

Exploring IEEE C37.246-2017 Guide for Protection Systems of Transmission-to-Generation Interconnections

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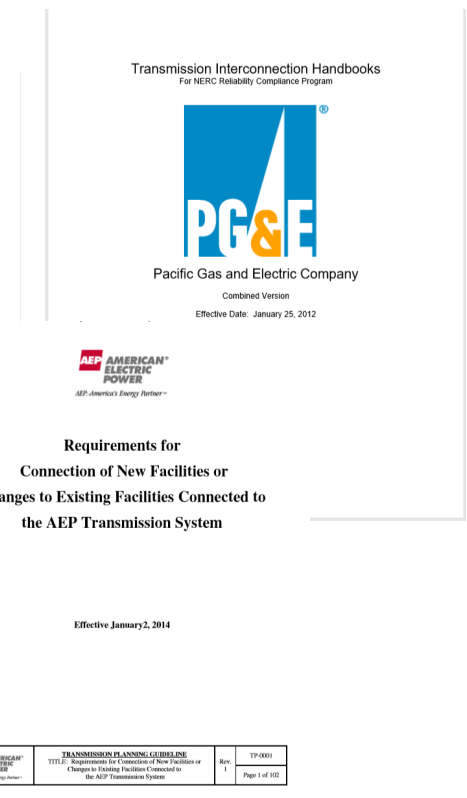
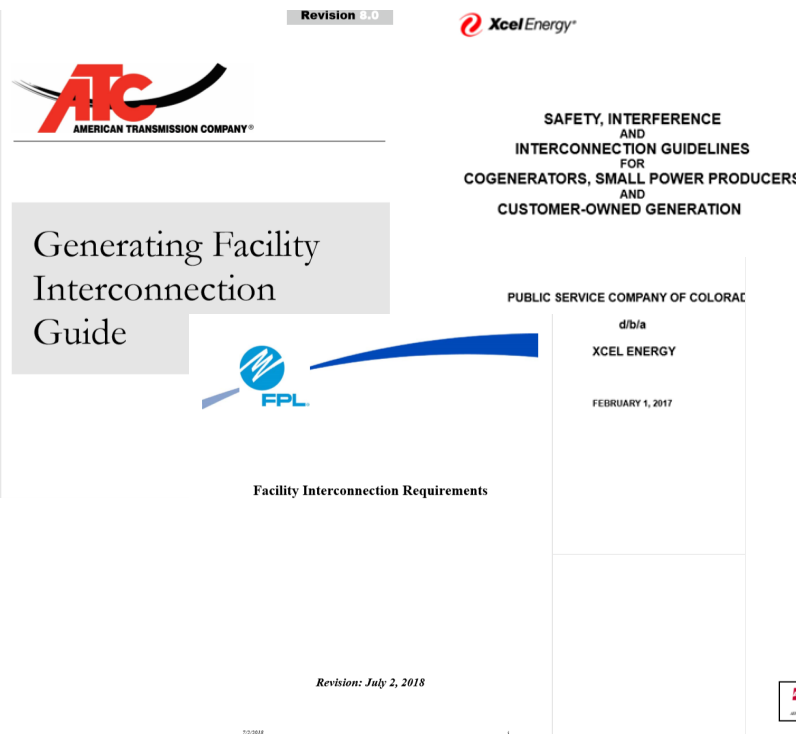
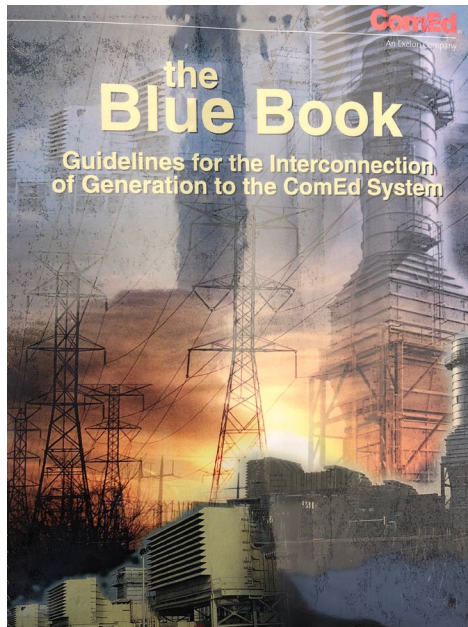
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Objectives

- Need for industry document
- Scope/purpose of new guide
- Guide contents
- Interconnection protection overview
- Summary

Need for industry document

- Past – vertically integrated utilities
 - Individual electric utilities maintain their own interconnection requirements



Need for industry document (cont.)

