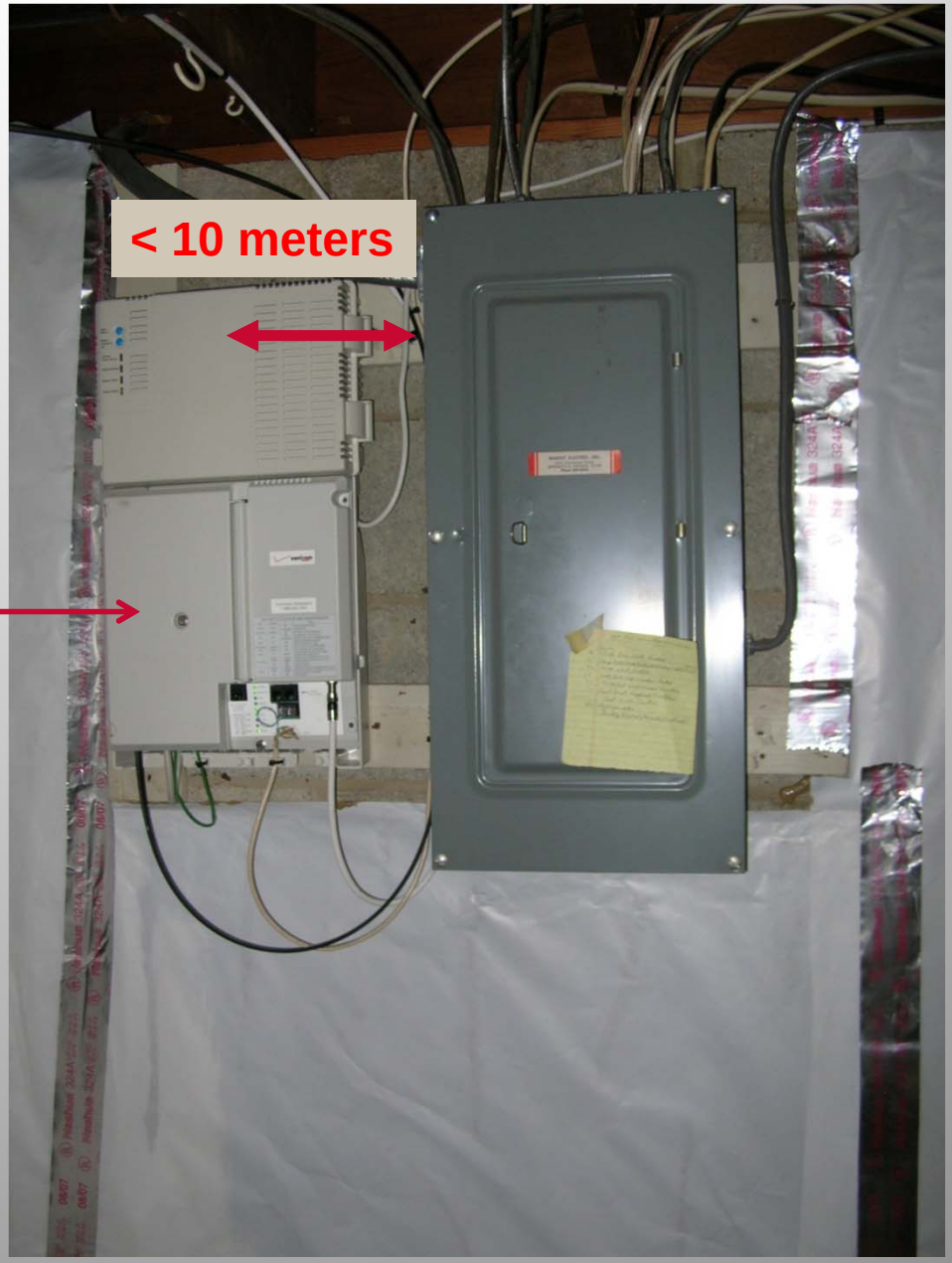

Isc =
3-20 kA
Type 3
Isc =
20-200 kA
Isc = Available short-circuit (fault) current


Isc =
3-20 kA
Type 3
Isc =
20-200 kA
Type 3
Isc = Available short-circuit (fault) current


Isc =
3-20 kA
Isc =
5 kA
Isc =
20-200 kA
Type 3
Isc = Available short-circuit (fault) current


Isc =
3-20 kA
Isc =
5 kA
Isc =
20-200 kA
Isc =
0.2-5 kA
Isc = Available short-circuit (fault) current

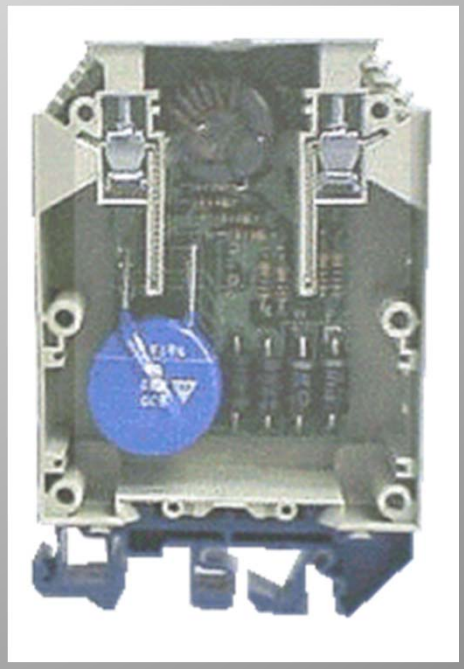
Type 2 SPD Required



# UL1449, Standard for Surge Protective Devices Types of Protectors

Type 4 – Component Assemblies

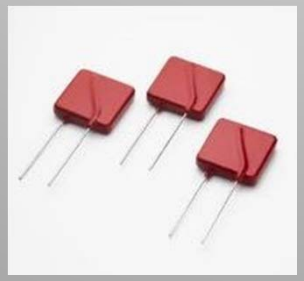
- assembly consisting of one or more Type 5 components
- disconnect (integral or external), or,
- a means of complying with the limited current tests in UL1449
- intended only for factory installation within another component, device or product

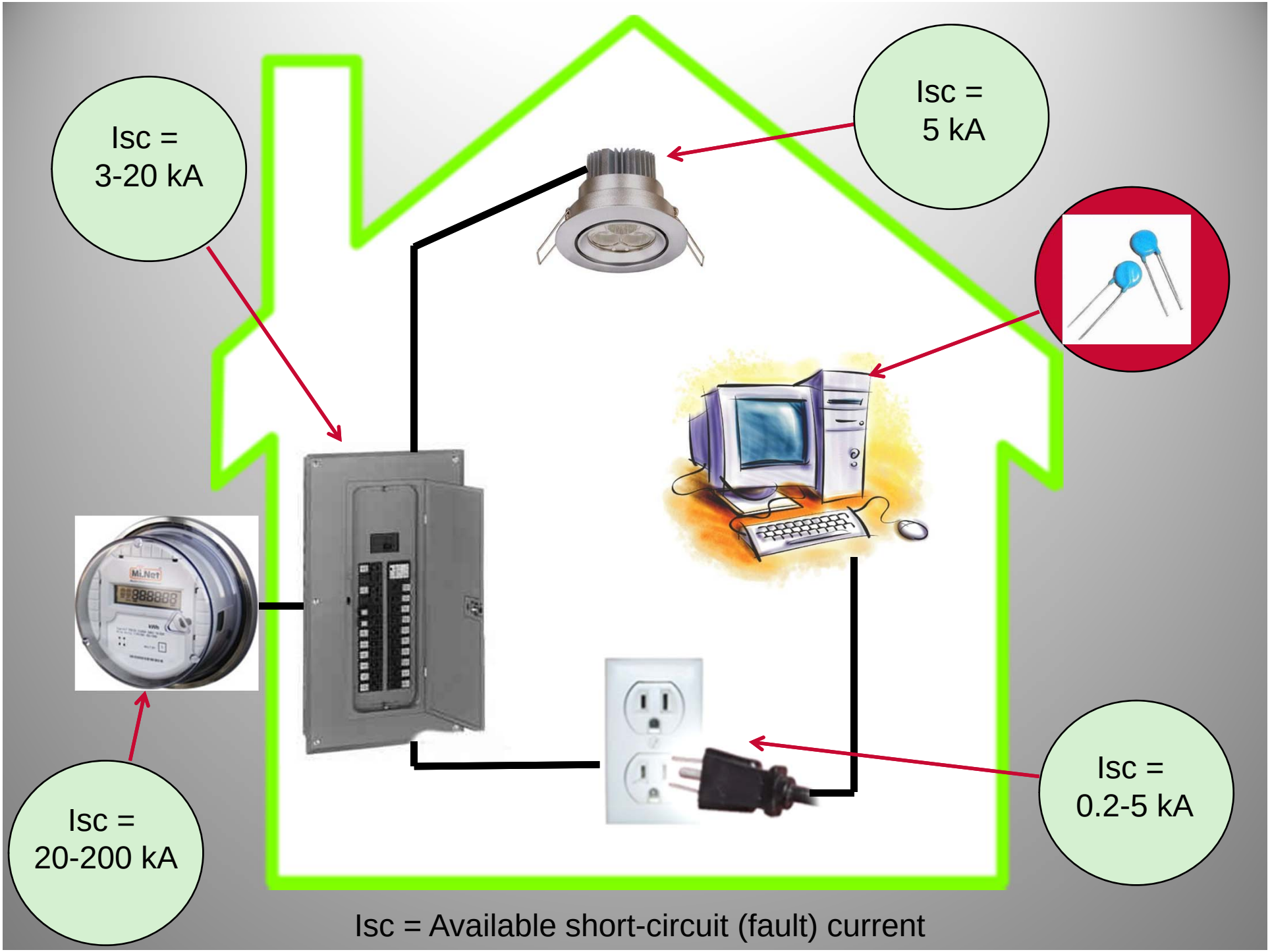


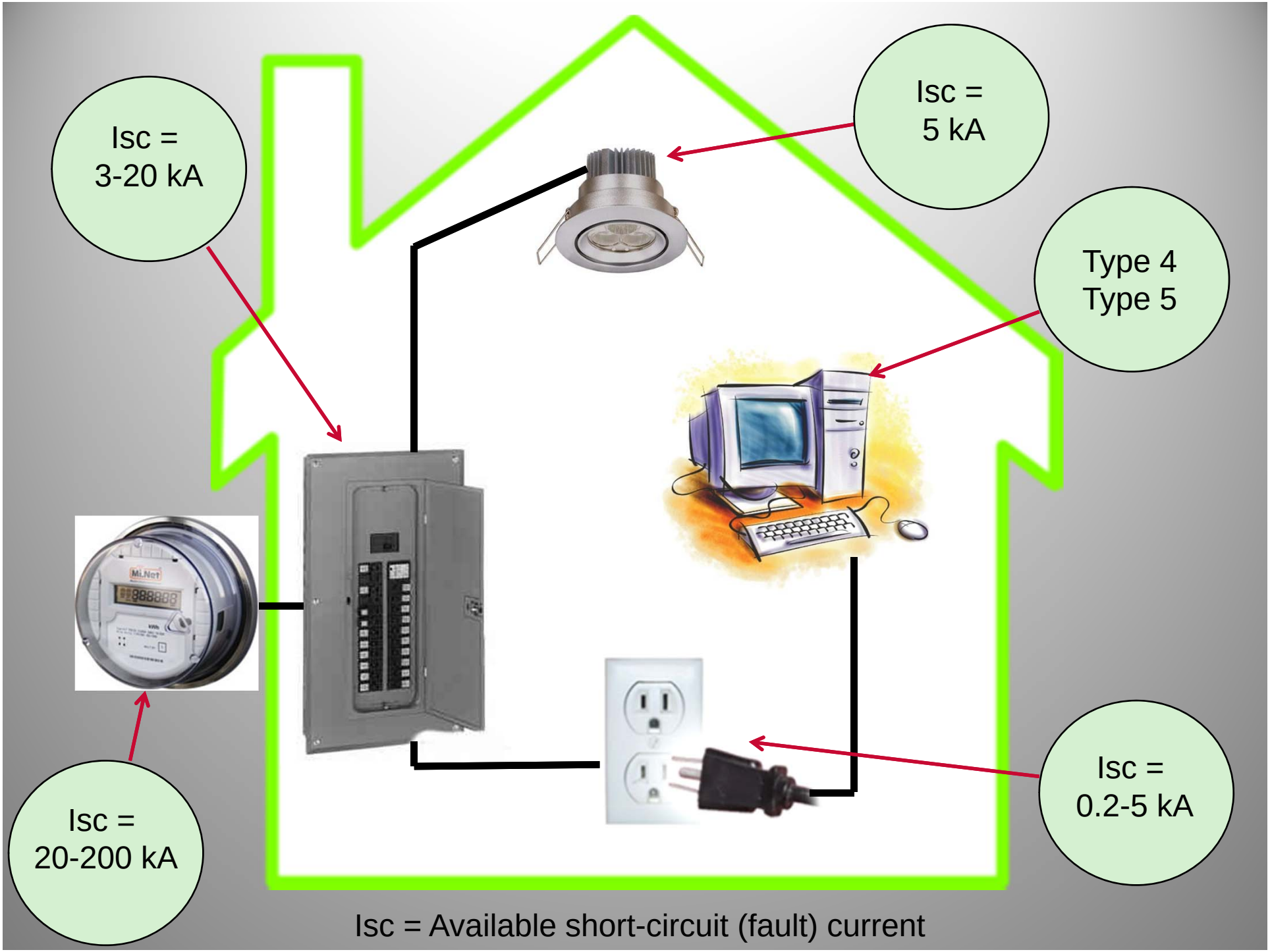
# UL1449, Standard for Surge Protective Devices Types of Protectors

