What's New in C37.113-2015

IEEE Guide for Protective Relay Applications to Transmission Lines

2018 Texas A&M Conference

for Protective Relay Engineers

Background

- Revision of C37.113-1999
- Application of relays and protection systems to protect transmission lines
- D19 Working Group of IEEE Power System Relaying and Control (PSRC) Committee
- 31 working group members
- Approved on December 5, 2015

C37.113-2015 (D19 WG) members

- Don Lukach - Chair
- Jeffrey Barsch – Vice Chair
- Martin Best
- Gustavo Brunello
- David Circa
- Stephen Conrad
- Randall Cunico
- Alla Deronja
- Normann Fischer
- Dom Fontana
- Gary Kobet
- Walter McCannon
- Alexis Mezco
- Dean Miller
- John Miller
- Joe Mooney
- James O'Brien
- Dean Ouellette
- Claire Patti
- Elmo Price
- Sam Sambasivan
- Mohindar Sachdev
- Phil Tatro
- Richard Taylor
- Michael Thompson
- Ian Tualla
- Demetrios Tziouvaras
- Jun Verzosa
- Solveig Ward
- Roger Whittaker
- Zhiying Zhang

Table of Contents

- Definitions, abbreviations, and acronyms
- Fundamentals
- Impact of system configuration on selection of protection schemes
- Relay schemes
- Annex and extensive bibliography

What's New

- Communication systems
- Redundancy
- Autoreclosing
- Ground overcurrent protection
- Line length considerations
- Lines terminated into transformers
- Current differential applications; Ground path configurations
- Effects of high grounding resistance

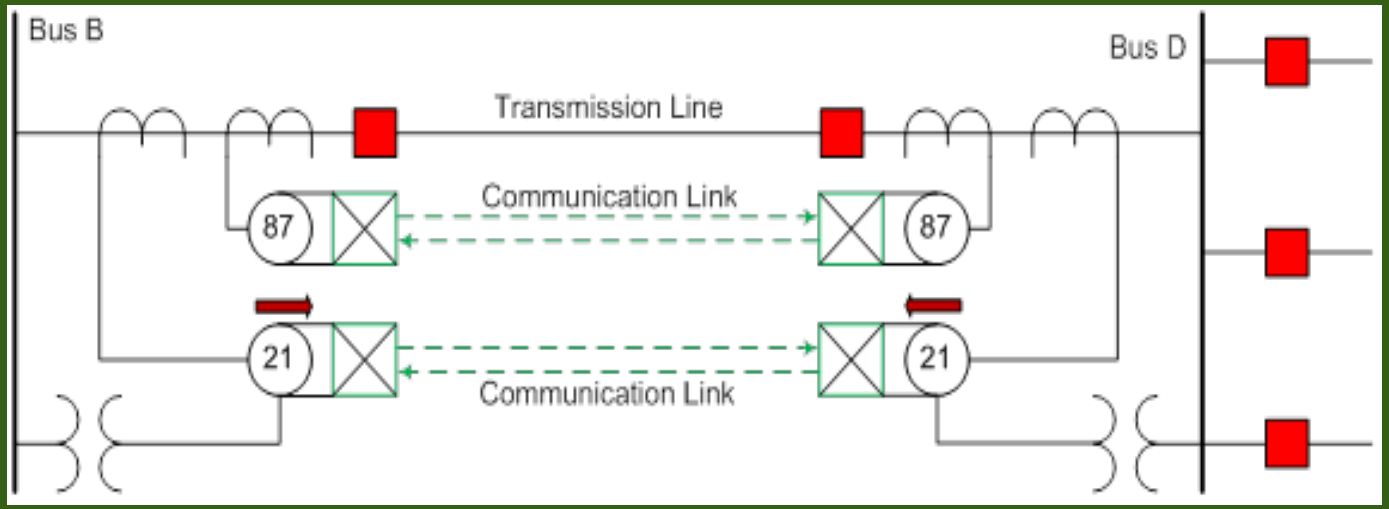
What's New (continued)

