

# IT 4823

## Information Security Administration

### Power Management



Notice: This session is  
being recorded.

# Power Management

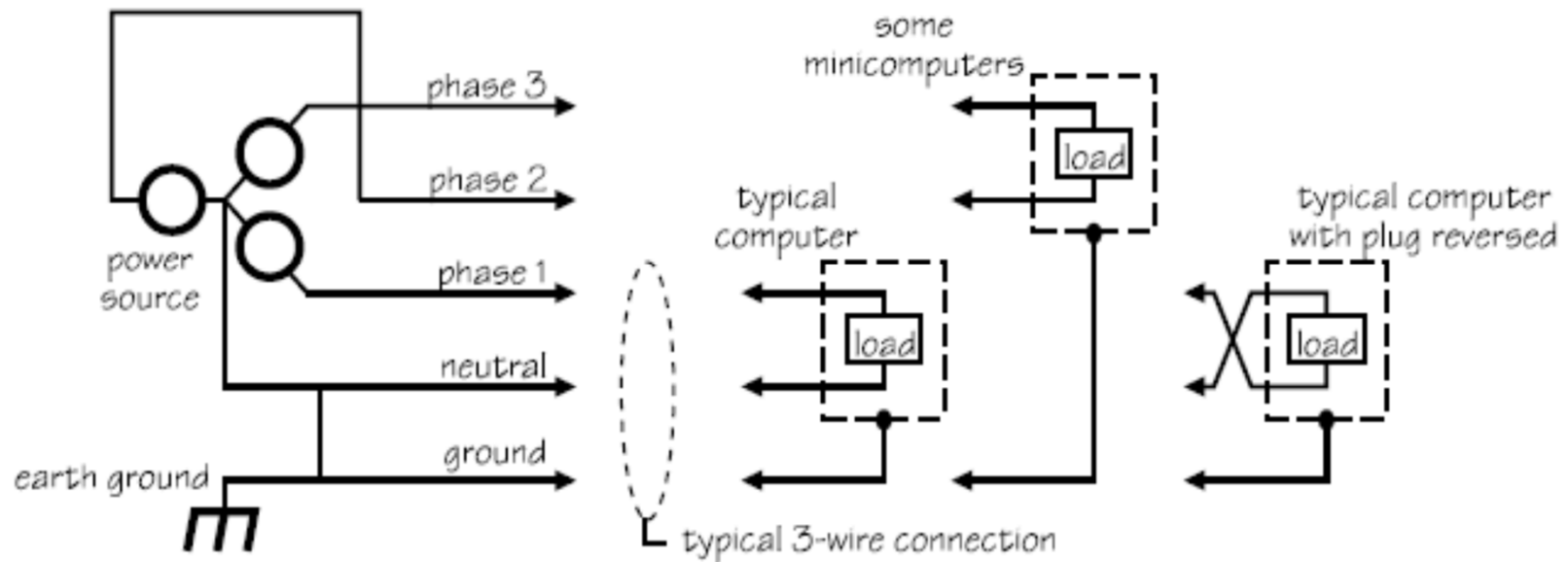
- Electrical quantity (voltage level; amperage rating) is a concern, as is quality of power (cleanliness; proper installation)
- Noise that interferes with the normal 60 Hertz cycle can result in inaccurate time clocks
- Overloading a circuit causes problems with circuit tripping and can overload electric conductors, increasing risk of fire **if** breakers are not properly sized.

# Grounding

- “Neutral” conductor: carries the return current of a circuit. Bonded to the center tap of a transformer.
- Safety ground: often also bonded to the center tap of the transformer; should be connected to earth ground.
- Signal ground or reference ground: a reference for low-voltage signals.