- Present – power industry deregulation
 - Independent power producers and transmission companies
 - Increasing penetration of inverter-based generation
 - Regulatory reliability standards

IEEE STANDARDS ASSOCIATION

IEEE

IEEE Guide for Protection Systems of Transmission-to-Generation Interconnections

IEEE Power and Energy Society

Sponsored by the
Power System Relaying and Control Committee

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USA

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Guide Scope and Purpose

- **Scope**

- Document accepted protection practices for transmission-to-generation interconnections
- Cover protection system applications at transmission-to-generation interconnections greater than 10 MVA
- Out of scope: distributed energy resources

- **Purpose**

- Provide guidance to those responsible for the protection of electrical transmission-to-generation interconnections greater than 10 MVA
- Not intended to supplant specific transmission or generator owner practices, procedures, requirements, or contractual agreements.

Guide contents

Establishing interconnection

- Technical data exchange between transmission and generator owners

Interconnection configurations

- Straight bus
- Dual-terminal bus
- Tapped connections

System studies

- Evaluate proposed transmission-to-generation interconnections
- Power flow, transient stability, short-circuit, and relay coordination

Guide contents (cont.)

Protection system settings for interconnections

- Specific protection system guidelines to be considered when designing new or upgrading existing interconnection substation.
- Interconnection substation protection and control functions
- Issues of autoreclosing near generation and interconnection communication-based transfer tripping
- Tapped connections
- Interconnections with renewable energy sources

Establishing interconnection

Role of transmission owner

- Selects relays and protection schemes
- Determines maximum and minimum fault current levels
- Approves generator step-up (GSU) or interconnection transformer winding configurations
- Provides data on:
 - Power system stability
 - Synchronizing practices
 - Autoreclosing practices
 - Grounding coordination

Establishing interconnection

Role of generator owner

- Proposes point of interconnection
- Provides design drawings
- Provides data on:
 - Generator
 - Transformer
 - Ride-through capability
 - Reactive power, frequency control
 - Short circuit levels

Establishing interconnection

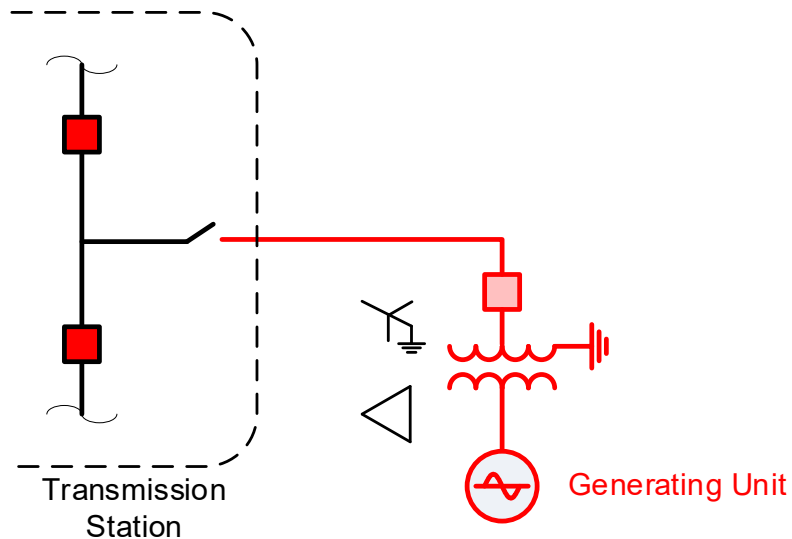
Specific considerations

- Various items to agree on:
 - Equipment
 - Protection
 - Testing
- Voltage transient effect