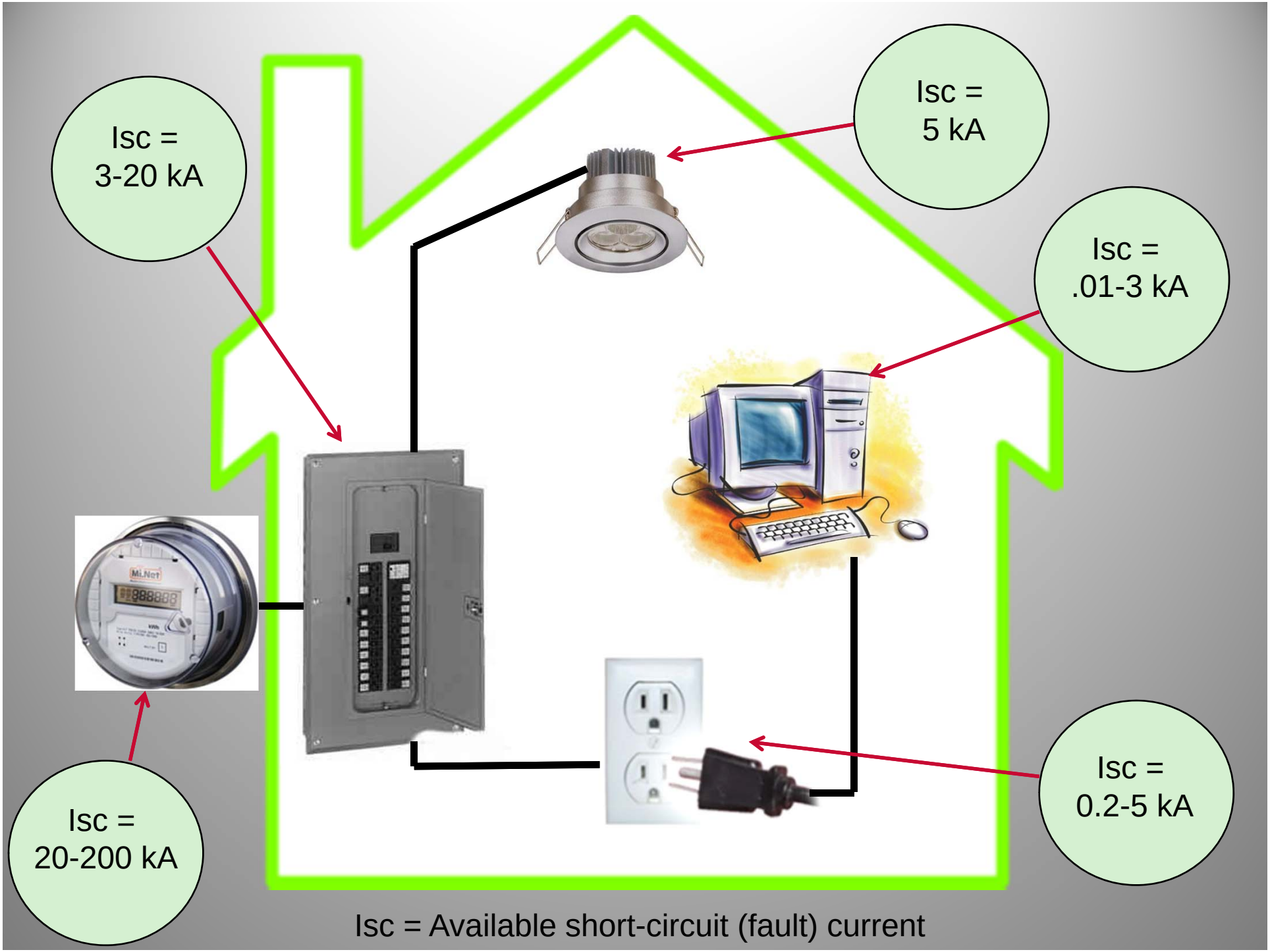
Type 5 – Discrete component surge suppressors

- components like MOVs
- mounted on a PWB or connected by its leads
- provided within an enclosure with mounting means and wiring terminations
- intended only for factory installation within another component, device or product




Isc =
3-20 kA
Isc =
5 kA
Isc =
20-200 kA
Isc =
0.2-5 kA
Isc = Available short-circuit (fault) current


Isc =
3-20 kA
Isc =
5 kA
Type 4
Type 5
Isc =
20-200 kA
Isc =
0.2-5 kA
Isc = Available short-circuit (fault) current


Isc =
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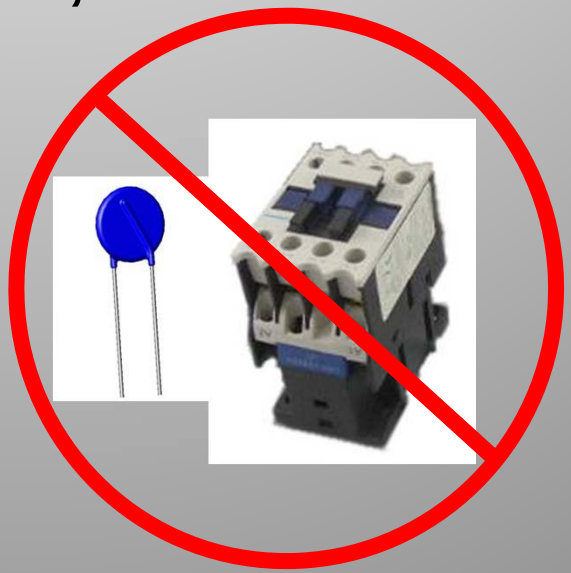
Isc =
5 kA
Isc =
.01-3 kA
Isc =
20-200 kA
Isc =
0.2-5 kA
Isc = Available short-circuit (fault) current

# UL1449, Standard for Surge Protective Devices Types of Protectors

**Types 1, 2, 3 and 4 “component assemblies” and Type 5 “discreet components” are NOT acceptable for field installation.**

**Sometimes Type 5 component MOVs are installed in the field across contactors, starter coils etc. This is NOT acceptable.**



# NFPA 70 – National Electrical Code
# Article 285;  Proposed New 285.13

**ROP**

**285.13 Type 4 and Other Component Type SPDs**. Type 4 component assemblies and other component type SPDs are only intended for factory installation and shall not be installed in the field.

# NFPA 70 – National Electrical Code
# Article 285; Proposed New 285.13

**ROC**

~~**285.13 Type 4 and Other Component Type SPDs.** Type 4 component assemblies and other component type SPDs are only intended for factory installation and shall not be installed in the field.~~

**285.13 Type 4 and Other Component Type SPDs.** Type 4 component assemblies and other component type SPDs shall only be installed by the equipment manufacturer.

# NFPA 780 – Standard for the Installation of Lightning Protection Systems

# NFPA 780 – Standard for the Installation of Lightning Protection Systems

**4.18 Surge Protection**

**4.18.2.1** SPDs shall be installed at all power service entrances.

# NFPA 780 – Standard for the Installation of Lightning Protection Systems

**4.18.5 Facility ac Surge Protection**

**4.18.5.1** The short-circuit current rating of the SPD shall be coordinated with the available fault current rating of the supply (panel) to which it is connected…

# NFPA 780 – Standard for the Installation of Lightning Protection Systems

**4.18.5 Facility ac Surge Protection**

**4.18.5.1** The short-circuit current rating of the SPD shall be coordinated with the available fault current rating of the supply (panel) to which it is connected…

**4.18.5.3** The protection of service entrances shall use Type 1 or Type 2 SPD, in compliance with applicable standards such as UL 1449, *UL Standard for Safety for Surge Protective Devices*, Edition 3.

# UL 96A – Installation Requirements for Lightning Protection Systems

**Surge Protection**

- installed on each electric service entrance
- UL 1449 and ANSI / IEEE C62.11, Standard for Metal – Oxide Surge Arresters for AC Power Circuits
- Type 1 SPD installed on the supply or load side of the service disconnect overcurrent protection
- Type 2 SPD installed on the load side of the service disconnect with overcurrent protection
- rated 20 kA or more nominal discharge current (In)

- Surge Protective Devices for AC Power
- **Protectors for Communications and Signaling Circuits**
- Grounding

# Communications and Signaling Systems

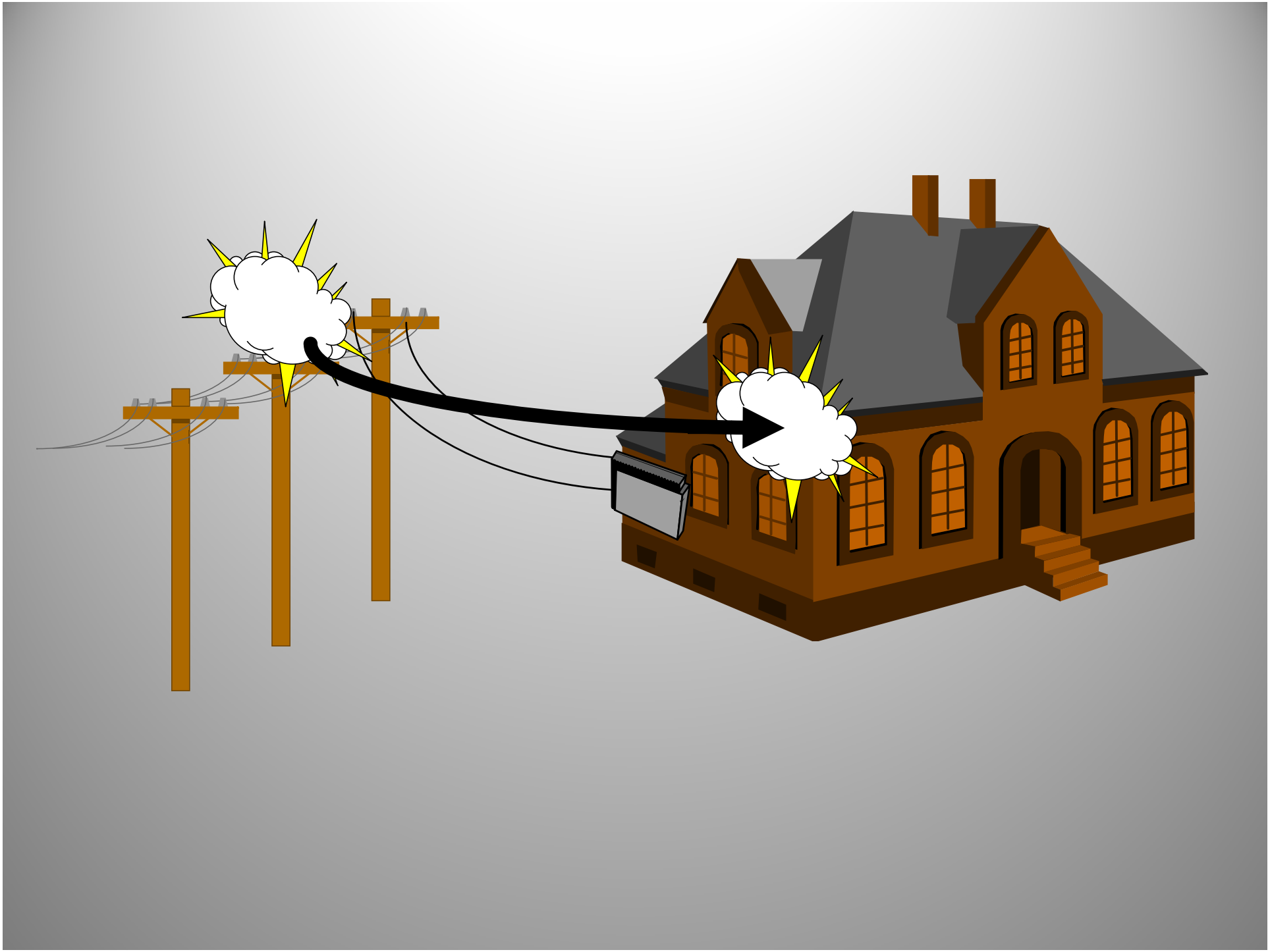
- PSTN (Traditional paired cable)
- Network Powered Broadband (Coaxial)
- Wireless (Antennas)
- Intra-building Circuits
  - Data
  - Alarm
  - Video (other than CATV or Antenna)

# Communications and Signaling Systems

- PSTN (Traditional paired cable)
- Network Powered Broadband (Coaxial)
- Wireless (Antennas)
- Intra-building Circuits
  - Data
  - Alarm
  - Video (other than CATV or Antenna)

# PSTN (Traditional Paired Cable)

- Shared facilities with power over long distances
  - Power contact
  - Induction
- Exposure to lightning
- Relatively light AWG wiring used
- Normal operating voltages / currents are low
- Secondary voltage protection can bring fault currents into the customer premises



# PSTN – Primary Protectors

**NFPA 70 – 800 Communications Circuits**

**800.90 Protective Devices.**

**(A) Application.** A listed primary protector shall be provided on each circuit run partly or entirely in aerial wire or aerial cable not confined within a block. …

**UL497 Protectors for Paired-Conductor Communications Circuits**

**Scope -** These requirements cover protectors for paired-conductor communications circuits to be used in accordance with Article 800 of the National Electrical Code, NFPA 70.