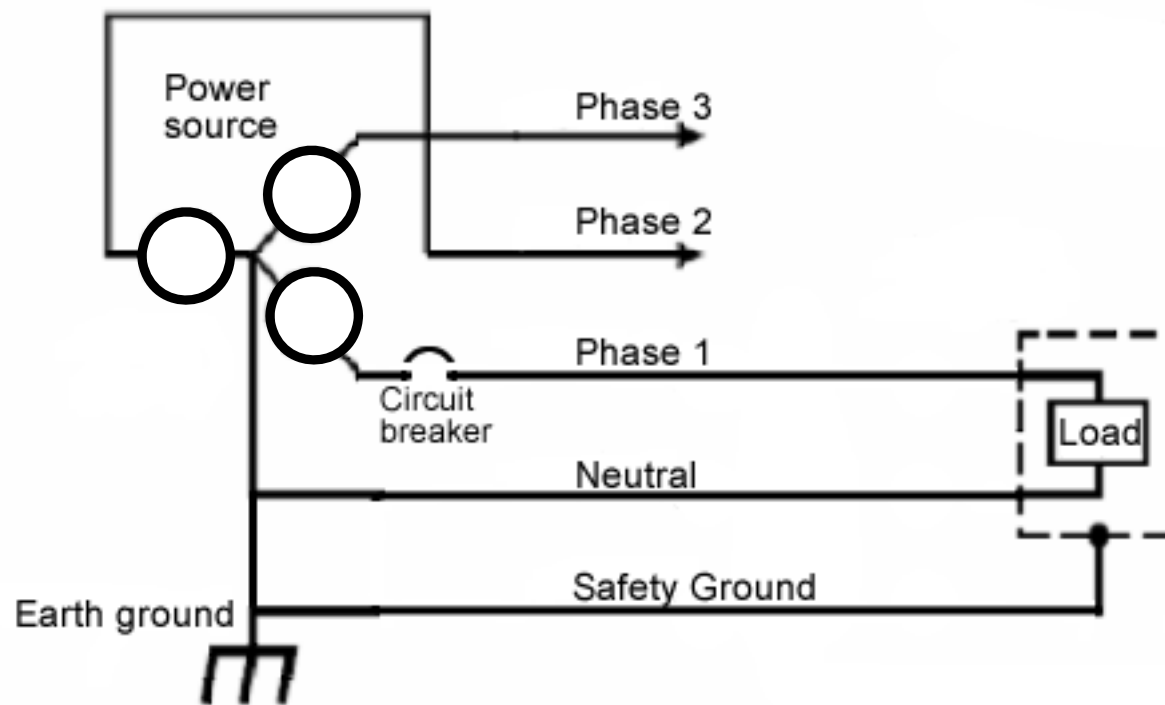
# Power Circuits

Figure 1: The 3-wire system



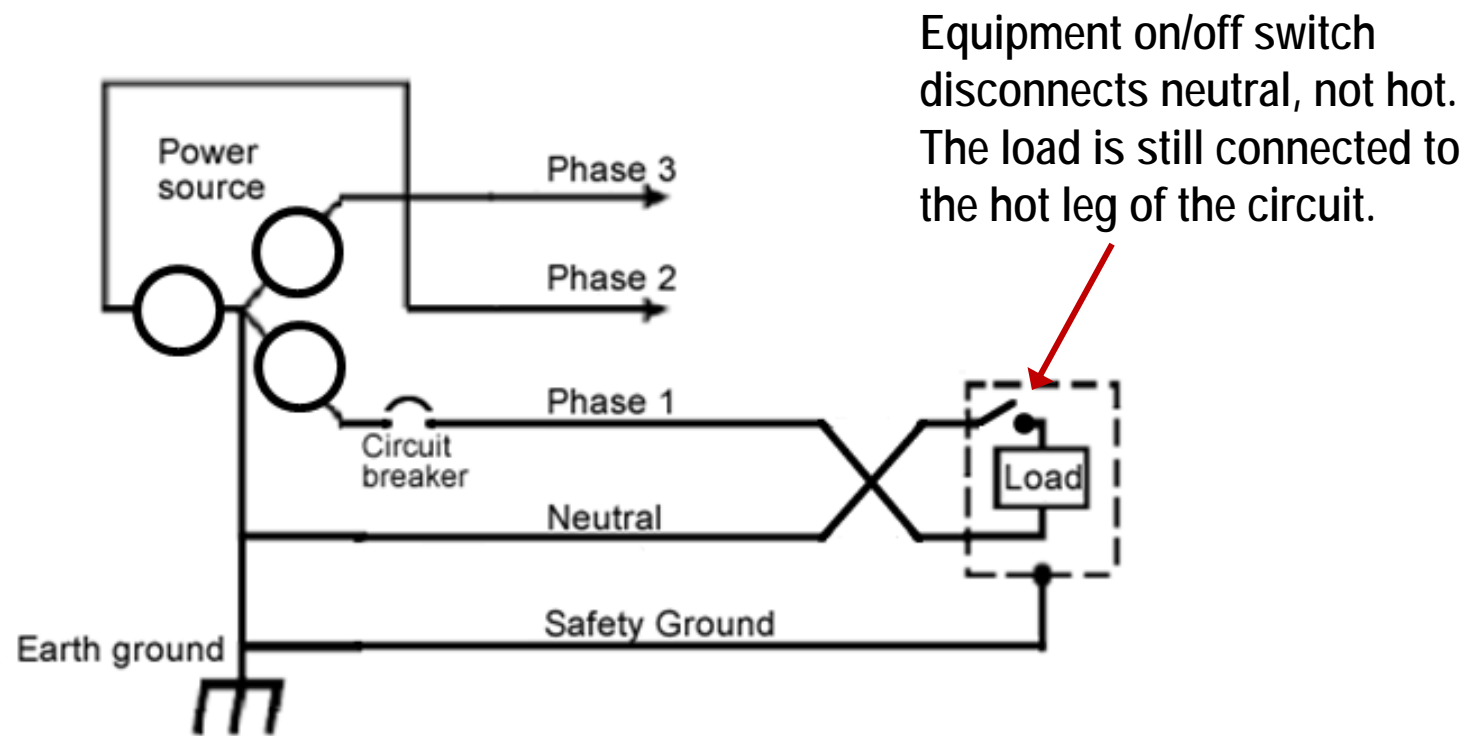
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# Typical Wiring