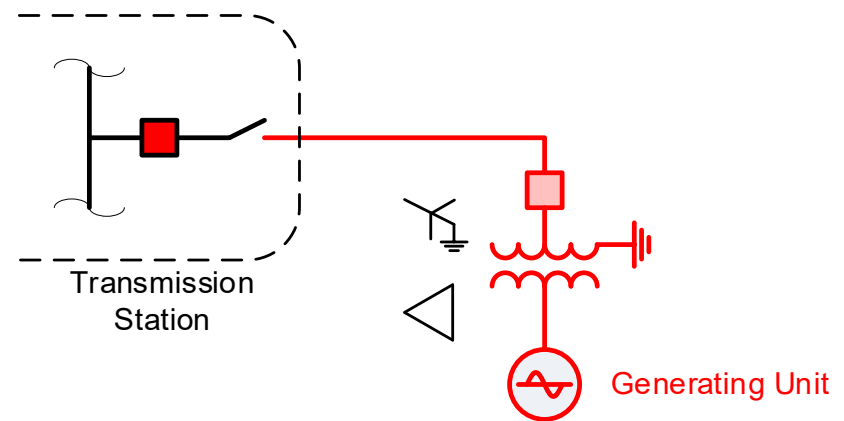
Interconnection configurations

Tie line

a) Double breaker arrangement

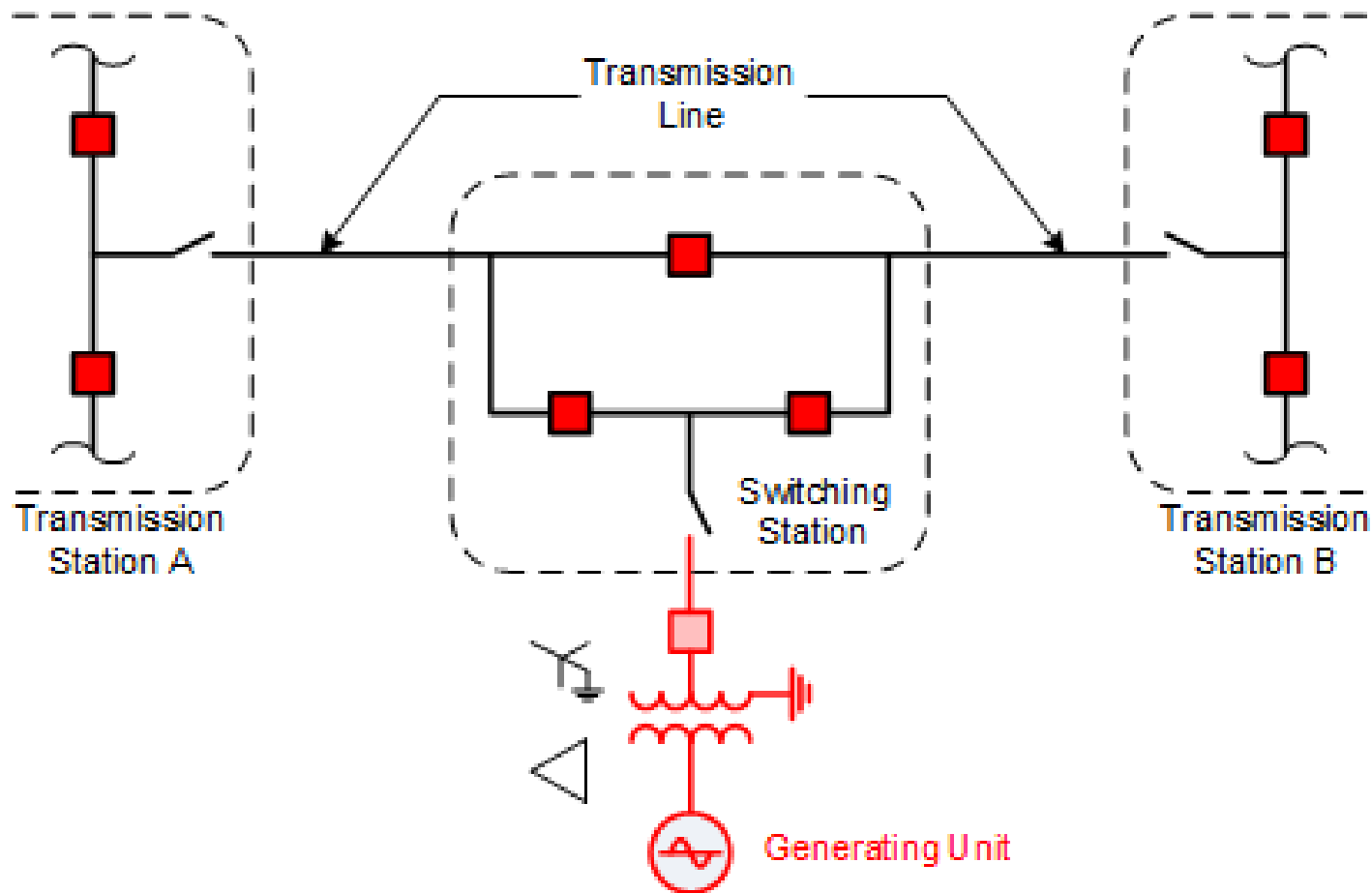


b) Single breaker arrangement



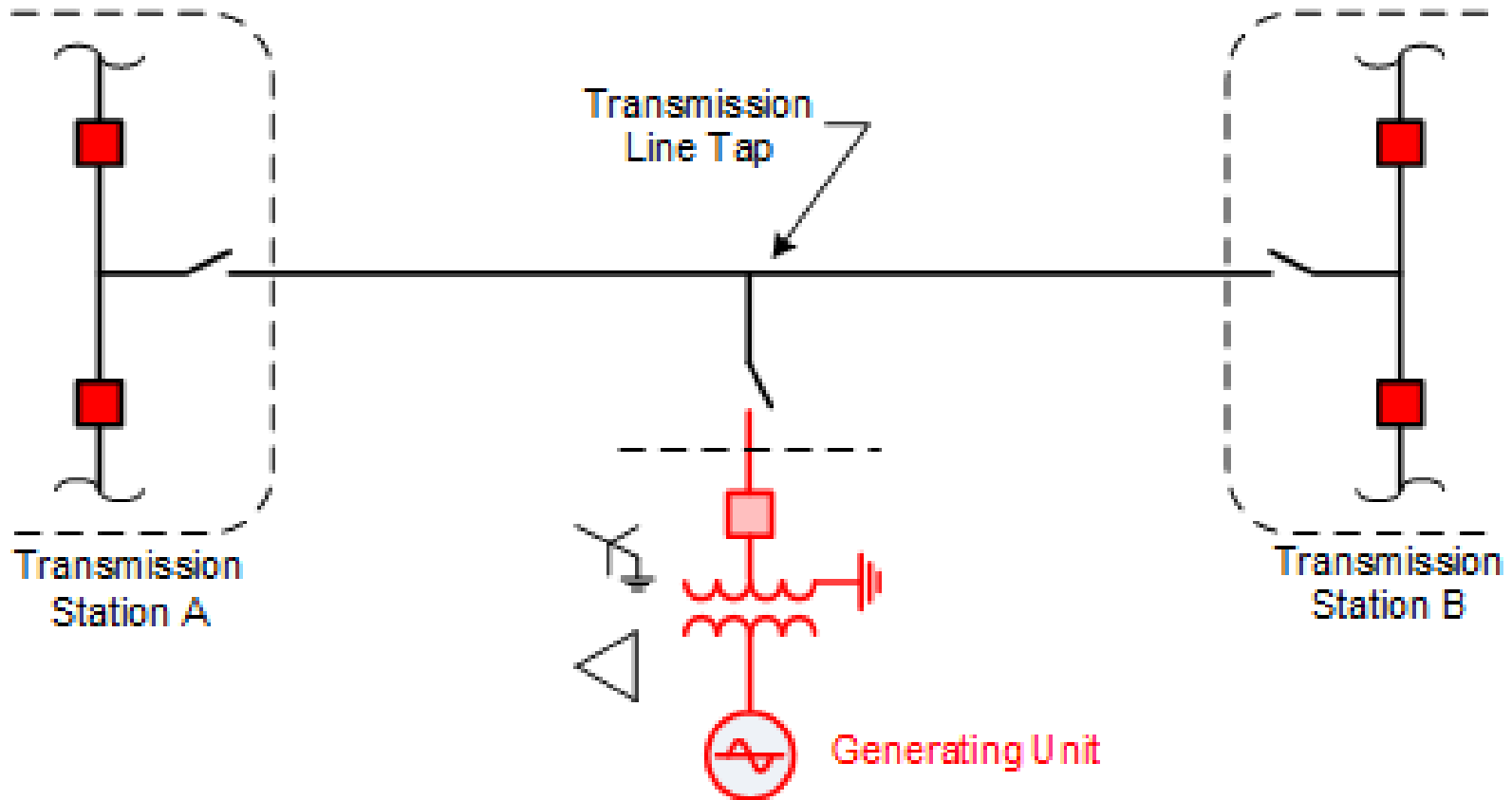
Interconnection configurations

Switching station



Interconnection configurations