**QVGV Primary Protectors for Communications Circuits**

This category covers protectors intended for use on communication circuits as defined in Article 800 of ANSI/NFPA 70, "National Electrical Code" (NEC).

# PSTN – Primary Protectors

**NFPA 780- Standard for the Installation of Lightning Protection Systems**

**4.18.6 Signal, Data, and Communications Surge Protection.**

- **4.18.6.1** SPDs shall be provided for all signal, data, and communication lines at facility entrances.

**4.18.3 Surge Threat Levels.**

**4.18.3.2 Signal, Data, and Communication Protection.**

- SPDs shall be listed for the protection of signal, data, and communications systems and shall have an *Imax* rating of at least **10 kA 8/20** or greater when installed at the entrance.

# Primary Protectors

# UL497 Primary Protectors

**18 Limited Short-Circuit Current Test**

- The test currents to be employed are 60, 120, and 350 amperes at not less than 480 volts rms
- The protector must carry the fault current until the fuse wire (bridal wire) opens

**19 Abnormal Operation Test**

- 30 amperes rms at 480 volts minimum for 15 minutes

**20 Endurance Conditioning Test**

- 500 cycles of a 10 ampere (short-circuit peak), 10 X 1000 µs wave with an open circuit minimum voltage of 1000 volts
- 100 cycles of a 100 ampere (short-circuit peak), 10 X 1000 µs waveform with an open circuit minimum voltage of 1000 volts
- Two cycles of a 5000 ampere (short-circuit peak), 8 X 20 µs waveform with an open circuit minimum voltage of 1000 volts

# UL497 Primary Protectors

**20 Endurance Conditioning Test (for NFPA 780)**

- 500 cycles of a 10 ampere (short-circuit peak), 10 X 1000 µs wave with an open circuit minimum voltage of 1000 volts
- 100 cycles of a 100 ampere (short-circuit peak), 10 X 1000 µs waveform with an open circuit minimum voltage of 1000 volts
- Two cycles of a ~~5000~~ 10,000 ampere (short-circuit peak), 8 X 20 µs waveform with an open circuit minimum voltage of 1000 volts

For devices that comply with the 8X20, 10 kA surge test required in NFPA 780, as indicated in the Listing information, this product name shall include “10 KA”.

# UL497 Primary Protectors – NFPA 780

# PSTN – Secondary Protectors

**NFPA 70 – 800 Communications Circuits**

**800.90 Protective Devices.**

**800.90 (D) Secondary Protectors**

Where a secondary protector is installed in series with the indoor communications wire and cable between the primary protector and the equipment, it shall be listed for the purpose…

**800.170 (B) Listing - Secondary Protectors**

The secondary protector shall be listed as suitable to provide means to safely limit currents to less than the current-carrying capacity of listed indoor communications wire and cable,…

# PSTN – Secondary Protectors

**UL497A Secondary Protectors for Communications Circuits**

**Scope -** Secondary protectors are intended to be used in the protected side of telecommunications networks that have an operating rms voltage to ground less than 150 volts and installed or used in accordance with the National Electrical Code, NFPA 70.

**QVRG Secondary Protectors for Communications Circuits**

- These protectors are intended to suppress abnormal voltage and/or current conditions that bypass the primary protector …
- Secondary protectors covered in this category have been investigated for use only on the equipment side of a primary protector …

# Secondary Protectors

# UL 497A Secondary Protectors

## 27 Overvoltage Test

27.1.1 A secondary protector shall limit current, current extinguish, or open the telephone loop circuit without loss of its voltage protection, or indication of a risk of fire or electric shock

- 40 amperes, 600V, 1.5 sec
- 7 amperes, 600V, 5 sec
- 2.2, 1.0, 0.5, and 0.25 amperes, 600V, 30 min
- 2.2A, 200 < V < 600 volts, 30 min
- 24 amperes, 240 volts, 30 min

## 28 Endurance Conditioning

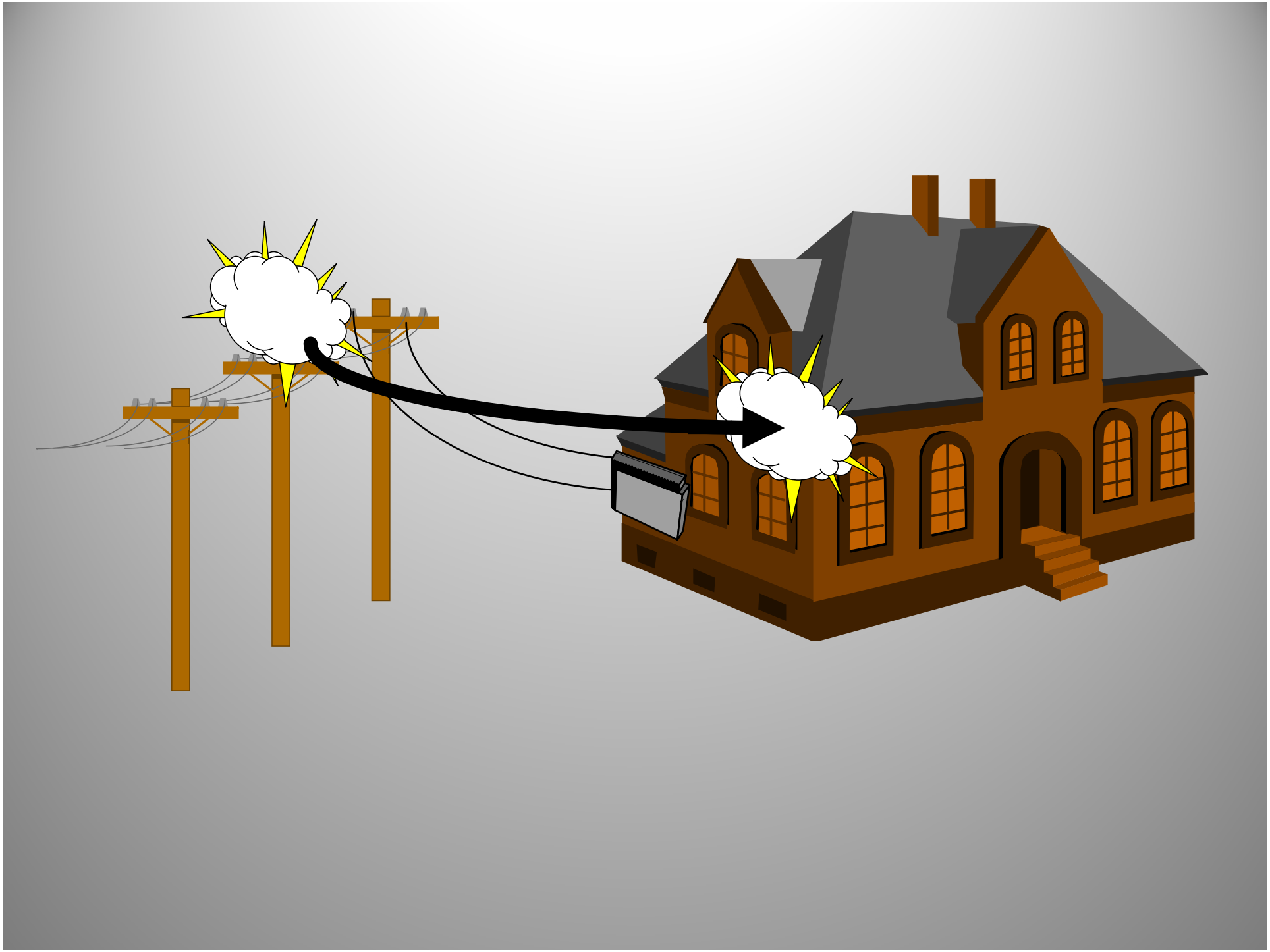
- 100 cycles of a 14 ampere (short-circuit peak), 10 X 1000 µs waveform with an open circuit minimum voltage of 1000 volts

# Communications and Signaling Systems

- PSTN (Traditional paired cable)
- Network Powered Broadband (Coaxial)
- Wireless (Antennas)
- Intra-building Circuits
  - Data
  - Alarm
  - Video (other than CATV or Antenna)

# Network Powered Broadband (Coaxial)

- Shared facilities with power over long distances
  - Power contact (Shield or center conductor)
  - Induction
- Exposure to lightning
- Coaxial shield equivalent to 6-8 AWG and can carry large fault currents
- No fuse wire in drop
- Operating voltages / currents can present a risk of electric shock



# Network Powered Broadband (Coaxial)

**NFPA 70 – 830 Communications Circuits**

**830.90 Primary Electrical Protection.**

- **(A) Application.** Primary electrical protection shall be provided on all network-powered broadband communications conductors that are neither grounded nor interrupted and are run partly or entirely in aerial cable not confined within a block …

**UL497C Protectors for Coaxial Communications Circuits**

Scope - These requirements cover protectors for use on coaxial cable circuits to be used in accordance with the applicable requirements of the National Electrical Code, NFPA 70

**QVKC Primary Protectors for Coaxial Communications Circuits**

This category covers primary coaxial protectors intended for use on coaxial communication circuits and network-powered broadband communications systems as defined in Article 830 of ANSI/NFPA 70, "National Electrical Code" (NEC).

# Primary Protectors for Coaxial Communications Circuits

# UL497C - Protectors for Coaxial Communications Circuits

**16 Limited Short-Circuit Current Test**

- Tested with a specified current limiting device
- The test currents to be employed are 60, 120, and 350 amperes at not less than 480 volts rms
- The protector must carry the fault current until the current limiting device opens

**17 High Current Ground Path Test**

- A coaxial cable circuit protector shall withstand a continuous fault current, which is capable of being caused by a power contact to the outer coaxial metal shield, …
- 80 amperes, 600 volts, 15 minutes

# UL497C - Protectors for Coaxial Communications Circuits

## 18 Cable Shield Fuse Test

- A coaxial cable circuit protector shall withstand a high current fault of 3500 amperes, which is capable of being caused by a power contact to the outer coaxial metal shield….
- The protector shall also maintain a ground continuity of 0.6 ohm or less

## 19 Endurance Conditioning Test

- 500 cycles of a 10 ampere (short-circuit peak), 10 X 1000 µs wave with an open circuit minimum voltage of 1000 volts.
- 100 cycles of a 100 ampere (short-circuit peak), 10 X 1000 µs waveform with an open circuit minimum voltage of 1000 volts.
- Two cycles of a 5000 ampere (short-circuit peak), 8 X 20 µs waveform with an open circuit minimum voltage of 1000 volts.

# Coaxial Fault Protectors

NEC 830.44(I) - Aerial Cables On Buildings

**(4) Protection from Damage.** Network-powered broadband communications cables attached to buildings and located within 2.5 m (8 ft) of finished grade shall be protected by enclosures, raceways, or other approved means.

# Coaxial Fault Protectors

NEC 830.44(I) - Aerial Cables On Buildings

**(4) Protection from Damage.** Network-powered broadband communications cables attached to buildings and located within 2.5 m (8 ft) of finished grade shall be protected by enclosures, raceways, or other approved means.

*Exception: A low-power network-powered broadband communications circuit that is equipped with a **listed fault protection device**, appropriate to the network-powered broadband communications cable used, and located on the network side of the network-powered broadband communications cable being protected.*

# Coaxial Fault Protectors

830.47 - Underground Circuits Entering Buildings

**(C) Mechanical Protection.**

**…**direct buried cables emerging from the ground shall be protected by enclosures, raceways, or other approved means extending from the minimum cover distance …

# Coaxial Fault Protectors

830.47 - Underground Circuits Entering Buildings

**(C) Mechanical Protection.**

**...**direct buried cables emerging from the ground shall be protected by enclosures, raceways, or other approved means extending from the minimum cover distance …

*Exception: A low-power network-powered broadband communications circuit that is equipped with a **listed fault protection device**, appropriate to the network-powered broadband communications cable used, and located on the network side of the network-powered broadband communications cable being protected.*

# Coaxial Fault Protectors

**Subject 2389 Coaxial Fault Protectors for Network-Powered Broadband Communications Systems**

Scope - … The coaxial fault protector monitors the coaxial circuit for open conditions in the center conductor and for shorts or leakage current to ground from the center conductor.

