

## ECE 528 – Understanding Power Quality

<http://www.ece.uidaho.edu/ee/power/ECE528/>

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### Lecture 39

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## Today...

- Final exam available
- More wiring and grounding
  - The GFCI – Ground Fault Circuit Interrupter
  - Isolated grounds
  - Separately derived systems
  - Ground loops

## GFCI circuit breakers and receptacles

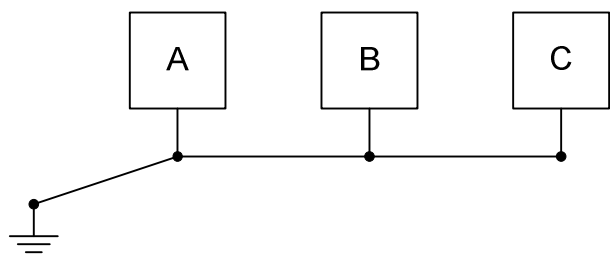
- Pros and cons of each
  - GFCI receptacles
    - Reduced circuit length, reduced leakage current, reduced nuisance tripping
    - May be more expensive if multiple receptacles are used instead of a single GFCI circuit breaker
  - GFCI circuit breakers
    - May “nuisance trip” on long circuits or where conditions may significantly increase the normal leakage current
    - May be less expensive

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## Isolated and shared grounds

- Shared grounds
  - May result in some noise on the grounding system due to adjacent loads
  - Even in a “perfect” system there will be current on the grounding conductor due to capacitive and inductive coupling and the availability of current paths (conduit, building steel, etc.)

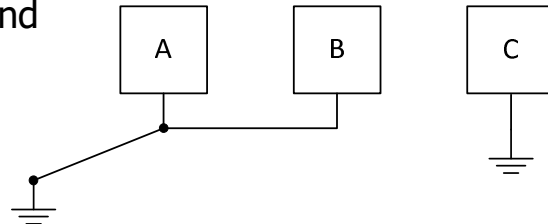


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## Isolated and shared grounds

- Incorrectly isolated grounds – ungrounded equipment
  - Sometimes called a “clean” ground
  - Occasionally found on CNC machines, and other “sensitive” industrial equipment
  - Perception is that this avoids “noise” on the grounding system – wrong

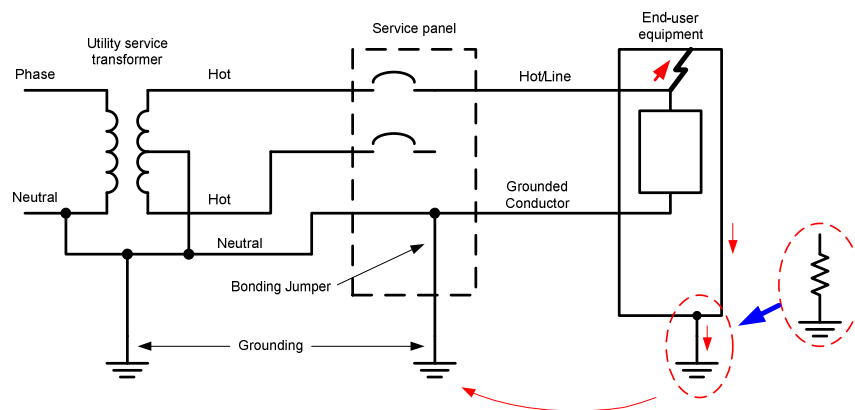


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## Wiring and grounding problems

- “Ungrounded” or poorly grounded equipment



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## Wiring and grounding problems