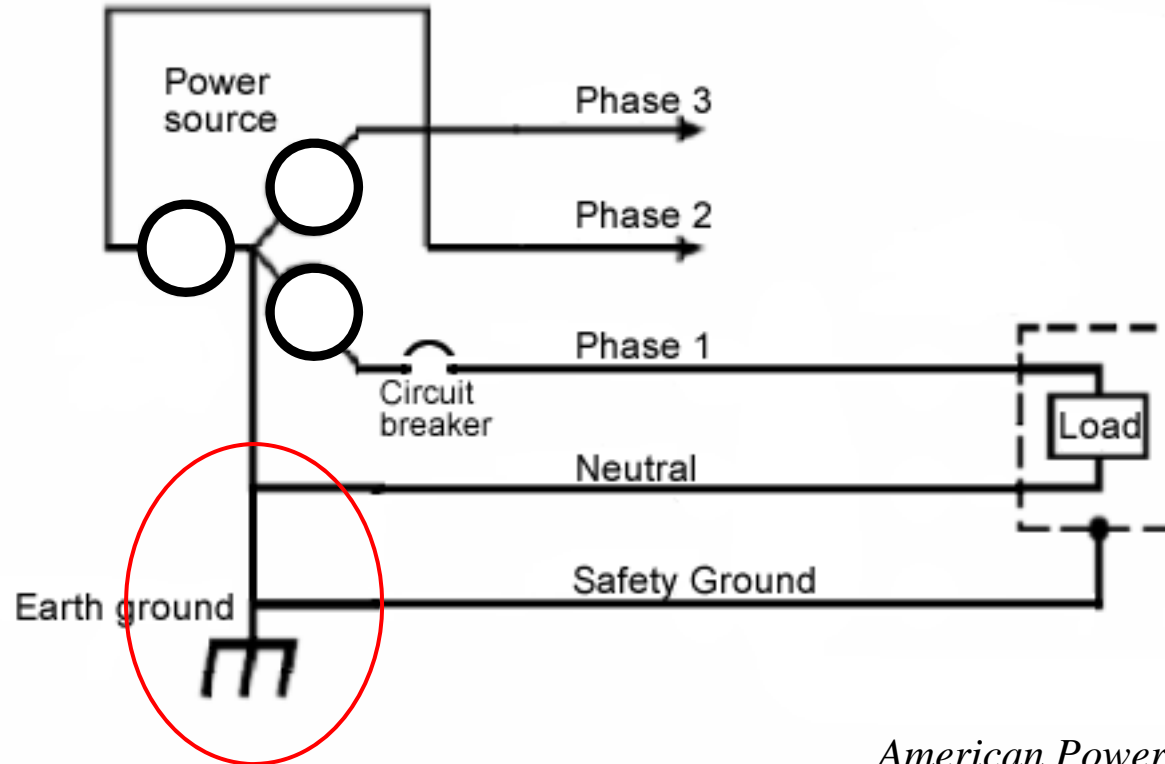
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# Reversed Plug or Wiring



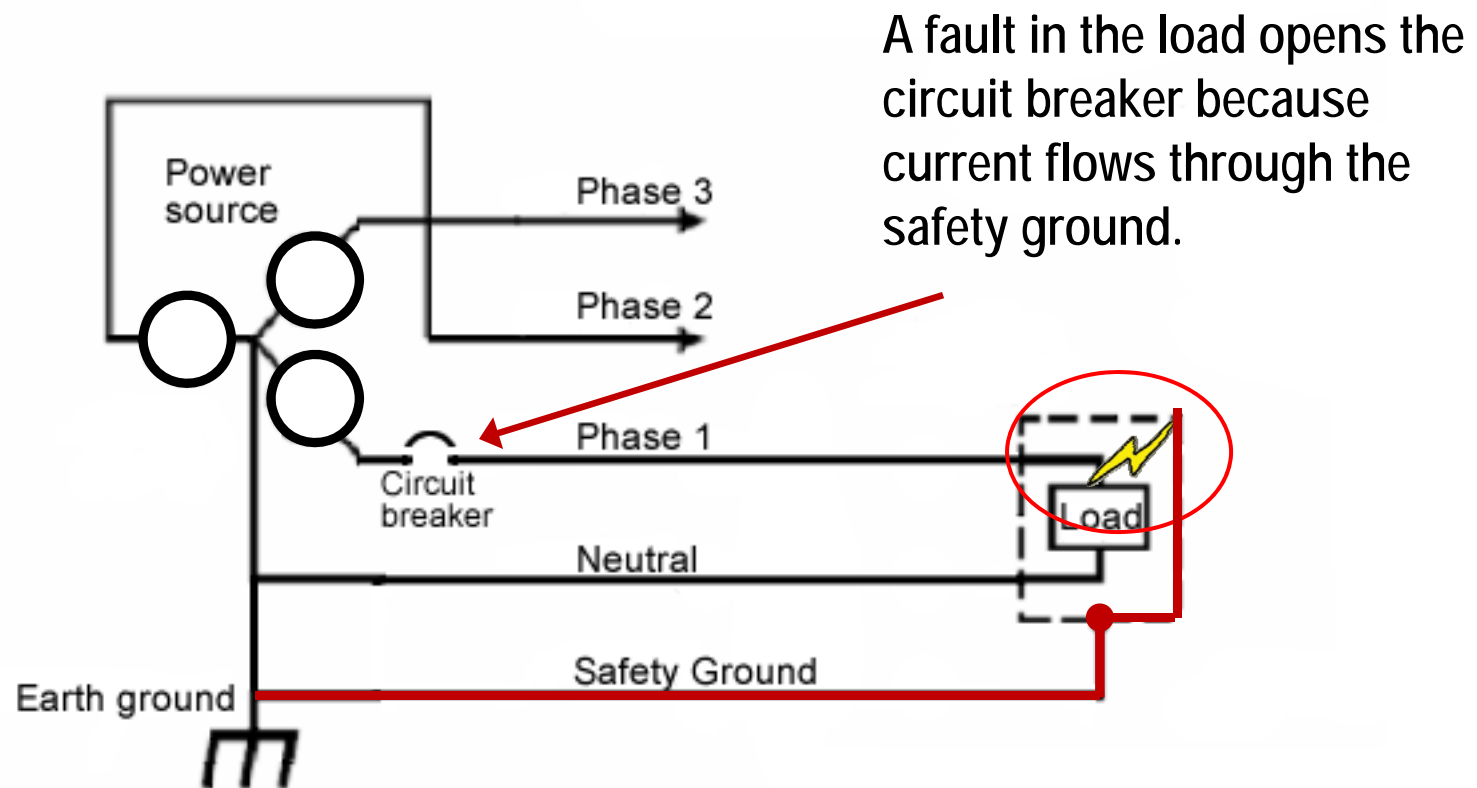
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# Why Three Wires?