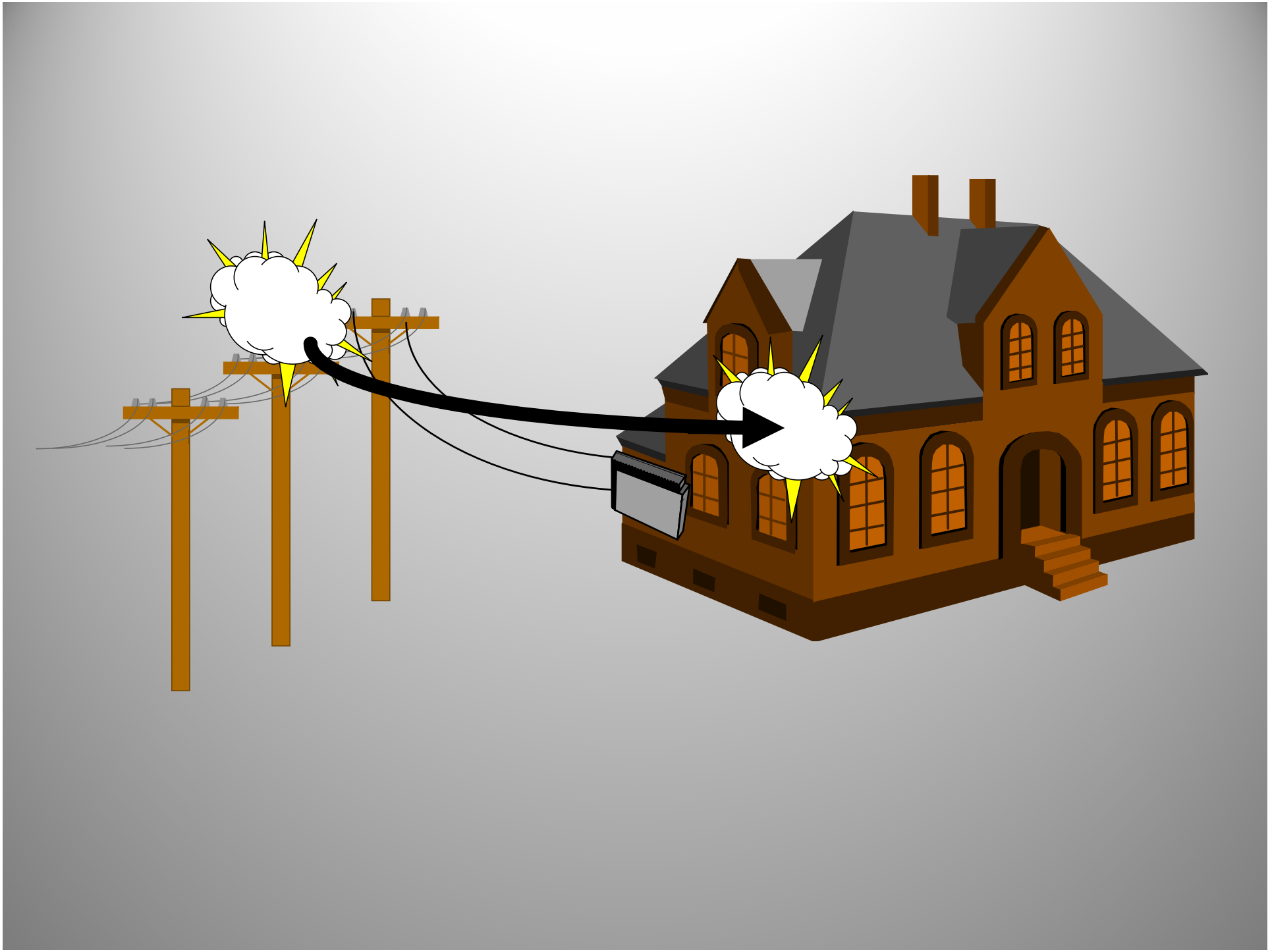
**DUAA Coaxial Fault Protectors for Network-Powered Broadband Communications Systems**

The units or systems covered in this category are designed to monitor, detect and disconnect network power on the communication cable when a fault condition exists.

# SU 2389 - Coaxial Fault Protectors

**7 Normal Operation Test**

- A leakage current detection level of between 0.5 – 5.0 mA is required
- Required to disconnect power in less than 7.2 seconds from point of fault detection when the leakage current level of 5.0 mA is reached



# SU 2389 - Coaxial Fault Protectors

**9 Limited Short-Circuit Current Test**

- The test currents to be employed are 60, 120, and 350 amperes at not less than 480 volts rms.
- The protector must still be operational after this test

**10 Endurance Conditioning Test**

- 500 cycles of a 10 ampere (short-circuit peak), 10 X 1000 µs wave with an open circuit minimum voltage of 1000 volts.
- 100 cycles of a 100 ampere (short-circuit peak), 10 X 1000 µs waveform with an open circuit minimum voltage of 1000 volts.
- Two cycles of a 5000 ampere (short-circuit peak), 8 X 20 µs waveform with an open circuit minimum voltage of 1000 volts.

# Communications and Signaling Systems

- PSTN (Traditional paired cable)
- Network Powered Broadband (Coaxial)
- Wireless (Antennas)
- Intra-building Circuits
  - Data
  - Alarm
  - Video (other than CATV or Antenna)

# Wireless (Antennas)

- High exposure to lightning
- High surge currents
- Shared facilities generally not an issue

# Wireless (Antennas)

**NFPA 70 – 810 Radio and Television Equipment**

**Proposed for 2014 NEC**

**New 810.6 Antenna Lead-In Protectors.** Where an antenna lead-in surge protector is installed it shall be listed as being suitable for limiting surges on the cable that connects the antenna to the receiver/transmitter electronics and be connected between the conductors and the grounded shield or other ground connection

**Subject 497E Protectors for Antenna Lead-in Conductors**

Scope - These protectors are intended to protect equipment, wiring, and personnel at the premises against the effects of excessive potentials and currents on the conductors caused by lightning.

# Wireless (Antennas)

**QVLA Protectors for Antenna Lead-in Conductors**

This category covers protectors for antenna lead-in conductors. These devices are used to limit surges on the antenna lead-in cable that connects the antenna to the receiver/transmitter electronics and are connected between the coaxial center conductor and the grounded shield (coaxial cable) or between the individual leads and ground (twisted pair, twin-lead, etc., cable).

**NFPA 780- Standard for the Installation of Lightning Protection Systems**

**4.18.6 Signal, Data, and Communications Surge Protection.**

- **4.18.6.1** SPDs shall be provided for all signal, data, and communication lines at facility entrances.

(Antenna lead-in conductors are considered one of these)

# Protectors for Antenna Lead-In Conductors

# SU497E - Protectors for Antenna Lead-In Conductors

**11 Maximum Discharge Current (Imax) Test**

- The surge is 8/20 at the rated maximum rated discharge current (Imax). One impulse is applied
- Typical values can be 10kA, 25 kA, 50 kA

**16.1 Impulse endurance conditioning test**

- 500 cycles of a 10 ampere (short-circuit peak), 10 X 1000 µs wave with an open circuit minimum voltage of 1000 volts
- 100 cycles of a 100 ampere (short-circuit peak), 10 X 1000 µs waveform with an open circuit minimum voltage of 1000 volts
- Two cycles of a 5000 ampere (short-circuit peak), 8 X 20 µs waveform with an open circuit minimum voltage of 1000 volts

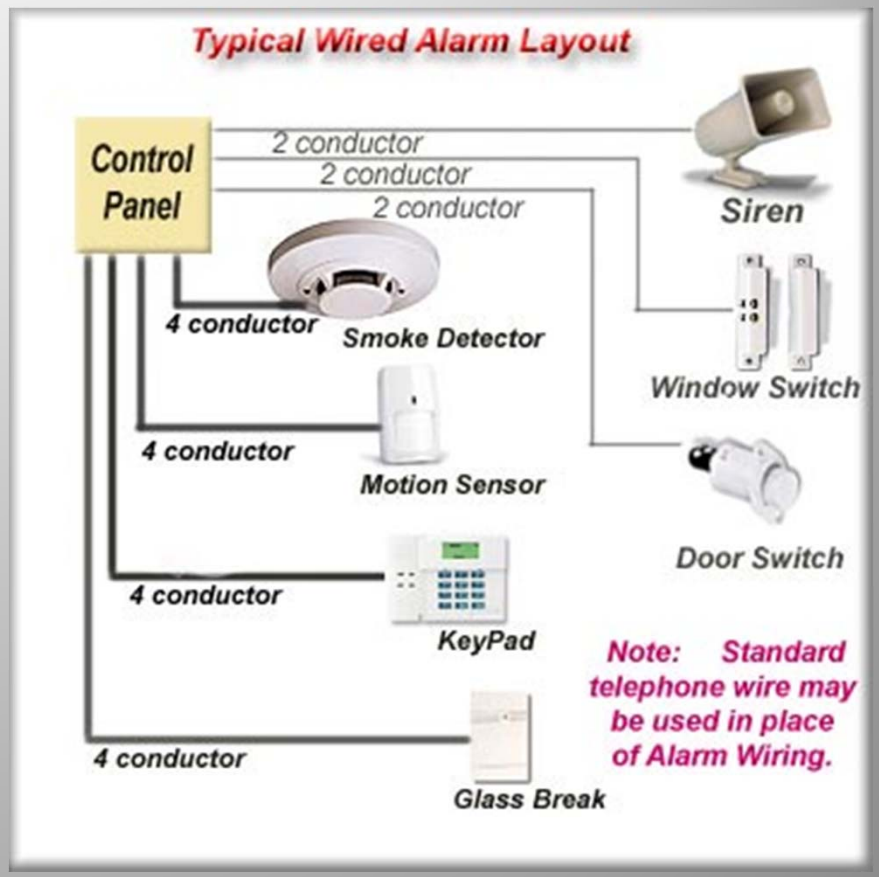
# Communications and Signaling Systems

- PSTN (Traditional paired cable)
- Network Powered Broadband (Coaxial)
- Wireless (Antennas)
- Intra-building Circuits
  - Data
  - Alarm
  - Video (other than CATV or Antenna)

# Intra-Building Circuits

- Secondary exposure to lightning effects
- Operating voltages / currents are low (signal or Class 2 limited power)
- NEC requires separation from electric power and light circuits
- No NEC requirements for protection

# Intra-Building Circuits



# Intra-Building Circuits

**UL497B Protectors for Data Communications and Fire-Alarm Circuits**

**Scope -** These requirements cover protectors for data communications and fire-alarm circuits.

**QVGQ Isolated Loop Circuit Protectors**

This category covers protectors intended for use on Class 2 or Class 3 remote control, signaling and power-limited circuits or *power-limited fire-alarm signaling circuits* as defined in Articles 725 and 760 of ANSI/NFPA 70, "National Electrical Code" (NEC).

These protectors are intended as suppression devices for abnormal voltage conditions that may exist on the circuit due to electrical transients from an electromagnetic disturbance.

These protectors are not intended for use on circuits exposed to accidental contact with electric light or power conductors operating at over 300 V to ground.

# UL497B - Protectors for Data Communications and Fire-Alarm Circuits

**13 Endurance Conditioning**

•50 cycles each polarity of a 10-ampere by 1000-volt pulse, each pulse consisting of a 10 X 1000 waveform

- Surge Protective Devices for AC Power
- Protectors for Communications and Signaling Circuits
- **Grounding**

# Surge Protective Devices for AC Power - Grounding

**285.28 Grounding Electrode Conductor Connections and Enclosures.** Except as indicated in this article, SPD grounding connections shall be made as specified in Article 250, Part III.

# Grounding Electrode System

250.50 Grounding Electrode System. All grounding electrodes that are bonded together form the grounding electrode system.