Tapped connection

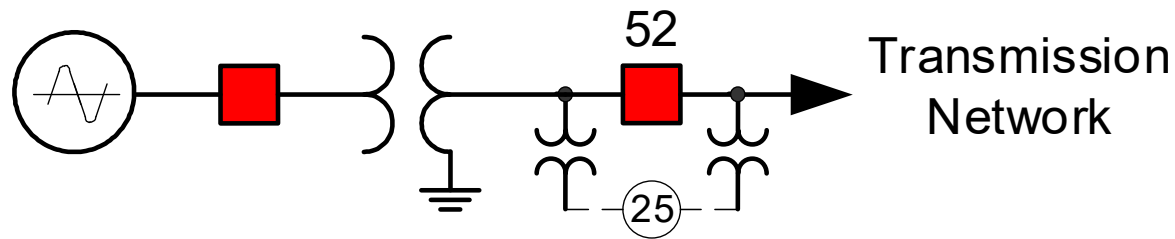


System studies

- System impact study
- Facilities study
- Specific system studies
 - AC power flow analysis
 - Transient stability analysis
 - Short circuit analysis
 - Relay coordination studies
 - Subsynchronous resonance (SSR) studies

Interconnection protection functions

Synch Check (25)



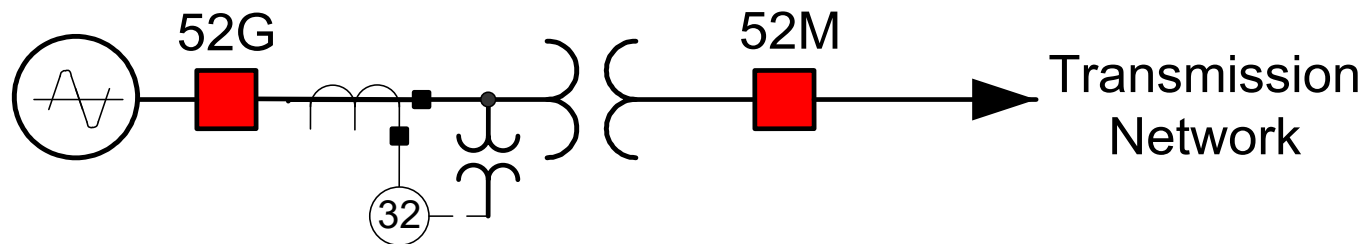
Interconnection protection functions

Degraded Grid Voltage (27)

- Generator auxiliary systems
- Specified limits
- Separation
- Multiple elements
- Coordination
- See guide for further details