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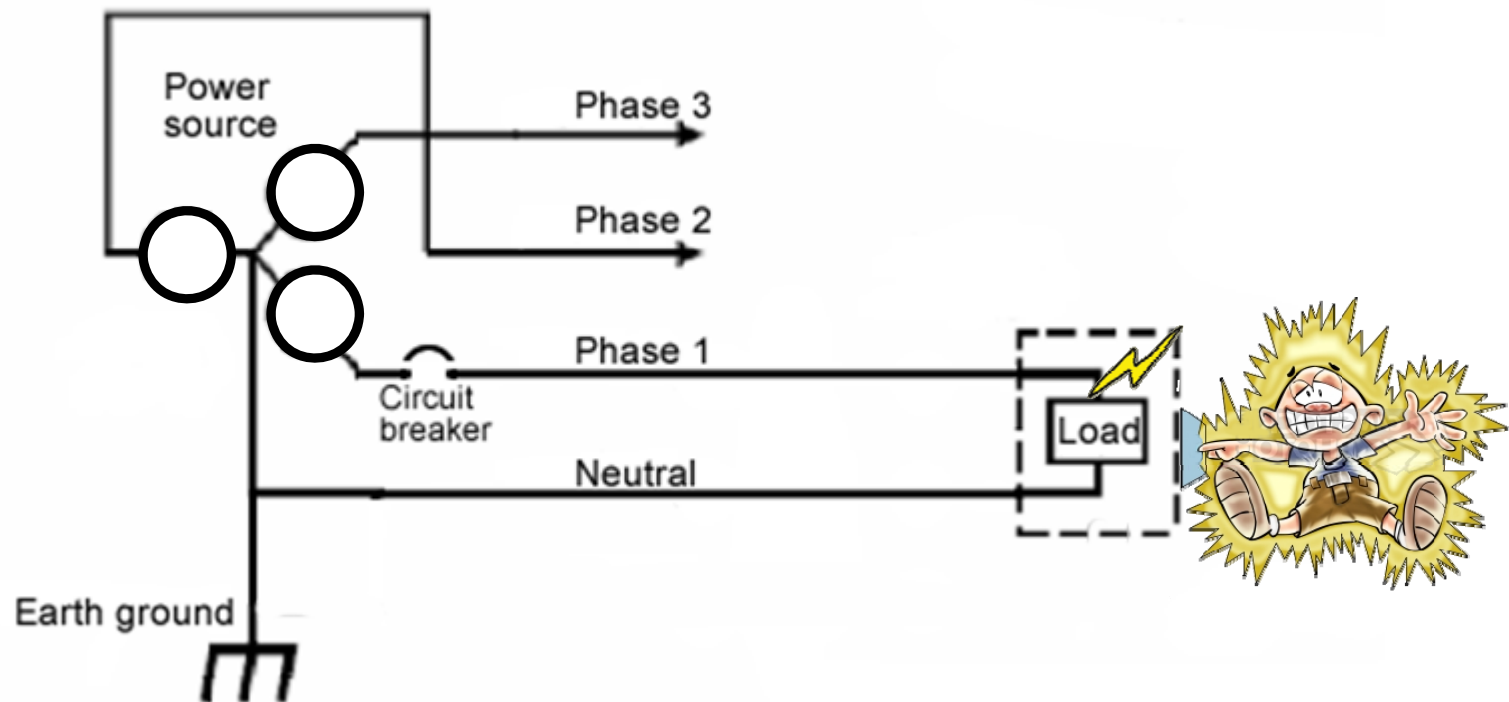
# Purpose of Safety Ground



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# Without Safety Ground !



