



Combining Battery and AC Sources for More Reliable Control Power

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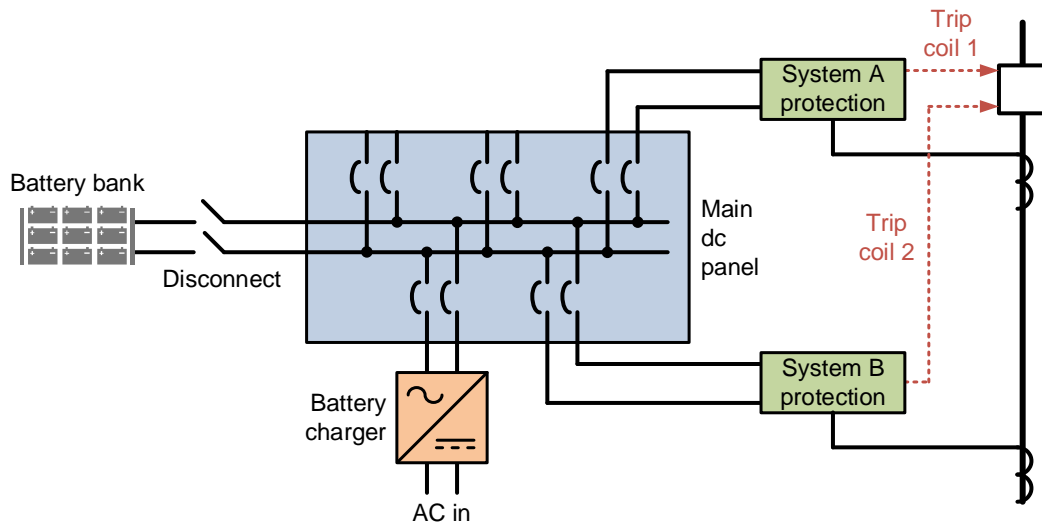
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Overview

- Reliable control power
- Combining control power sources
- Energy storage
- Diversity strategies
- Applications that benefit from reliable control power



DC system

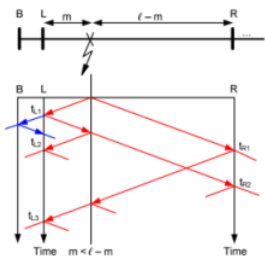


1950s battery bank

My grandfather's battery bank



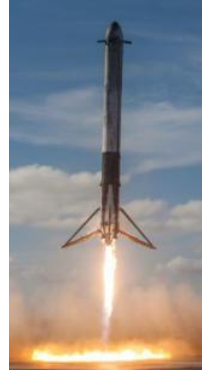
The year is 2021...



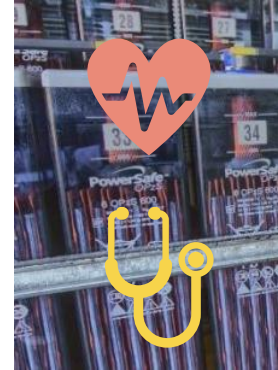
Traveling-wave relays



Pocket computers

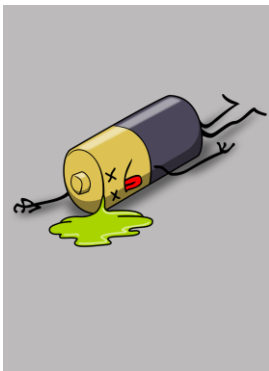


Landing rockets



Today's battery banks

How does control power fail?



Battery failure



DC control system faults



Battery charger failure



Human error

Why use station batteries?

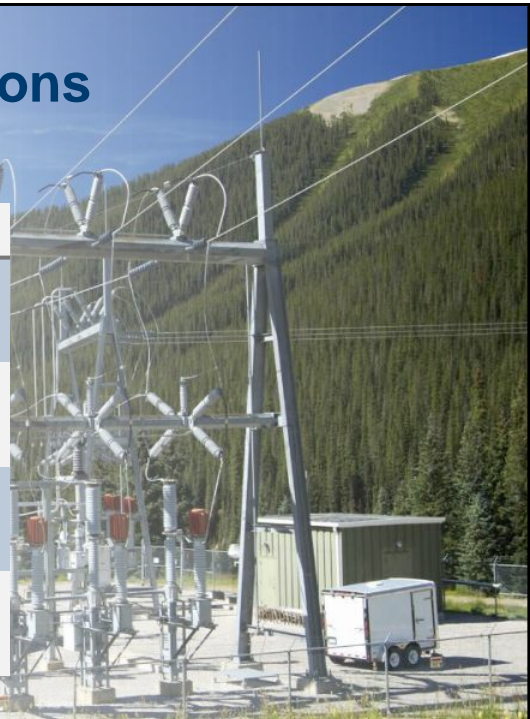
- Provide isolation between protection and the power system it protects
 - *Fault depresses voltage*
- Provide reliable power until repairs can be made to station service or charger
 - *Energy storage capacity*
- Provide momentary high current for tripping
 - *Maximum discharge rate*