Interconnection protection functions

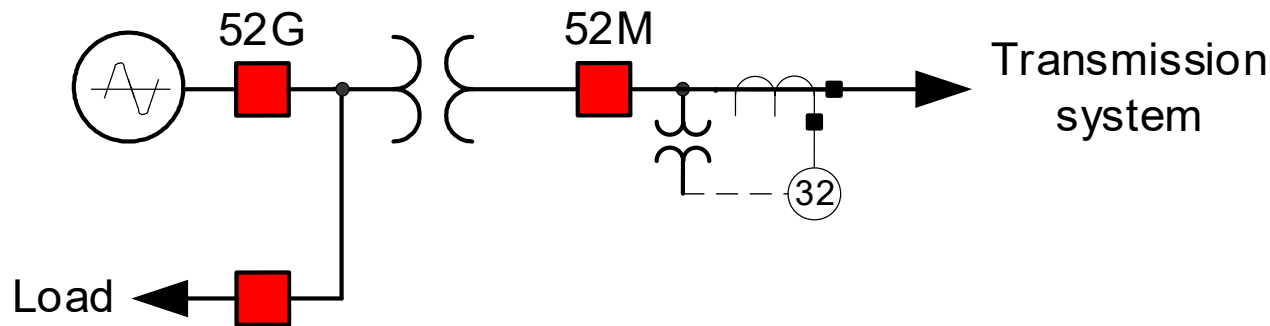
Reverse Power (32) – generator motoring



- Typically, part of generator protection
- Applied with loss of prime mover energy
- Trip 52G for power flow into the generator

Interconnection protection functions

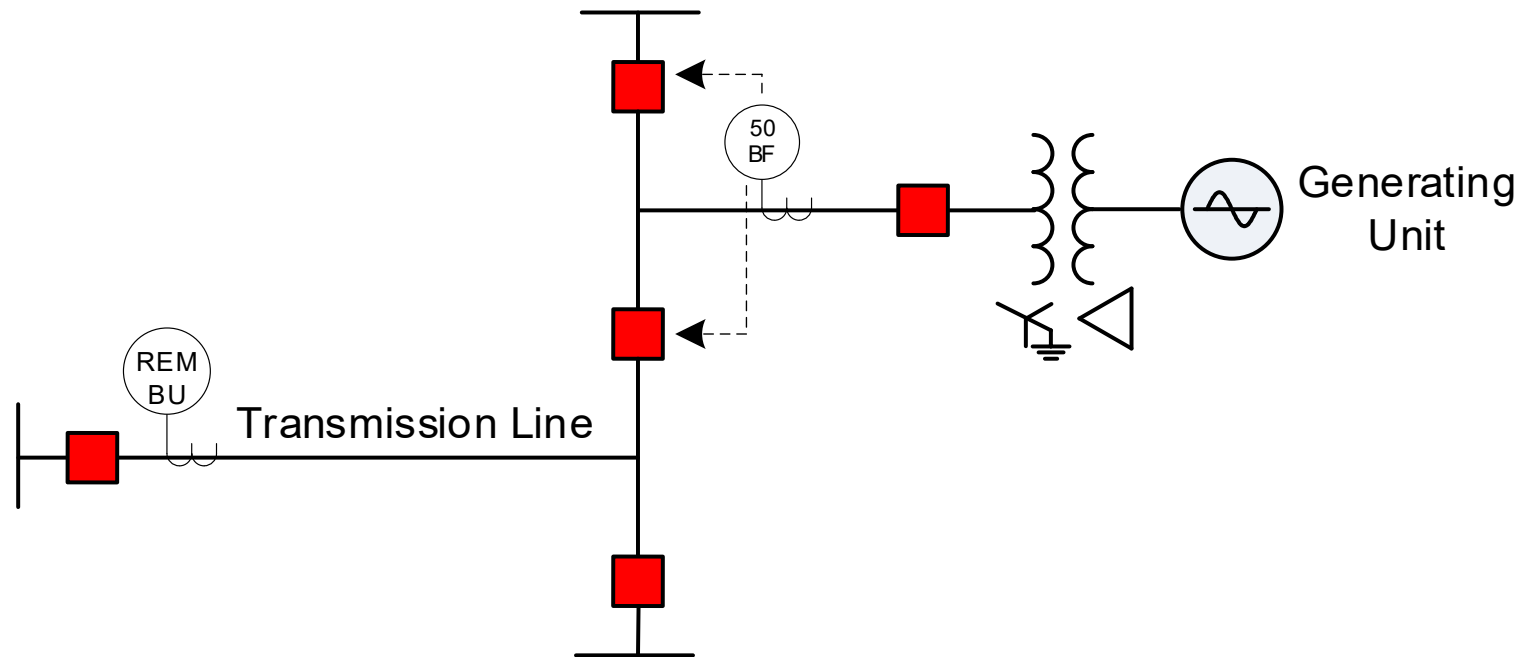
Reverse Power (32) – one-way power flow



- Generation for local load, no energy export
 - Industrial plant with local generation
- Lost network source, power flowing into transmission system
- Trip 52M
- Trip 52G