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# Dedicated Circuits

- Purpose: to isolate computer equipment from other loads
- Other loads can trip circuit breakers!
- Some loads (large motors, fluorescent lights) generate electrical noise

# Determining Power Requirements

- Watts: power consumed; heat dissipated
- Volt-amps: apparent power; voltage times current.
- $W = PF * VA$ 
  - For power-factor-corrected power supplies,  $W=VA$  ( $PF = 1$ )
  - For “small” equipment, PF is about 0.60, and W will be less than VA.
- UPSs have both a maximum Watt rating and a maximum VA rating

# Determining Power Requirements

- HVAC
- Lighting
- “Convenience” power

These may be interrupted briefly.

# Uninterruptible Power Supply (UPS)

- In case of power outage, UPS is backup power source for major computer systems
- Four basic UPS configurations:
  - Standby
  - Line-interactive
  - True online (double conversion online)
  - Rotating (motor-generators)
  - Also, ferroresonant transformer UPSs for industrial use.

# UPS Sizes

- To 1,000 VA: Desktop equipment
- 1 to 2.5 kVA: Servers, etc.
- 2.5 to 10 kVA: Small computer rooms
- 10 to 100 kVA: Data centers
- 100 + kVA: Large installations

# Runtime of UPS Systems

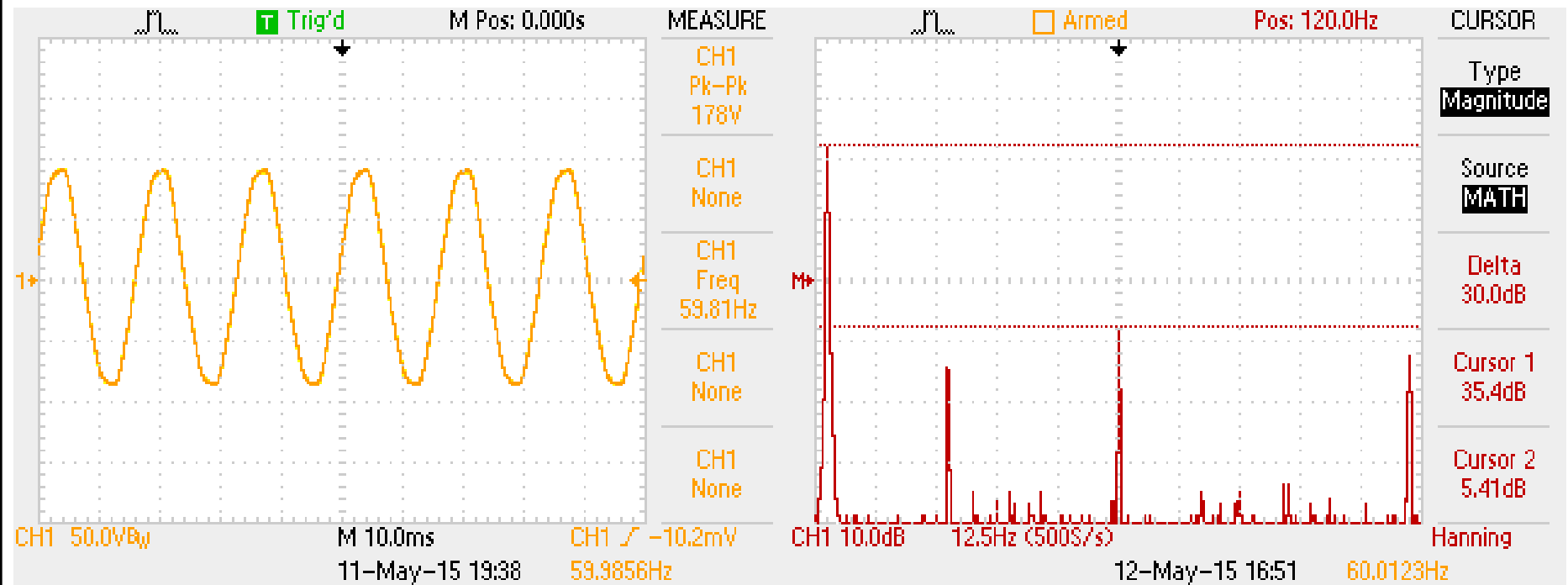
- Generally measured in minutes.
- Important factors in run time:
  - Percent of full load
  - Battery capacity.
- Batteries have a limited lifetime: 3 – 7 years.
- The UPS is out of service while batteries are being replaced.

# UPS Output Waveforms

- Alternating current delivered by power utilities is a 60 Hz sine wave.
- UPSs can also produce sine wave power...
- But not all of them do. It is cheaper to make a UPS that generates a “stepped square wave” that supposedly approximates the sine wave.