Consequences of interruptions

Loss of availability

IED	Startup time (s)
Manufacturer A relay	<5
Manufacturer B relay	30
Automation controller	60
Station computer	500 – 1,000

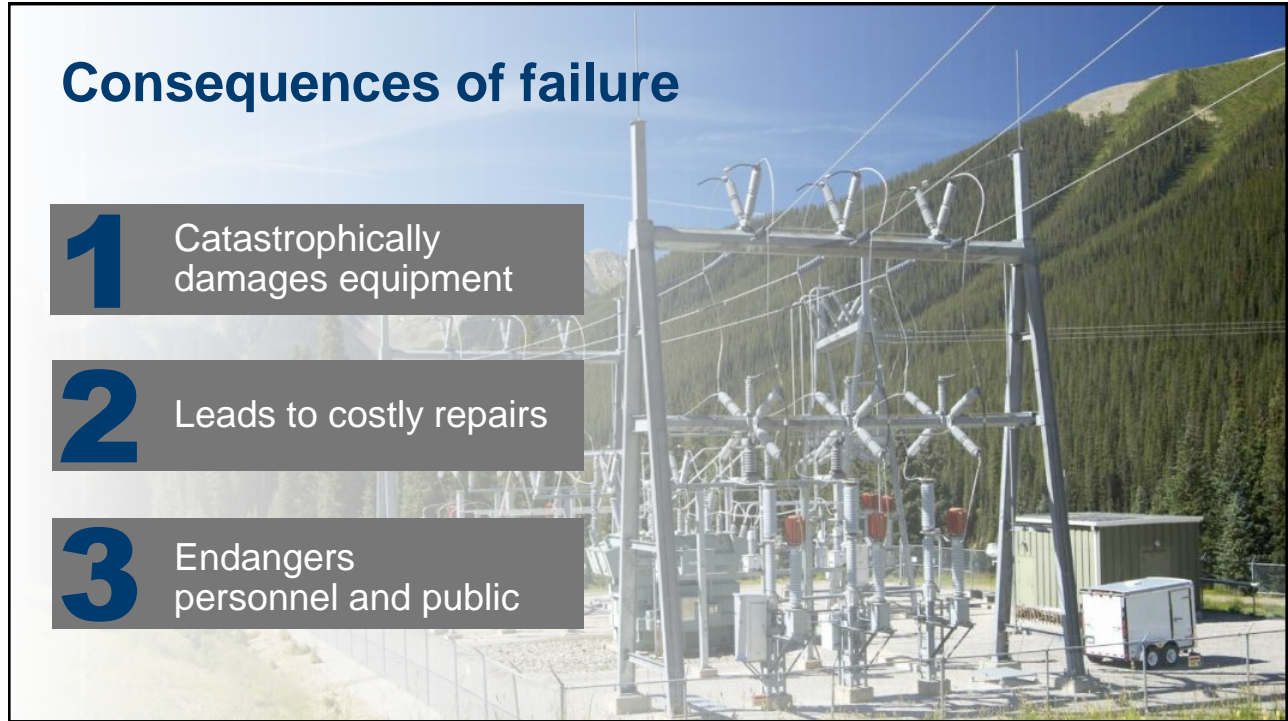


Consequences of failure

1 Catastrophically damages equipment

2 Leads to costly repairs

3 Endangers personnel and public



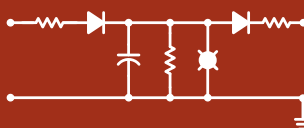
Today's solutions



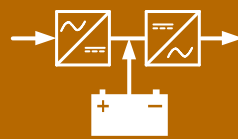