**(1) Metal Underground Water Pipe**

**(2) Metal Frame of the Building or Structure**

**(3) Concrete-Encased Electrode**

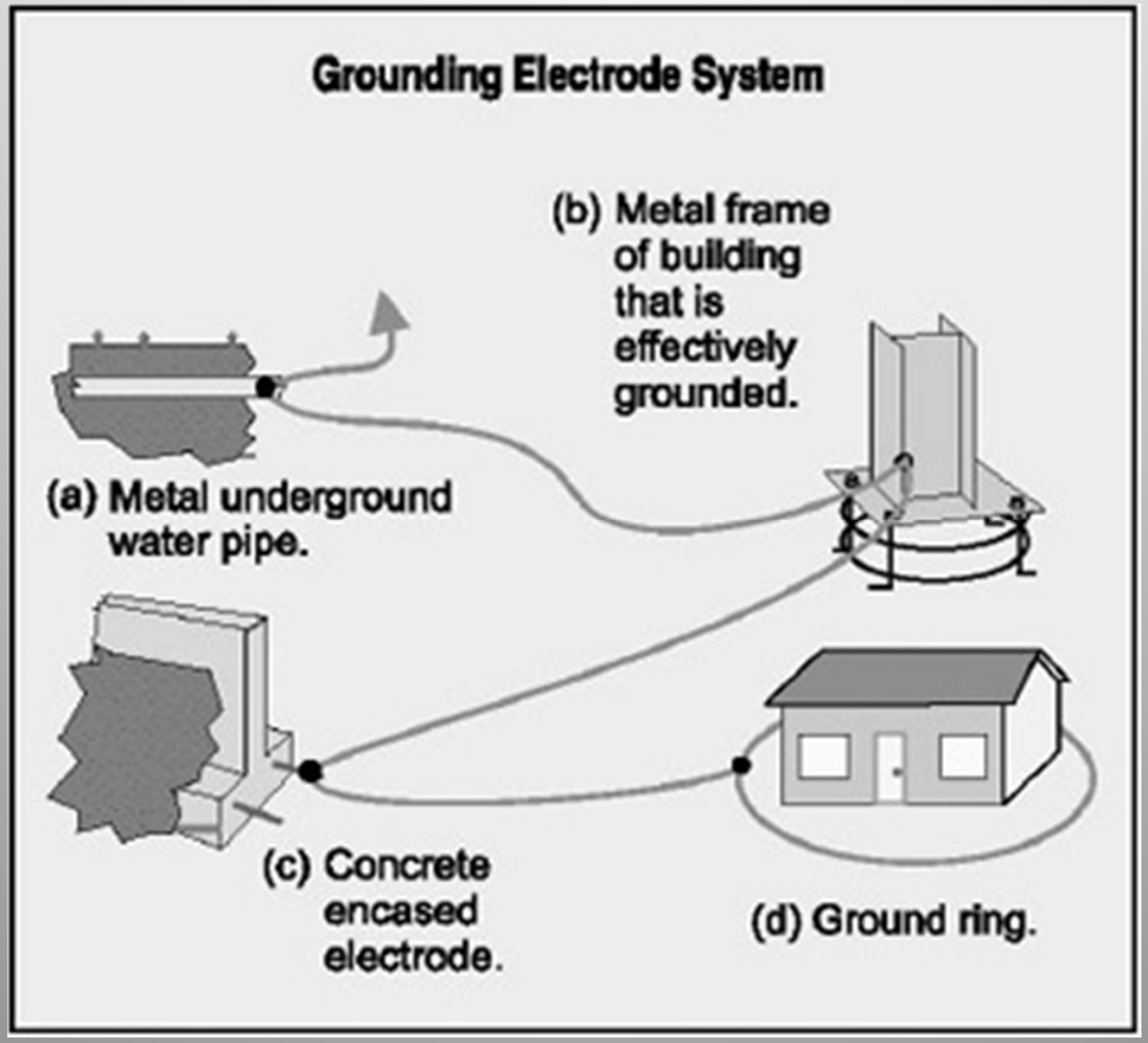
**(4) Ground Ring**

**(5) Rod and Pipe Electrodes**

**(6) Other Listed Electrodes**

**(7) Plate Electrodes**

# Grounding Electrode System



## Grounding Electrode System

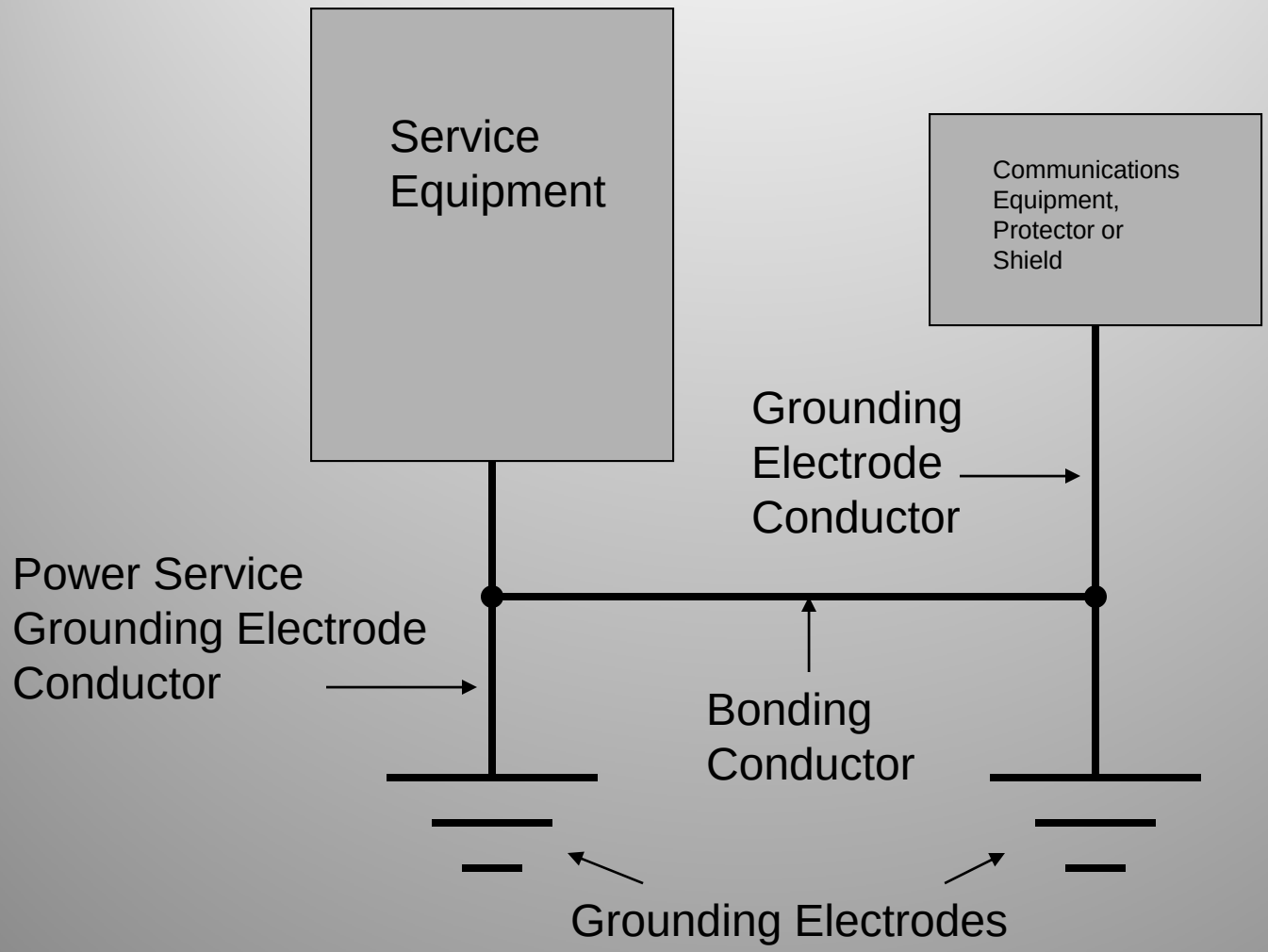
“Grounding Electrode Conductor”

-Connects things that need to be grounded to a grounding electrode or grounding electrode system.

“Bonding Conductor”

-Bonds or connects parts of a grounding system together.

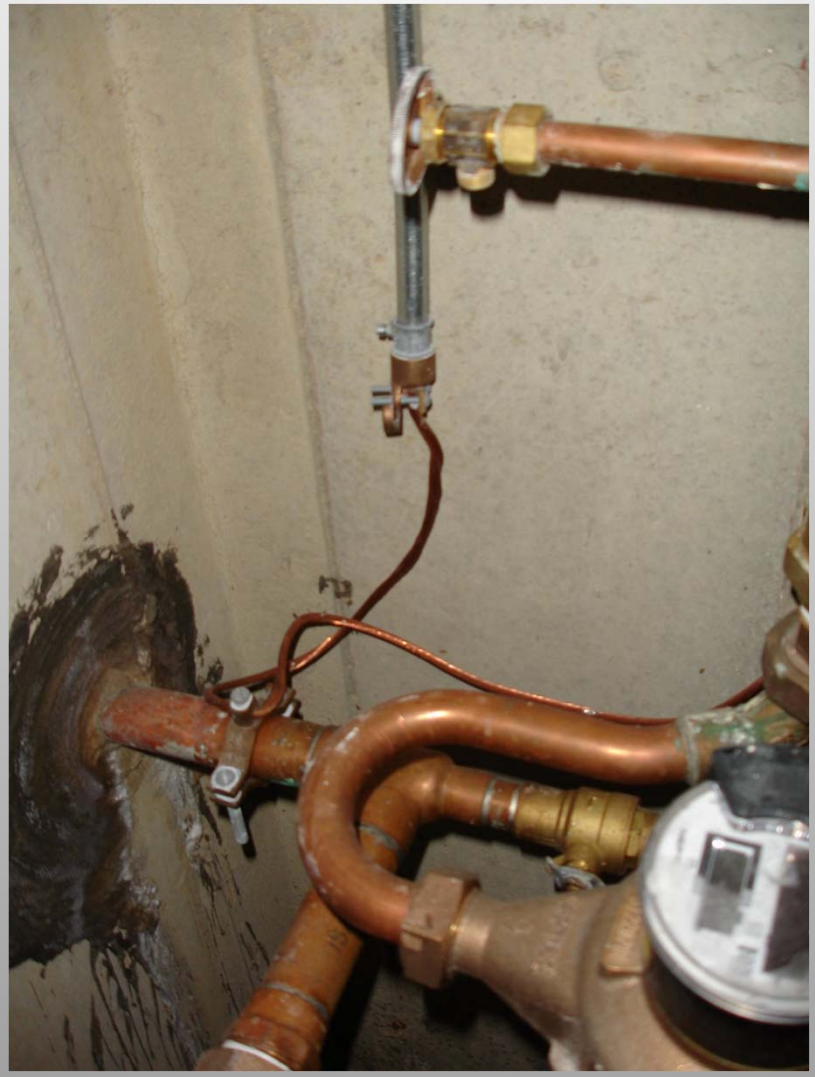
# Grounding Electrode System



# Bonding Conductor or Grounding Electrode Conductor

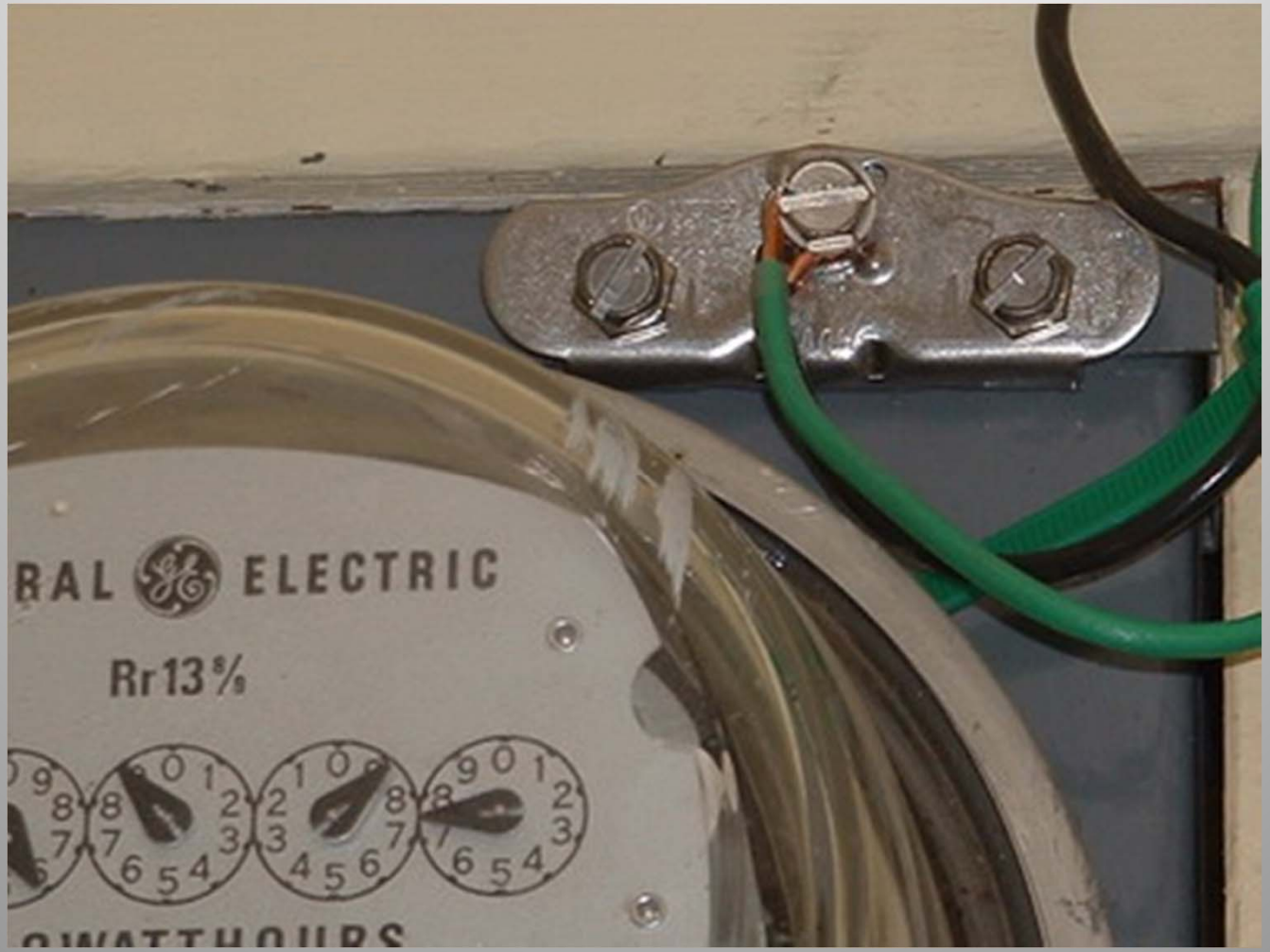
- **Length.** Short as practicable
- **Run in Straight Line.** Run in as straight a line as practicable
- **Physical Protection**. Protected where exposed to physical damage