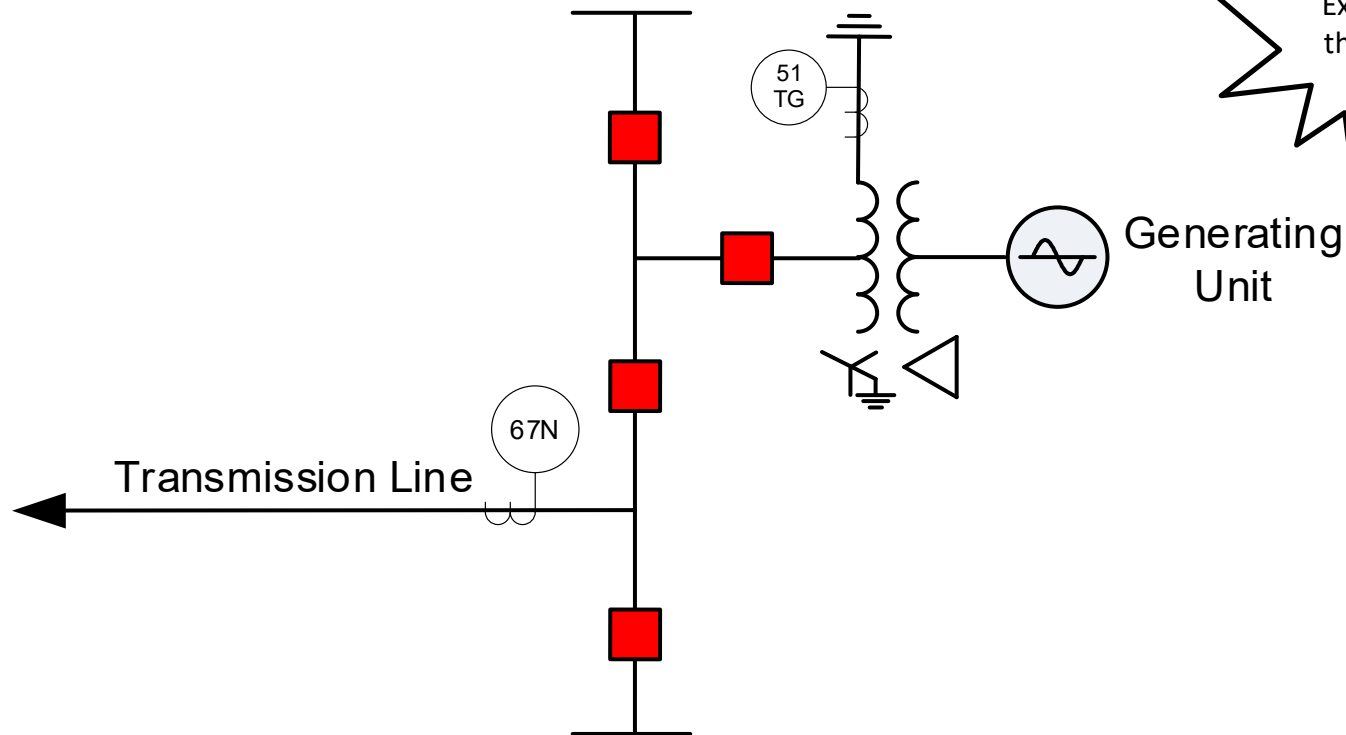
Interconnection protection functions

Breaker failure protection (50BF)



Interconnection protection functions

GSU Ground Overcurrent (51TG)



Interconnection protection functions

Frequency protection (81)

- Typically applied at generation
- Anti-islanding protection
- Manufacturer recommendations
- Regional requirements
- Backup

Interconnection protection functions

Bus differential protection (87B)

- When is interconnection a bus?
- IEEE Std C37.234 - Protective Relay Applications to Power System Buses.