Dual station battery systems



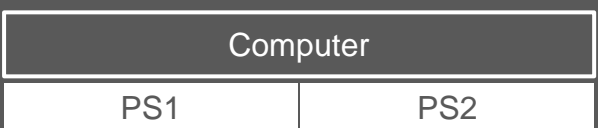
Monitoring



Capacitive trip units



Uninterruptible power supplies



Computer

PS1	PS2
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Dual power supplies

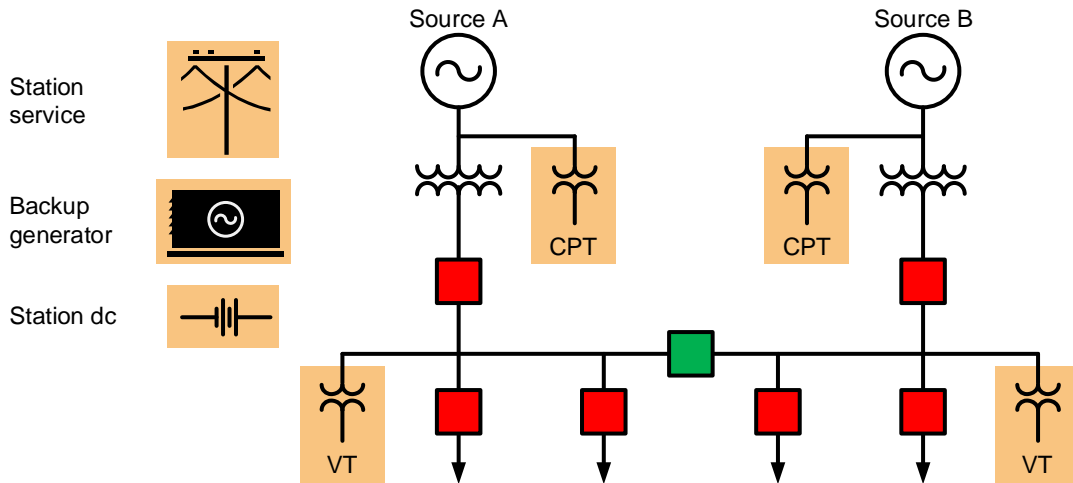
**Water, water, everywhere,
Nor any drop to drink**



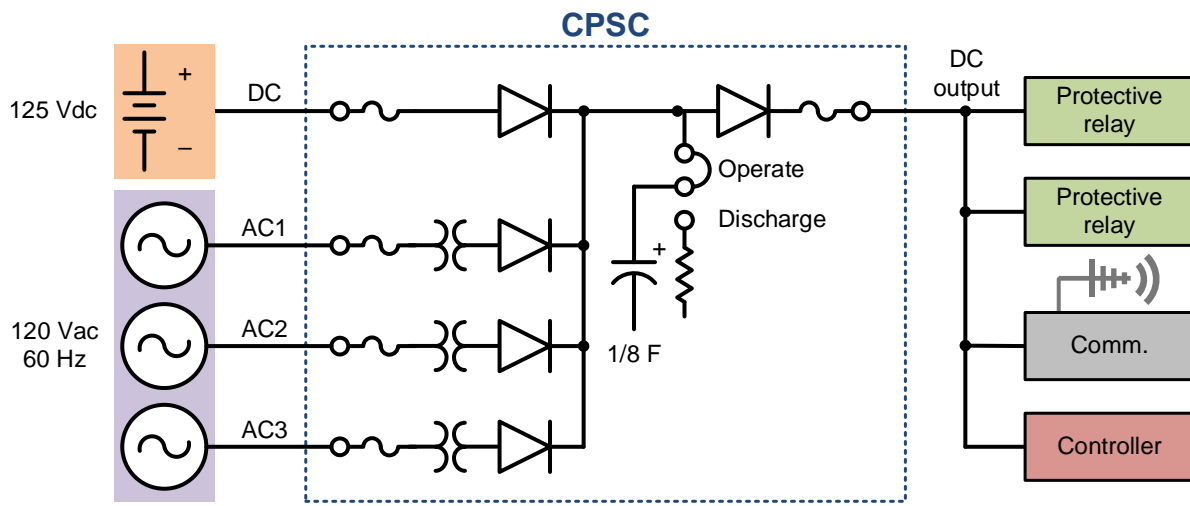
**Power, power, everywhere,
Nor any source avails**