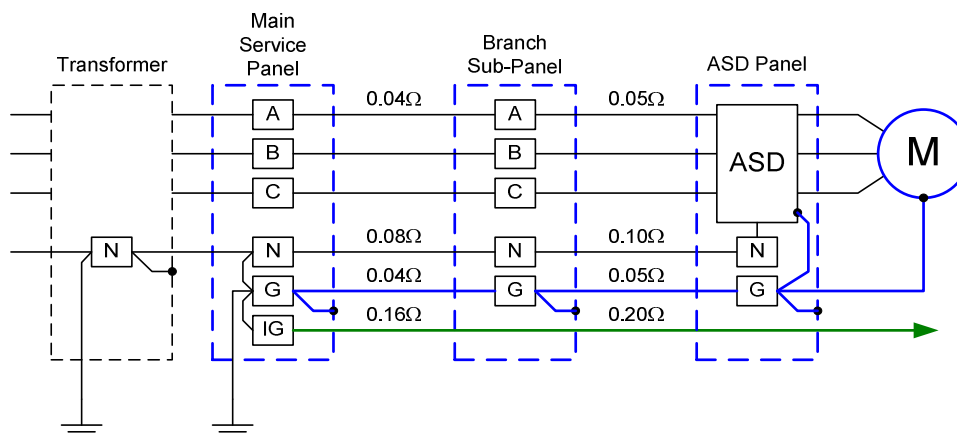
- Ungrounded equipment
  - NEC violation
  - Unlikely to resolve interference problems
  - May result in high touch potentials even without a fault due to capacitive coupling inside the equipment
  - Ground fault in the equipment is unlikely to trip some upstream protective device

## Isolated grounds – the right way

- “Isolated” can be misleading
- “Dedicated” or “Insulated” might have been better terms
- An isolated equipment grounding conductor is a separate, additional grounding conductor
- It is only connected to the grounding system at the ground bus in the main service panel or a separately derived system
- It is insulated as it passes through downstream panels to some end device where it is used as that device’s equipment grounding conductor

## Isolated grounds – the right way

- Where does the noise come from?

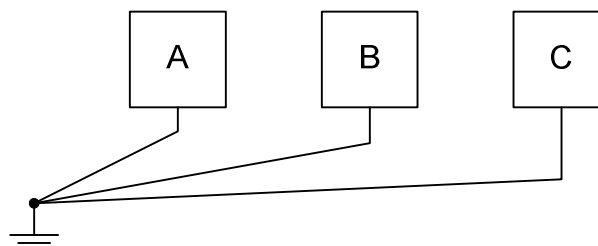


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## Isolated and shared grounds

- Isolated grounds – the right way
  - Reduces noise on the grounding system due to adjacent loads
  - Other ground current paths between devices are carefully eliminated
  - Remember Kirchhoff's current law...



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## Isolated grounds – the right way

- Isolated grounds are used to reduce noise on the equipment grounding conductor associated with other loads on the system
- Covered in the 2014 NEC in article 250.96
- Usually used for computers or other “sensitive” equipment
- Receptacles are color-coded orange or have an orange triangle on their face



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## Separately derived systems

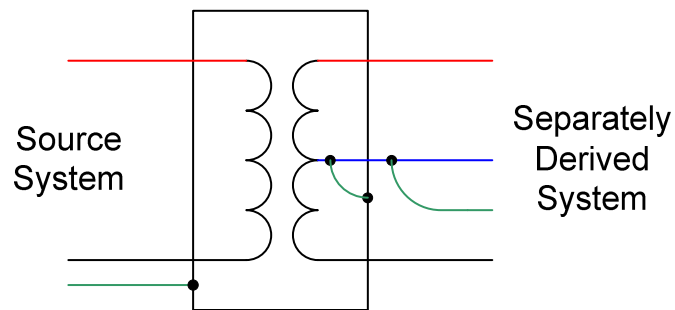
- A wiring system with power derived from a source other than a main service
  - Generators
  - Battery systems
  - Transformers
- Can help reduce “noise” on grounding system and Neutral-to-ground voltage
  - Provides a local ground reference and a nearby Neutral-to-ground bond
  - Usually a less extensive system
    - One floor of an office building
    - A server room

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# Separately derived systems