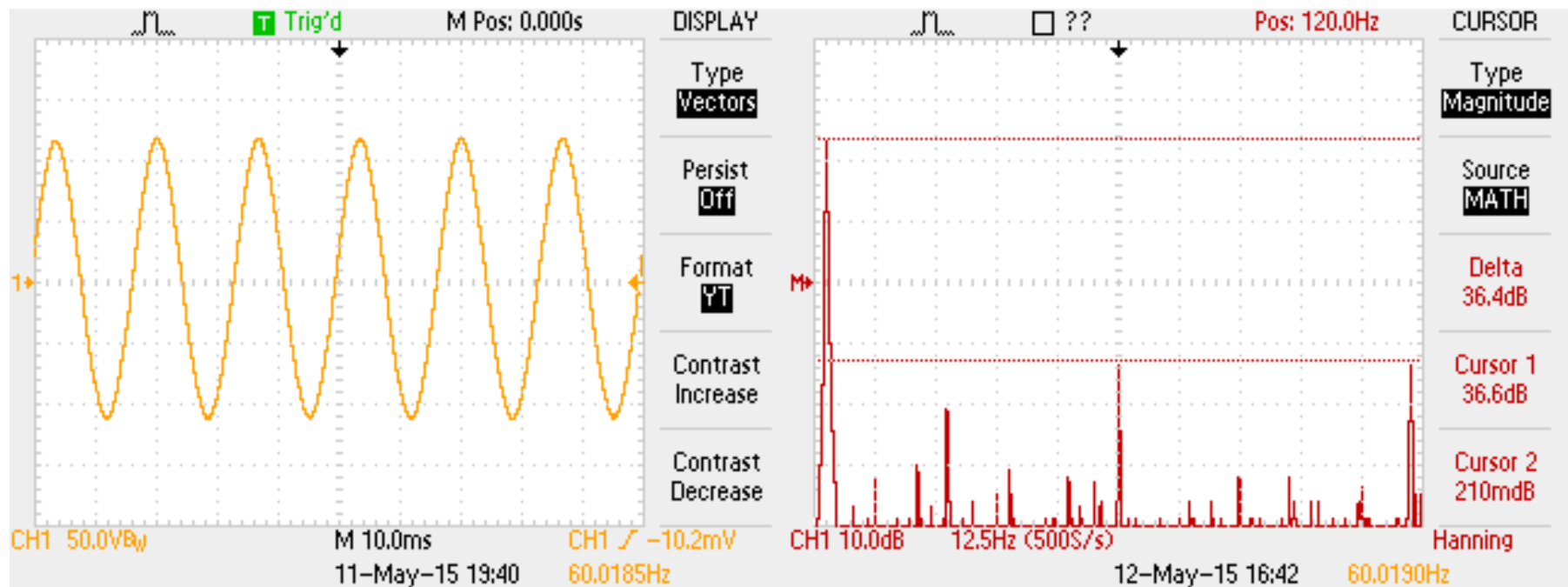


# Sine Wave from Utility Power



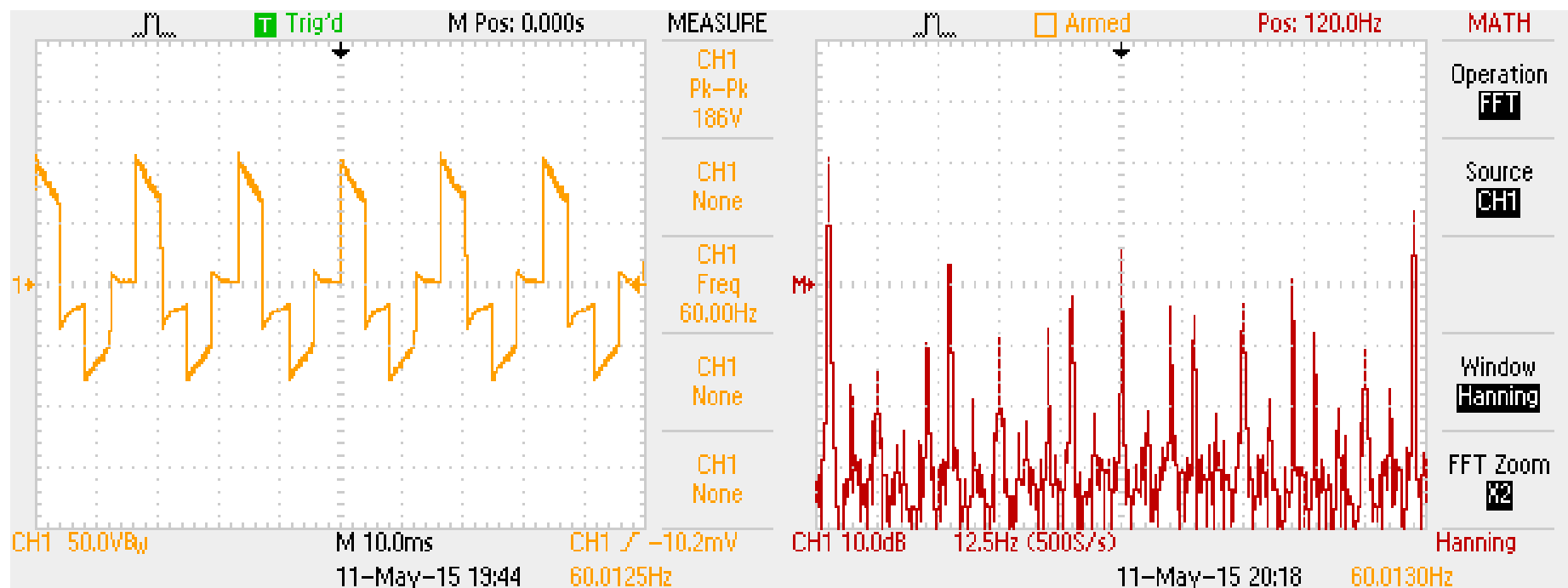
Oscillogram by [Warren Young](http://superuser.com/questions/912679/when-do-i-need-a-pure-sine-wave-ups), Creative Commons BY-SA License  
<http://superuser.com/questions/912679/when-do-i-need-a-pure-sine-wave-ups>

# From a "True Sine Wave" UPS



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# From a "Stepped Square Wave" UPS



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# Do I Need a Sine Wave?