# Grounding Electrode System



# Grounding Electrode System

# Grounding Electrode System



# Grounding Electrode System

# Grounding Electrode System

# Grounding Electrode System

# Protectors for Communications and Signaling Circuits - Grounding

## 8##.100 Cable and Primary Protector Bonding and Grounding

- If the building or structure served has an intersystem bonding termination as required by 250.94, the bonding conductor shall be connected to the intersystem bonding termination

- If the building or structure served has no intersystem bonding termination, the bonding conductor or grounding electrode conductor shall be connected to the nearest accessible location on one of the following:

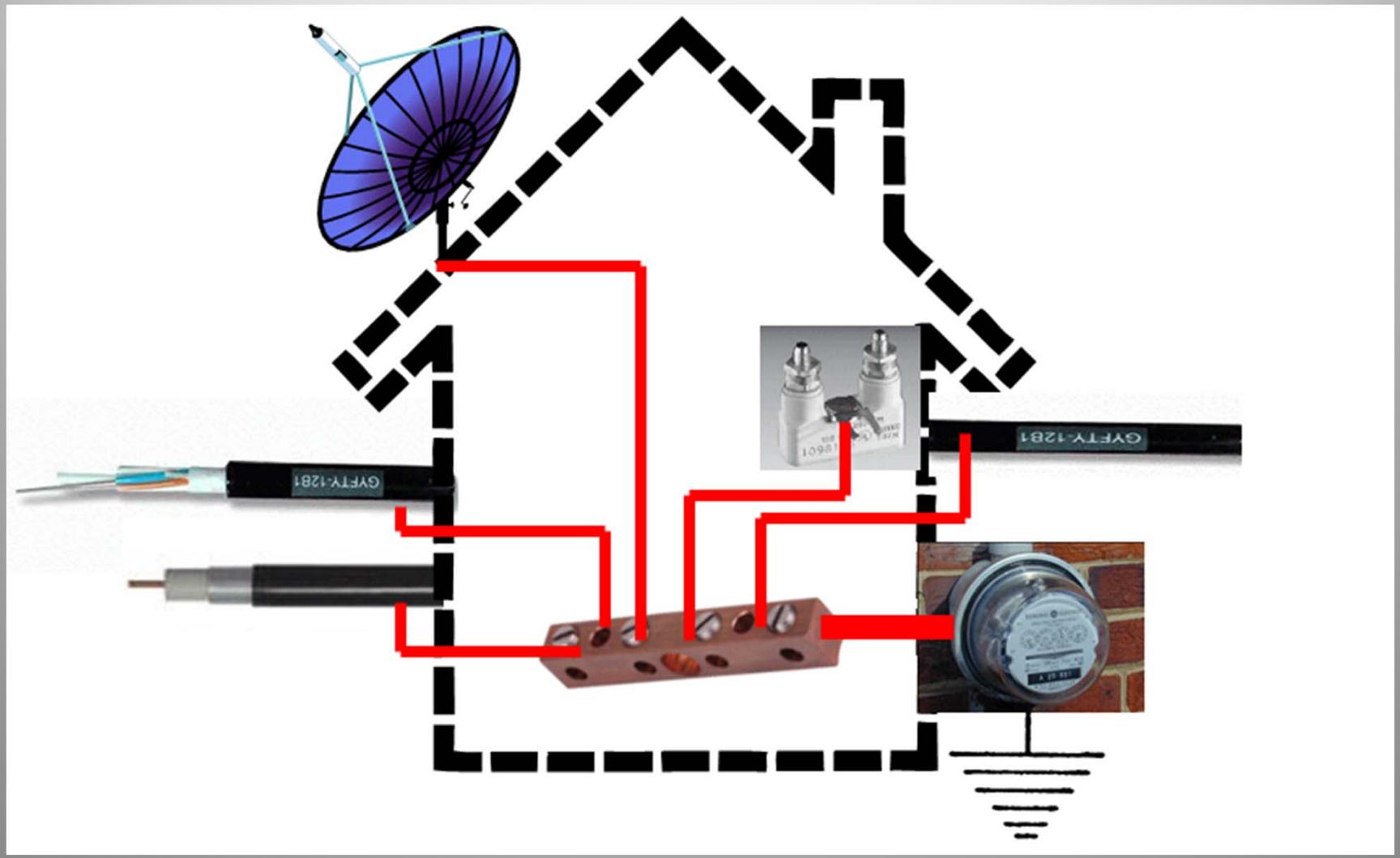
(1) The building or structure grounding electrode system as covered in 250.50

# Protectors for Communications and Signaling Circuits - Grounding

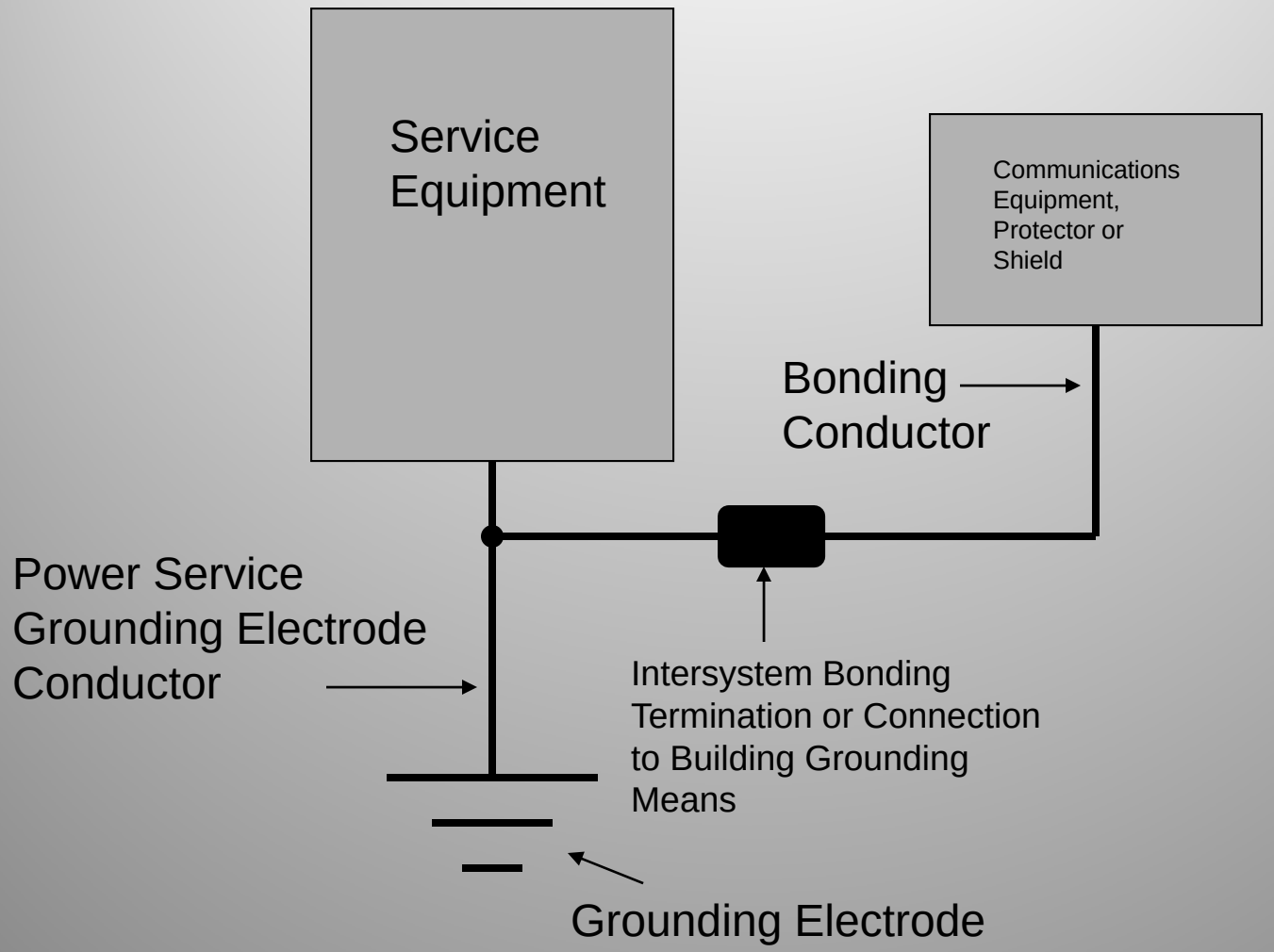
## **250.94** Intersystem Bonding Termination

- for connecting bonding conductors required for other systems
- accessible for connection and inspection
- terminals for connection of at least three bonding conductors.
- be securely mounted and electrically connected to the grounding electrode system with a minimum 6 AWG copper conductor
- listed as grounding and bonding equipment.

# Intersystem Bonding Termination



# Grounding Electrode System



# Intersystem Bonding Termination

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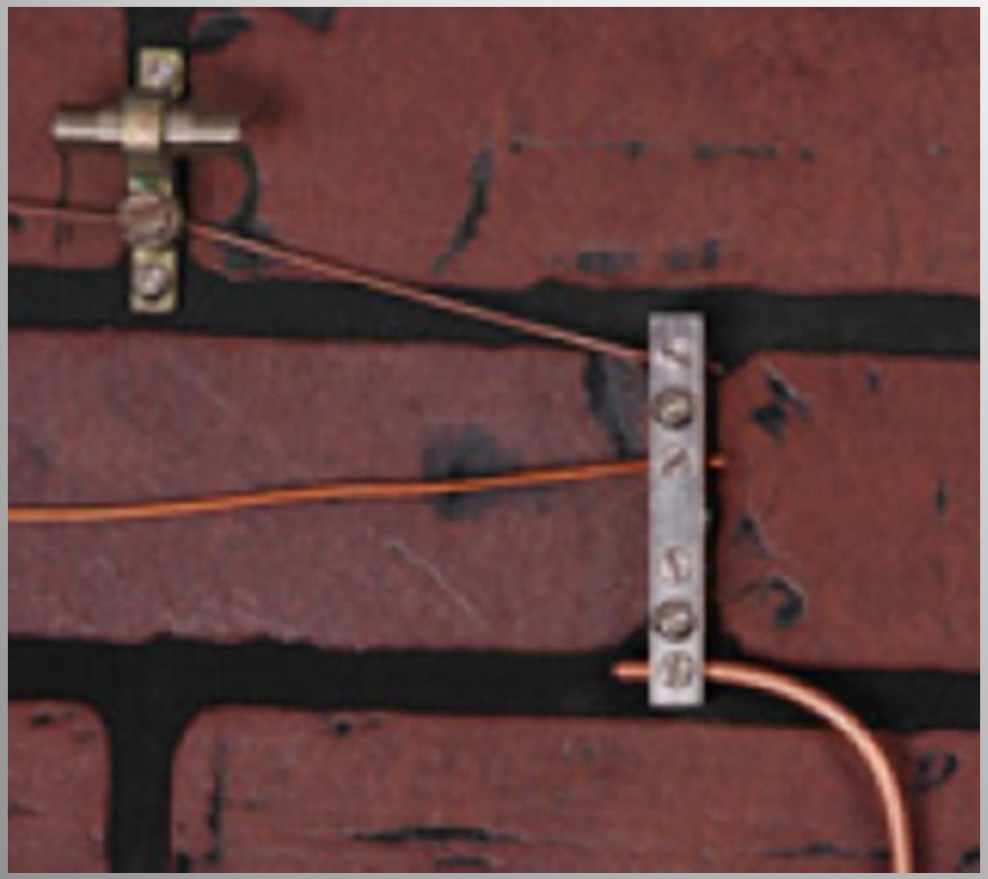


# Equipment Grounding Conductor

**“Equipment Grounding Conductor” (EGC)**

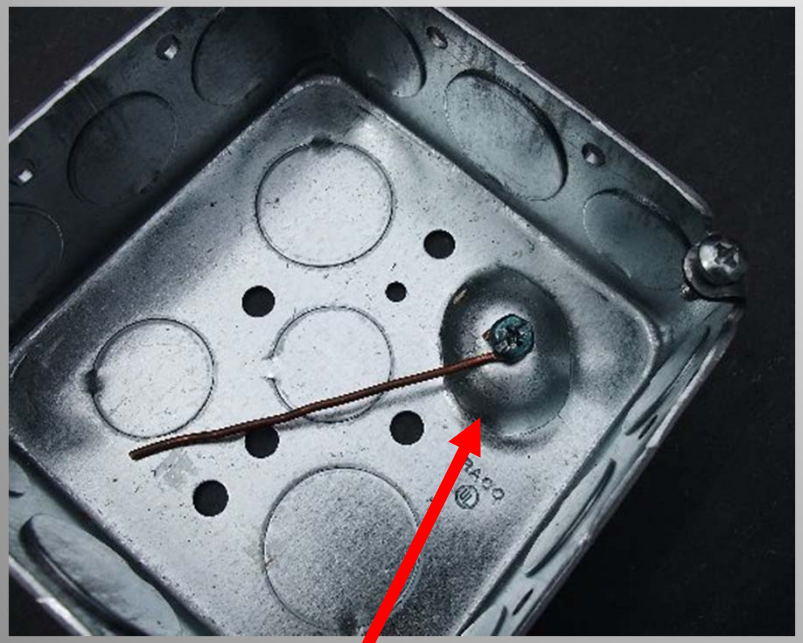
-The conductive path(s) installed to connect normally non–current-carrying metal parts of equipment together and to the system grounded conductor or to the grounding electrode conductor, or both.