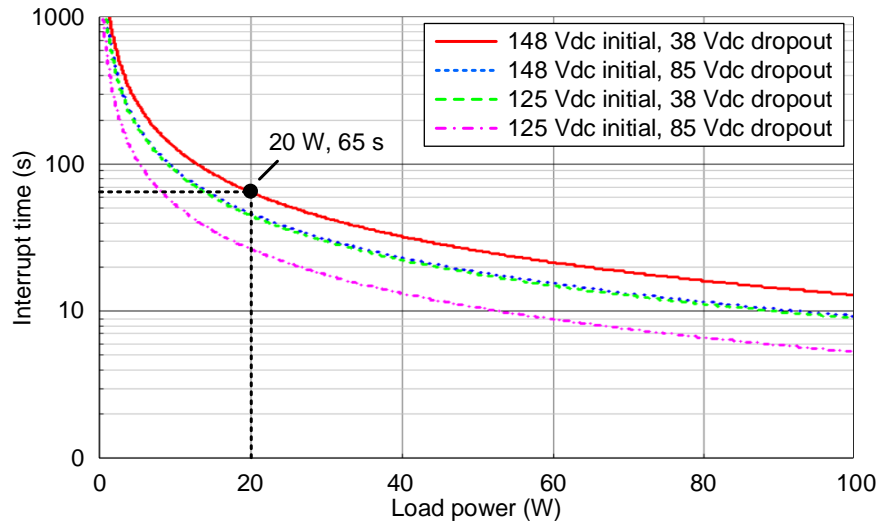
Can we use all sources of control power?



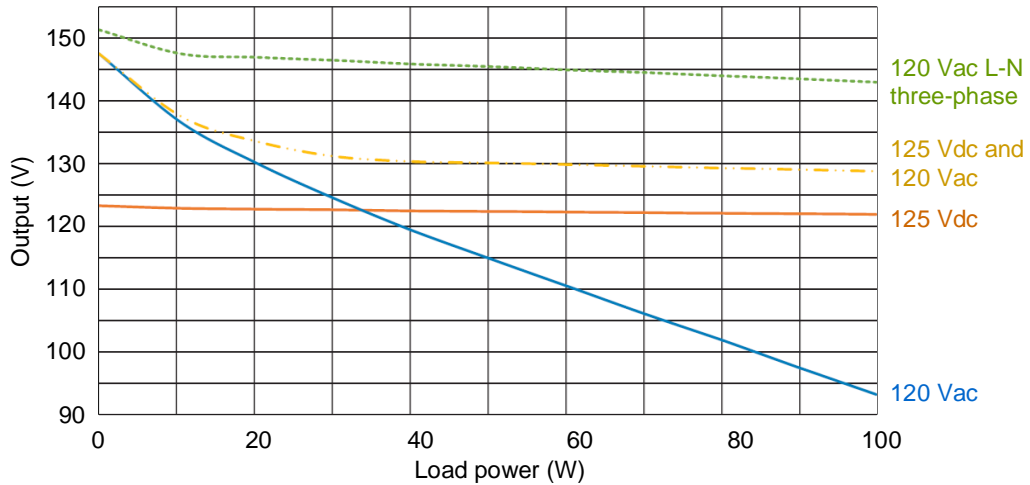
Combine dc with isolated ac and store energy in large capacitor



Ride-through times for total loss of source

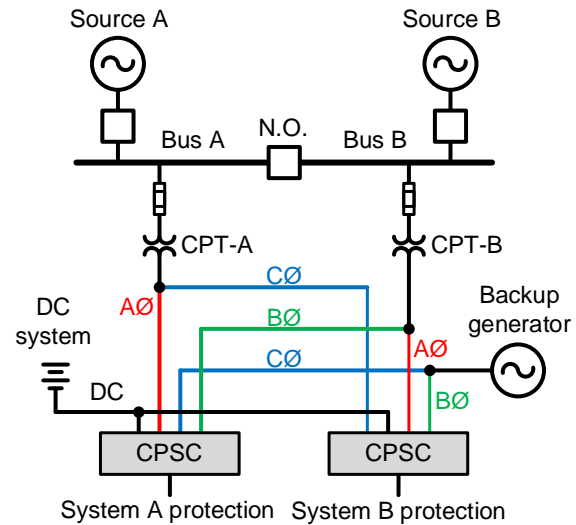


Output voltage depends on input and load



Designing reliability using diversity

- Connects to different source locations
- Uses different phases
- Systems A and B connect to different sources