Interconnection protection functions

Tie line current differential protection (87L)

- When is interconnection a line?
- Current differential scheme
 - Not affected by weak infeed conditions
 - Only requires line currents
 - Setting simplicity

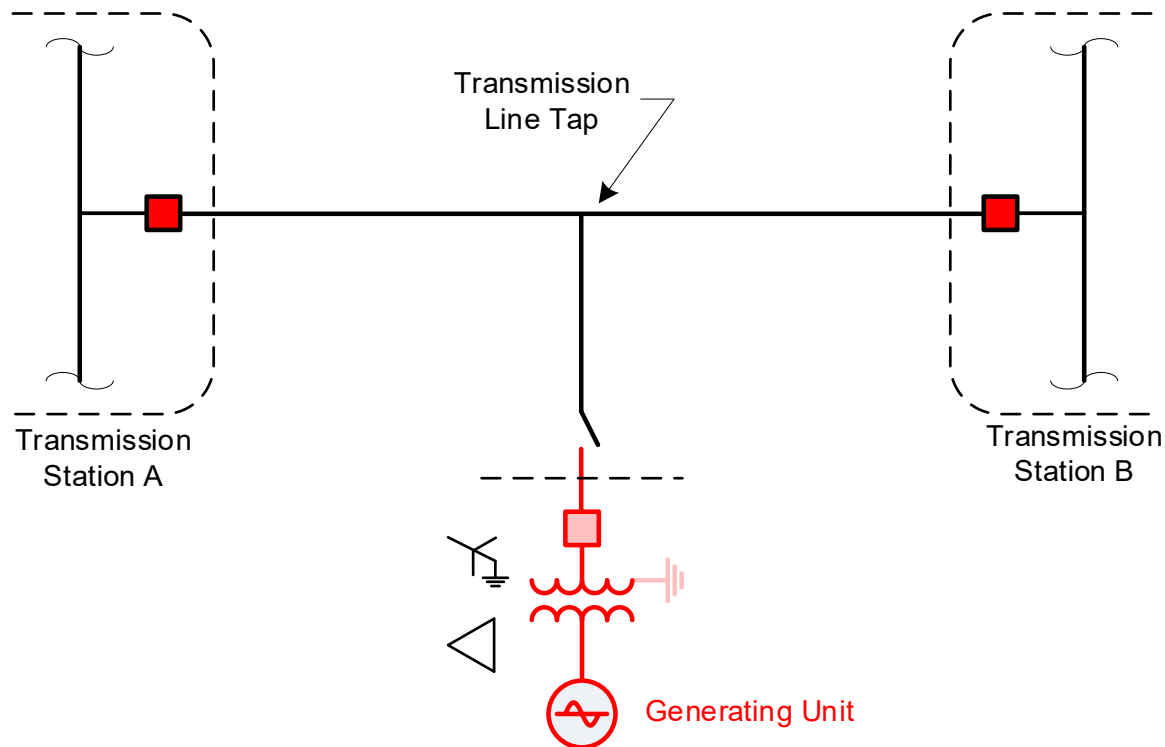
Line autoreclosing

- Intermittent faults
- Consider possible damage to generation
- Mitigating options

Tapped connections

Design issues

- Tap adds exposure for line faults to the existing circuit
- Loss of the transmission line results in a loss of generator



Tapped connections Protection issues

- More complex multi-terminal protection schemes
- May require communication assisted schemes
- Relay coordination issues
- Zone 1 distance protection
- Infeed effects

Renewable energy resources

Wind plants

- Fault current contribution
- Varying fault currents
- Fast protection response needed

Renewable energy resources

Solar PV inverters

- Current controlled devices
- Fault currents
- Time-delayed protection issue
- Filtering components of the inverter
- Fast protection response required

Summary

- Engineering transmission-to-generation interconnection
 - Design reliable interconnection for dependable system operation during normal or abnormal system conditions.
 - Collaborate between transmission and generator owners during interconnection design
- Role of IEEE C37.246 guide
 - Aid protection engineers in interconnection design
 - Document and explain protection principles and best practices
 - Expound on practical application issues