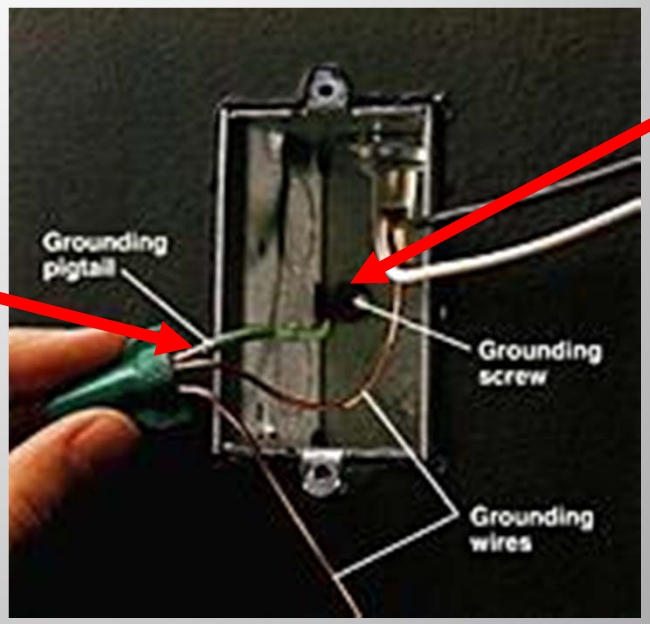
# Equipment Grounding Conductor

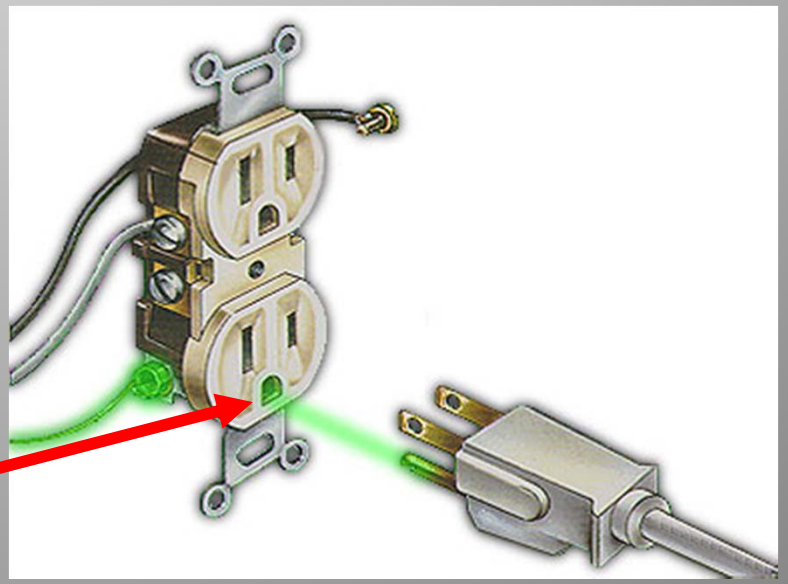
## 250.118 Types of Equipment Grounding Conductors

(1) A copper, aluminum, or copper-clad aluminum conductor
(2) Rigid metal conduit
(3) Intermediate metal conduit
(4) Electrical metallic tubing
(5) Listed flexible metal conduit
(6) Listed liquid tight flexible metal conduit
(7) Flexible metallic tubing where the tubing is terminated in listed fittings
(8) Armor of Type AC cable
(9) The copper sheath of mineral-insulated, metal-sheathed Cable
(10) Type MC cable
(11) Cable trays
(12) Cablebus framework
(13) Other listed electrically continuous metal raceways and listed auxiliary gutters
(14) Surface metal raceways listed for grounding

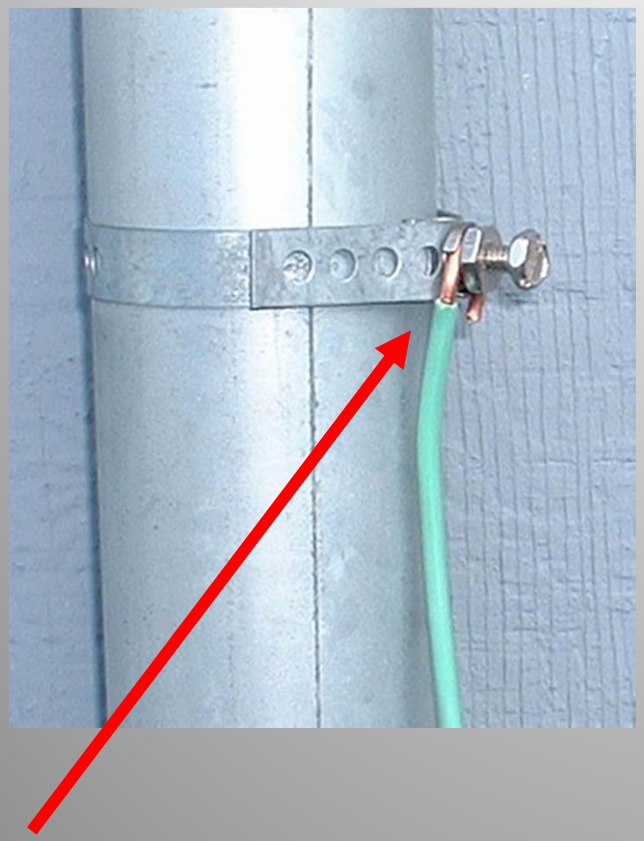
# Places to Connect to an Equipment Grounding Conductor

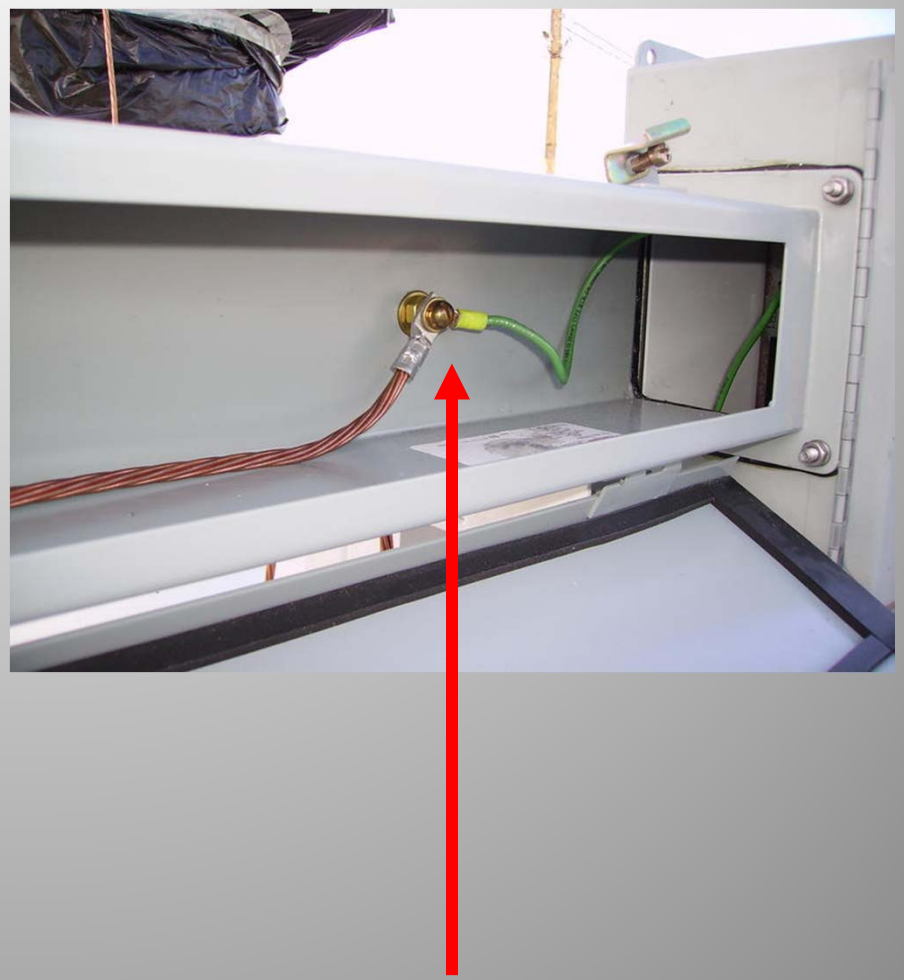




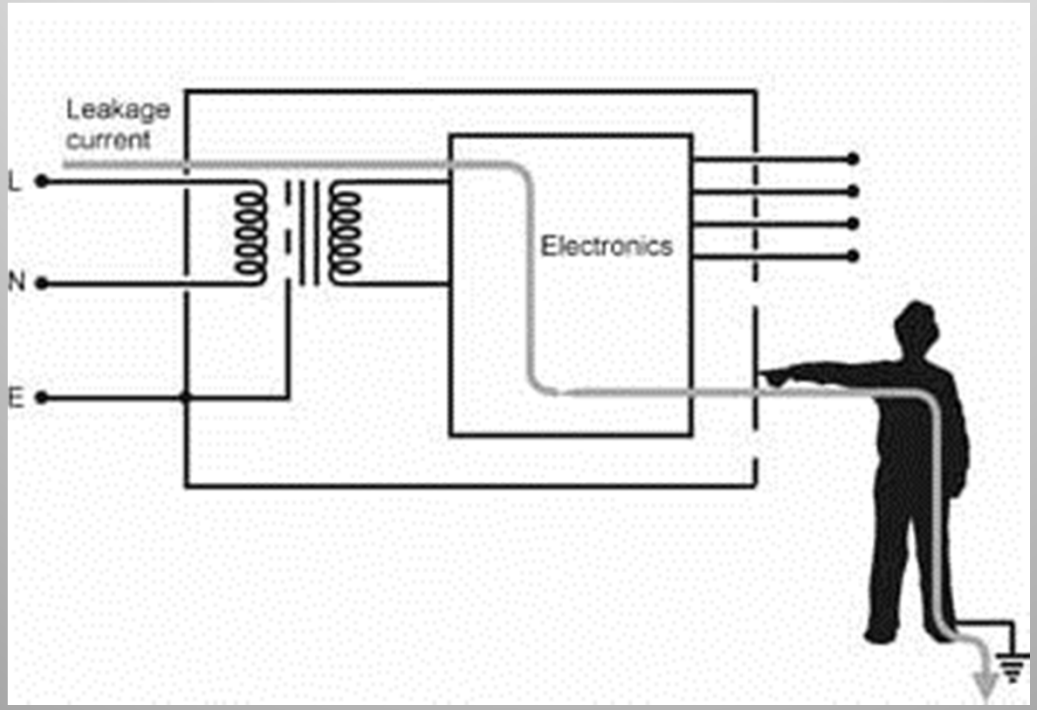
# Places to Connect to an Equipment Grounding Conductor