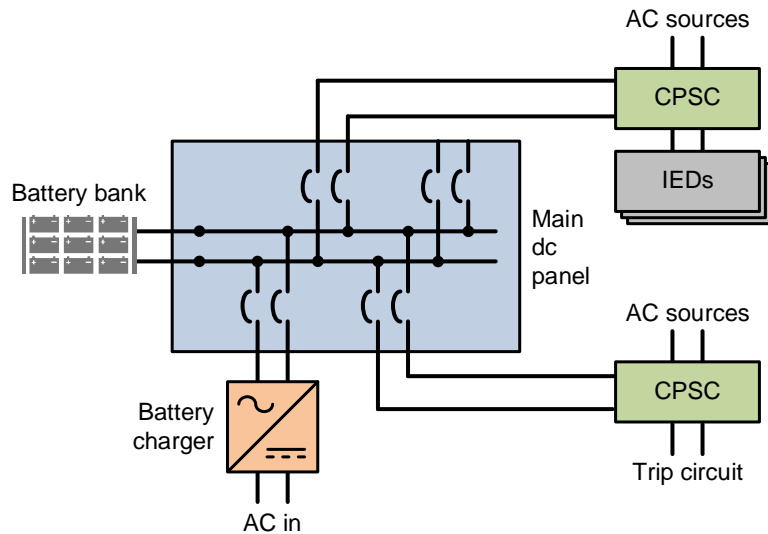
Applications benefitting from reliable control power

- Stations without dual batteries
- Battery maintenance
- Stations with no battery
- Safety scheme
- Electromechanical relay replacement



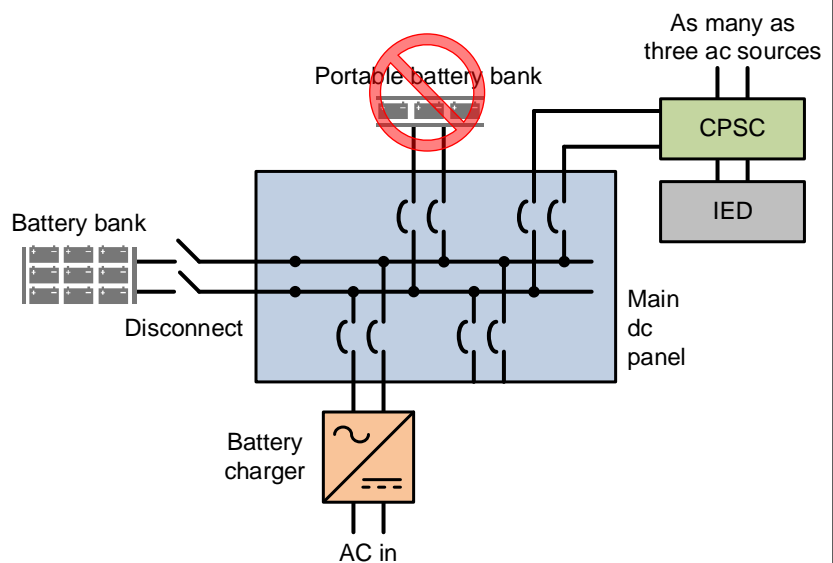
Typical station without dc redundancy

- CPSC is in branch circuits
- CPSC provides alternative energy source to trip breakers



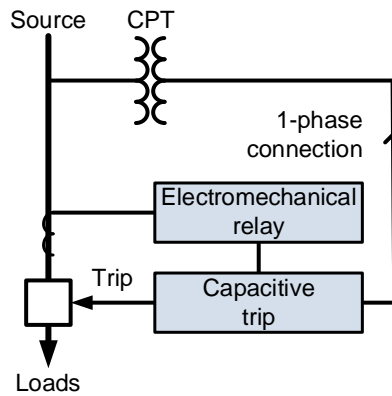
Maintenance and human performance

- Eliminates need for portable battery banks
- Provides energy to trip breakers in an emergency
- Reduces human errors



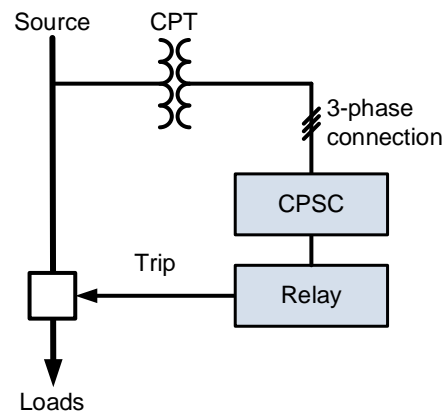
Electromechanical relay applications

- Capacitive trip device trips breaker
- Relays do not require a power source to operate
- Mechanical flags indicate contact operation