- For computer equipment, possibly not; a good computer power supply should be able to deal with ugly power.
- For audio or video equipment, and equipment with active power factor correction, yes.
- UPSs last forever; over dozen years, the major cost will be battery replacement, not initial price.
- Conclusion: Buy the more expensive model with sine wave output.

# “Smart” UPSs

- Many UPSs have built-in monitoring
  - Voltage
  - Current
  - Failures
  - Battery state
- Small and medium UPSs are available with a USB connection to communicate with a server.
- Software is available to shut down a server before UPS battery is exhausted.

# Emergency and Standby Generators

- Emergency generators
  - Legally required in many cases.
  - For life-safety equipment.
  - Power available within ten seconds.
  - Require separate power distribution routing.
- Standby generators
  - May or may not be legally required
  - Power equipment not related to life safety.
  - Power available within 60 seconds.

# Continuous and Prime Power Generators

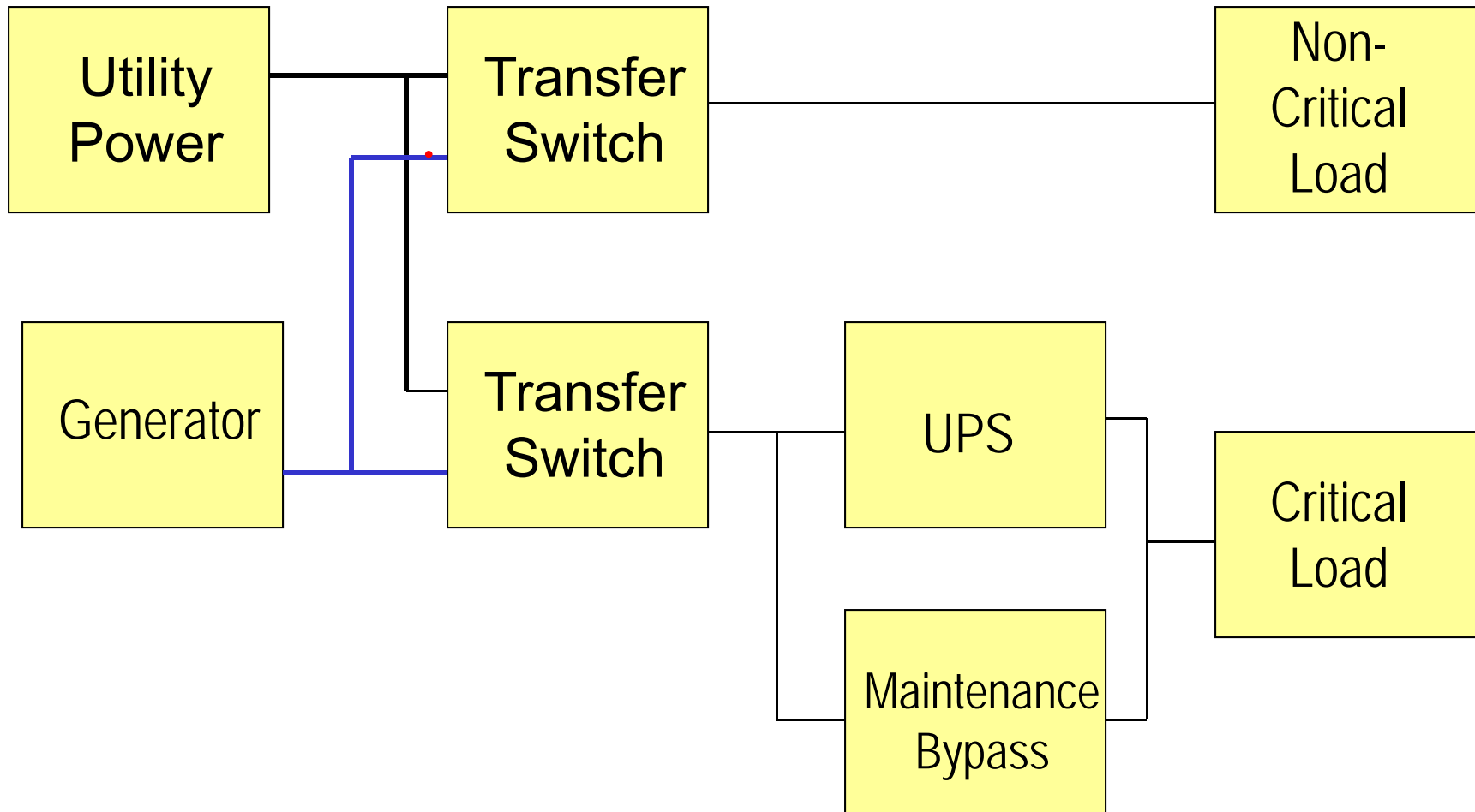
- Continuous power generators: Provide power to a load with limited fluctuation for years at a time.
- Prime power generators: Provide power to a fluctuating load for years at a time.
- Reciprocating engines or gas turbines.
- Unusual in the data center environment.