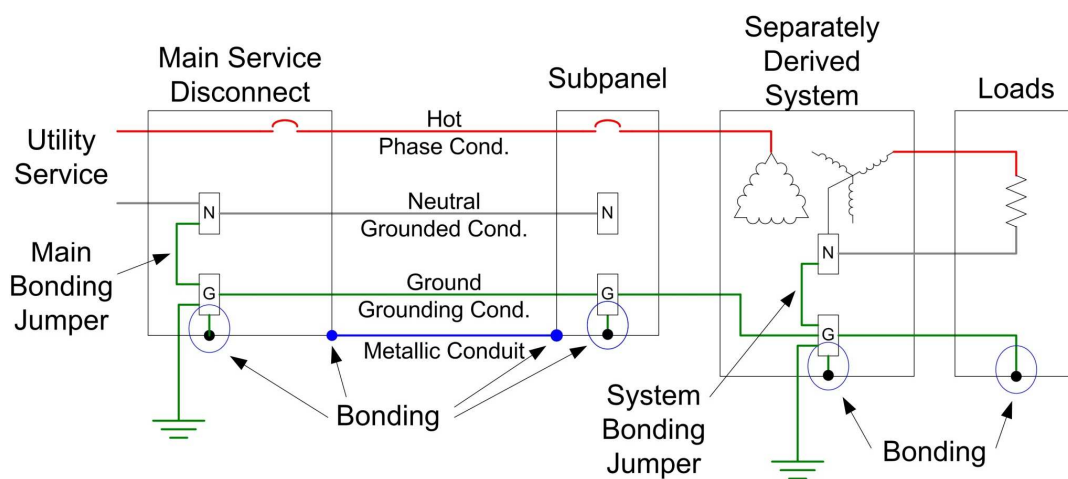
- Example



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# Separately derived systems



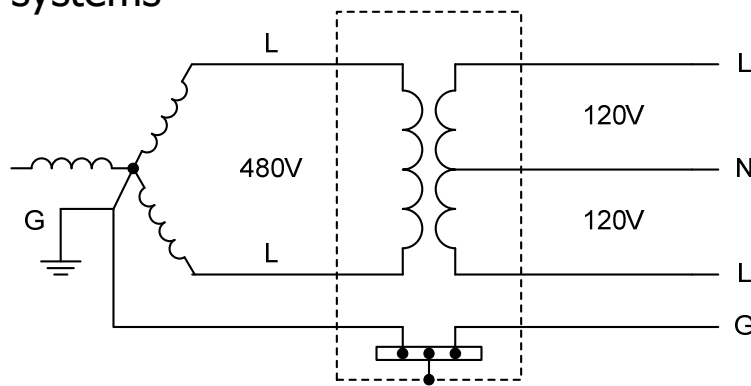
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Also see figure 10.5 in PSQ

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## Separately derived systems and neutral-to-ground bonds

- Another missing ground – common mistake in separately derived systems

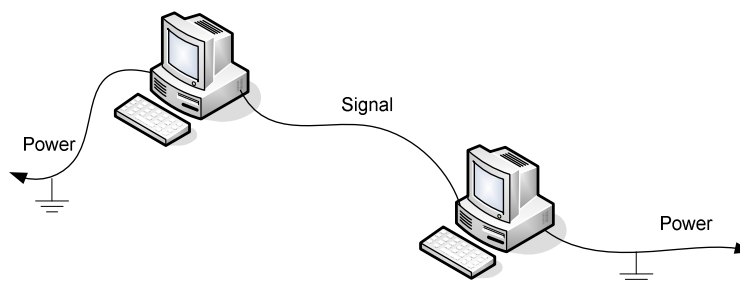


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## Ground loops

- An electrical connection (usually in a communication circuit) between two or more devices that are connected to different ground references



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## Ground loops

- Causes equalizing current flow between devices on communication circuits
- Where it's a problem:
  - Communication circuits with ground connections at both ends
    - Serial cables, including USB
    - Parallel cables
    - Some remote transducer signal cables
    - Most audio/video signal cables
  - Ever wonder why it's hard to find a 50' parallel printer cable, or USB cable?

## Ground loops

- Symptoms
  - Data errors
  - Remote sensing errors
  - Audible "hum" in audio systems
  - Bars on video screens
    - What about flat panel displays?
  - Damaged equipment

## Ground loops - Solutions

- Establish a single, nearby ground point for interconnected devices
- Use a “ground loop isolator” – essentially a high frequency isolation transformer
- Use differential mode communication systems with appropriate surge suppression at both ends of the circuit
- Use optical isolation / fiber-optic cables (this is becoming easier)



From: radioshack.com



Picture from B &amp; B Electronics

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## Coming up...

- Communications wiring
- Troubleshooting
  - Loose connections
    - Symptoms and tests
- Communications wiring

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