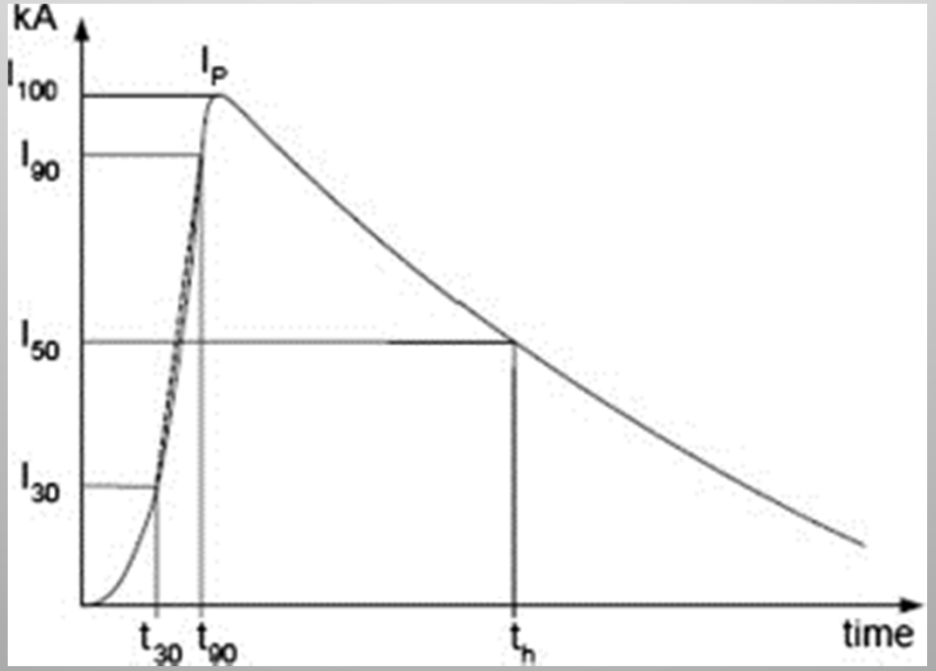
# Equipment Grounding Conductor

OK for leakage currents

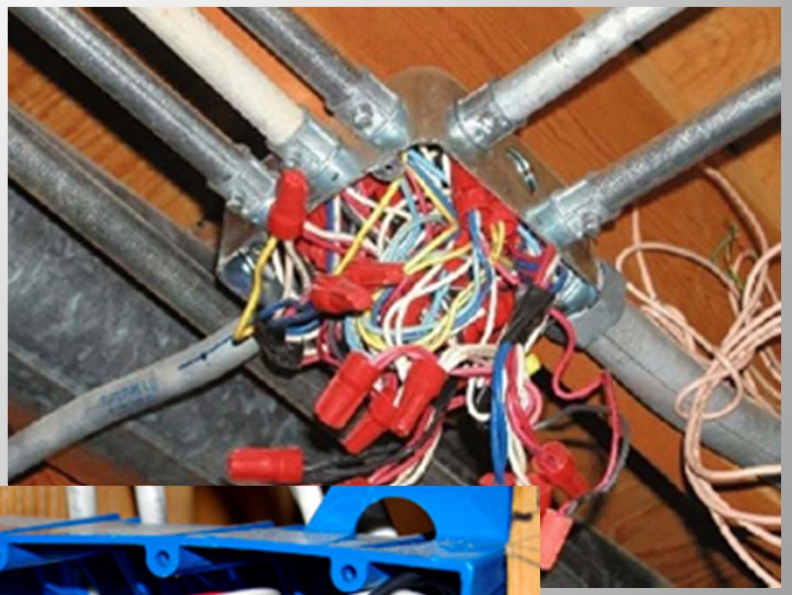


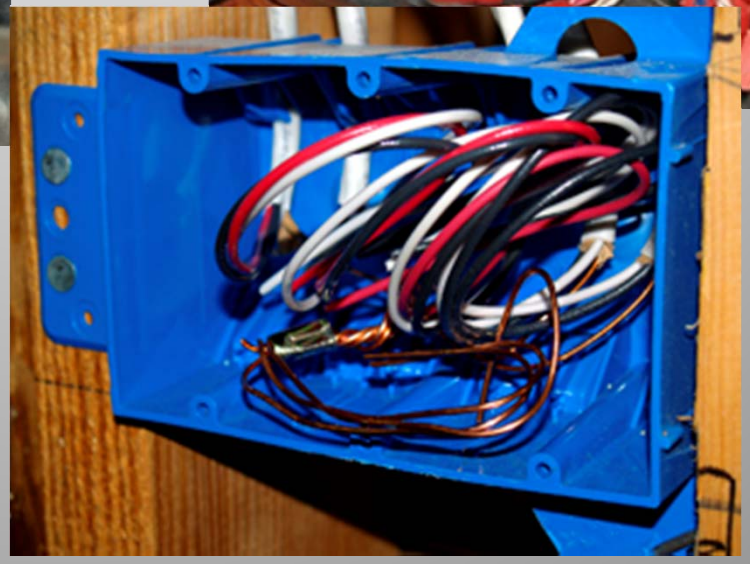
# Equipment Grounding Conductor

Not so good for surges



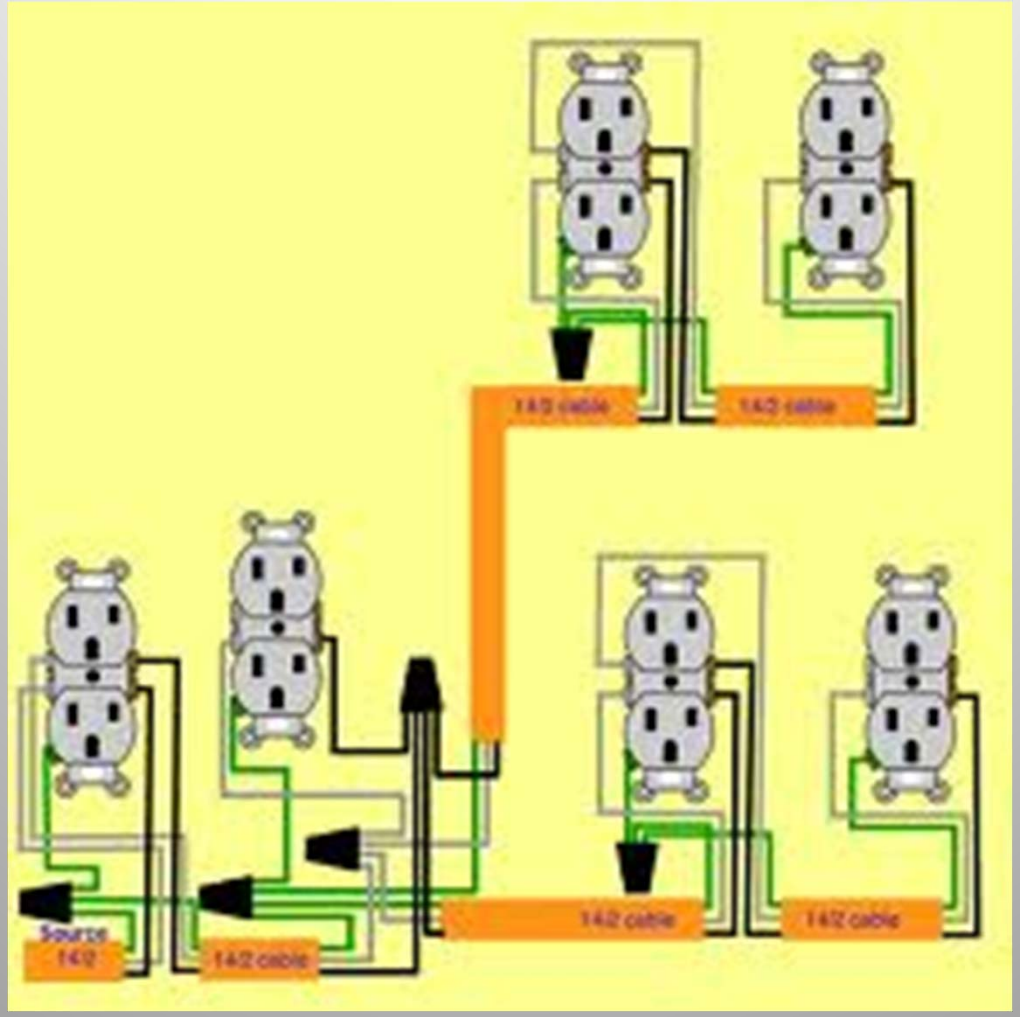
# Equipment Grounding Conductor





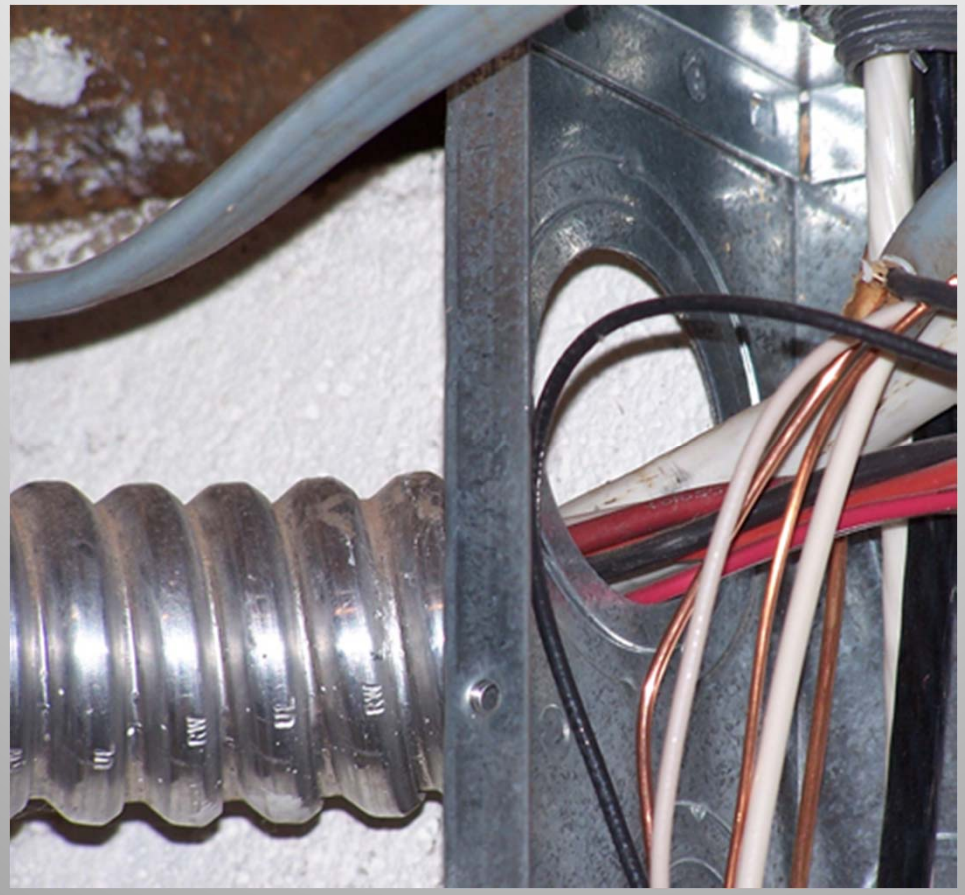
**Run in Straight Line???**

# Equipment Grounding Conductor




As short as practicable**???**

# Equipment Grounding Conductor



**Even Connected???**

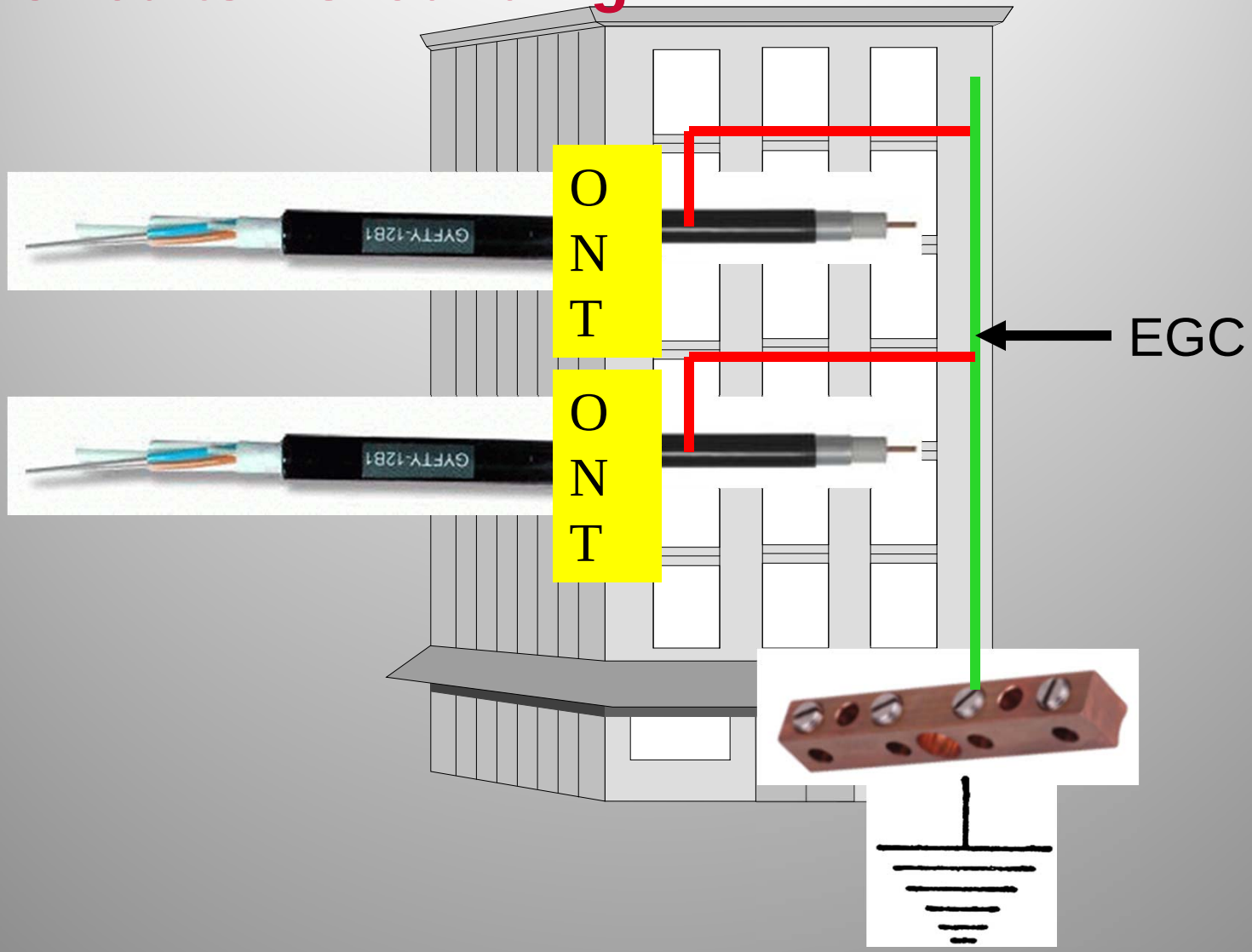
# Protectors for Communications and Signaling Circuits - Grounding

## 840.101 Premises Circuits Not Leaving the Building

**(A) Coaxial Cable Shield Grounding.** The shield of coaxial cable shall be grounded by one of the following:

(2) A fixed connection to an equipment grounding conductor as described in 250.118

# Protectors for Communications and Signaling Circuits - Grounding



# Questions?