# Fueling Generators

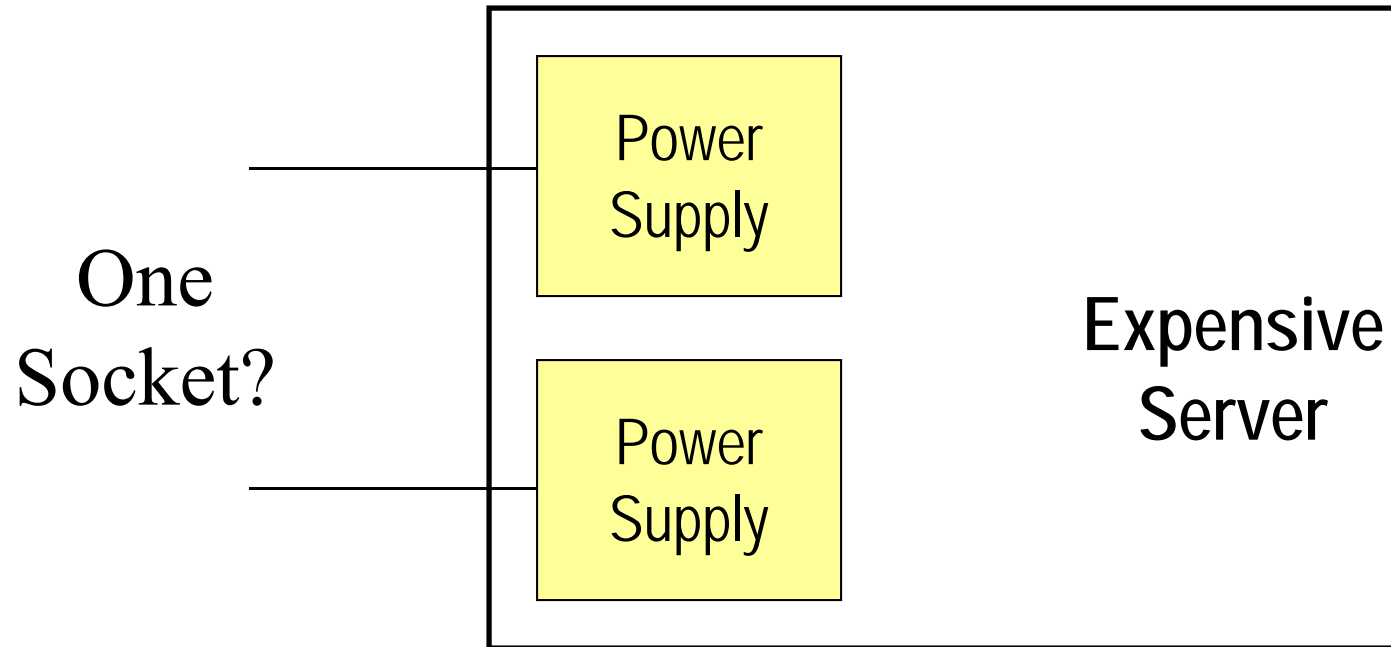
- Gasoline: Not practical for emergency or standby applications; dangerous; fuel has limited lifetime.
- Diesel: Run time is limited to storage tank size; refueling may not be possible in some kinds of emergencies.
- Propane: Same considerations as Diesel.
- Natural gas: Potentially unlimited run time, but depends on natural gas utility.



# Designing Power Systems



# Dual-Corded Systems



For most effective use, the power to each power supply should be independent, *i.e.* two UPSs on different circuits.

# Emergency Shutoff

- An important aspect of power management is the need to be able to stop power immediately should current represent a risk to human or machine safety
- Most computer rooms and wiring closets equipped with an emergency power shutoff
- Accident-resistant cover is essential

# Energy Management

- Energy is a significant cost in medium and large data centers.
- Cooling is a substantial portion of that cost.
- Energy management can significantly lower costs.

# Demand Billing and Load Shedding

- Utility companies offer “demand rate” billing to medium and large customers.
- The rate per kilowatt-hour varies hourly with the demand on the utility’s generating resources.
- Businesses that can reduce load during times of peak demand can realize significant savings.

# Load Shedding Strategies

- Local generation: Use locally generated power for HVAC during peak periods.
- Store pre-chilled water for cooling use during peak periods.
- “Spin down” some disks during peak periods, or always.
- Reduce clock speed, shut down idle cores in servers not under load.
- Relocate workloads to “the cloud.”

# Alternative Power Sources

- Use 208 or 420 V. power distribution to reduce losses due to step-down conversions.
- Use DC power distribution. (Probably suitable only for completely new data centers. See the Open Compute Project.)
- Consider solar panels.
- Consider fuel cell generators rather than Diesel or natural gas internal combustion generators.
- Check economics of continuous generation.

# DCIM Software

- “Data Center Infrastructure Management”
- Energy monitoring
- Ability to power down idle servers.
- Collects data for capacity planning.



# Questions