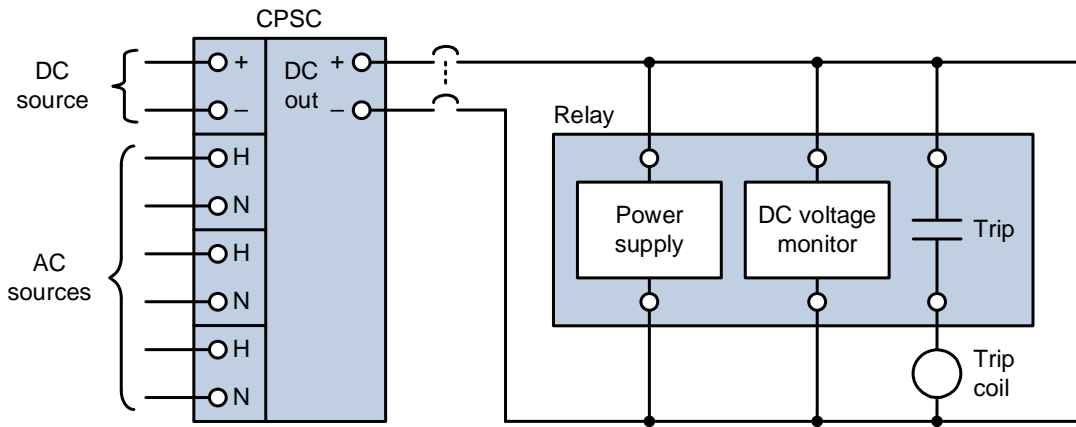


Complements digital relay upgrades

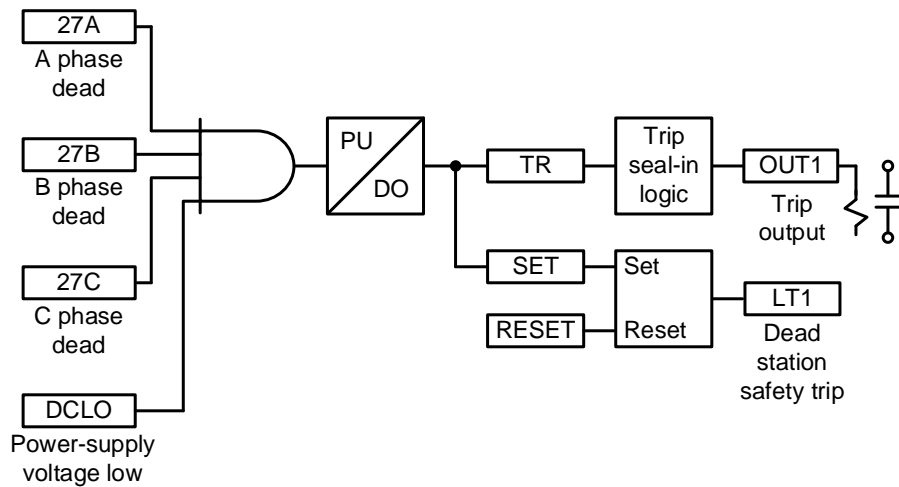
- Provides ride-through for momentary interruptions
- Can even replace capacitive trip units
- Keeps relay powered long enough to store event record



Safety schemes protect people and equipment



Safety schemes protect people and equipment

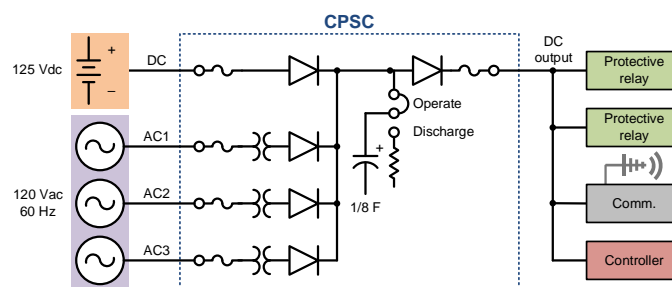


CPSC solves most auxiliary supply issues

- Capacitor provides ride-through during short circuits
- AC supplies are available if station is energized
 - Loss of station service
 - Loss of charger
- Capacitor provides momentary high current when needed
 - Hidden battery failures
 - Human error-caused battery disconnection
 - Out-of-service battery for testing or maintenance
- Black station safety logic can preemptively open breakers

Conclusion

- Reliability of dc systems is critical
- Substations contain many power sources
- Multiple unreliable sources can produce a reliable source
- Many applications could benefit from combining control power



Questions?