- Transfer and stub bus configurations
- Relay elements used in step distance schemes
- Polarization methods
- Specially shaped characteristics
- Single-phase tripping and reclosing
- Fault and system studies

Communications

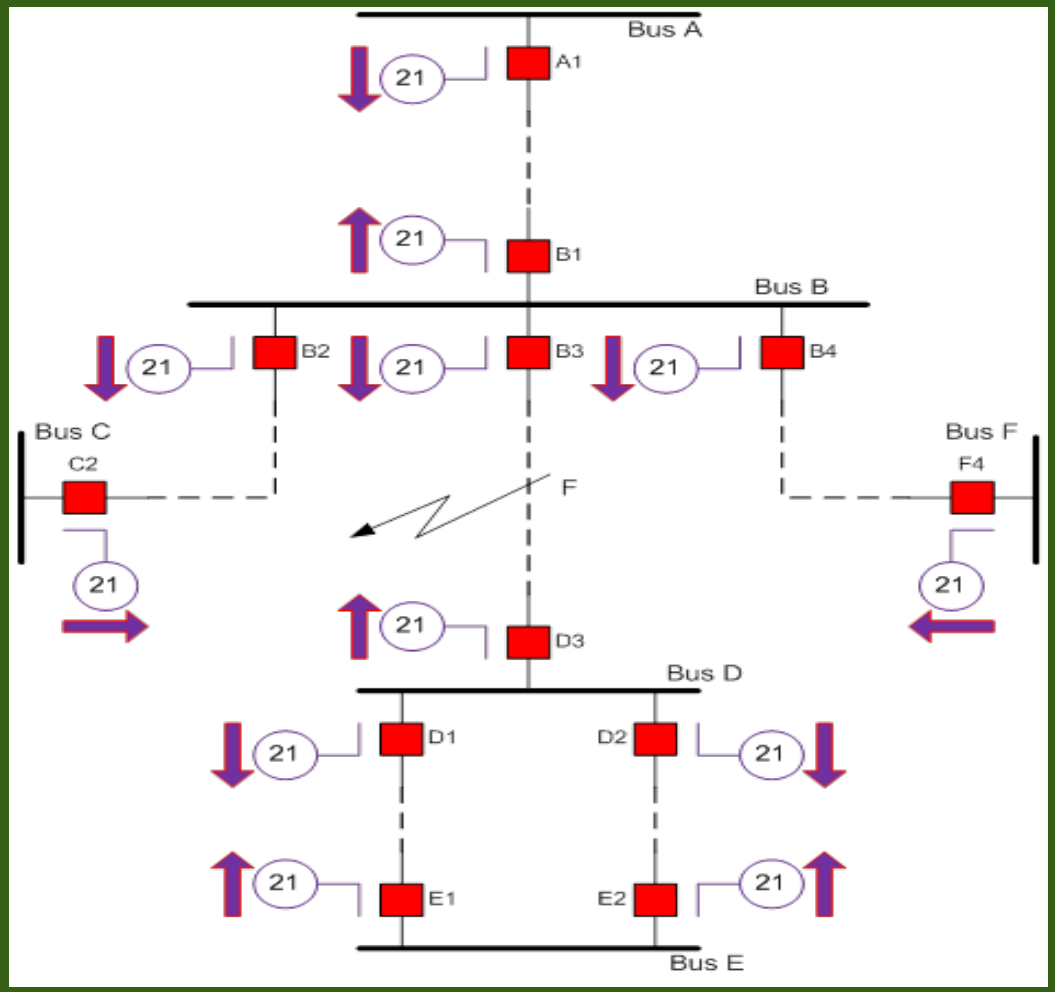
- Communications allows for include high-speed clearing
- Considerations when choosing a communication-based scheme

Redundancy and Backup Considerations



Main 1 and main 2 systems for protecting a transmission line

Remote backup protection of a transmission line

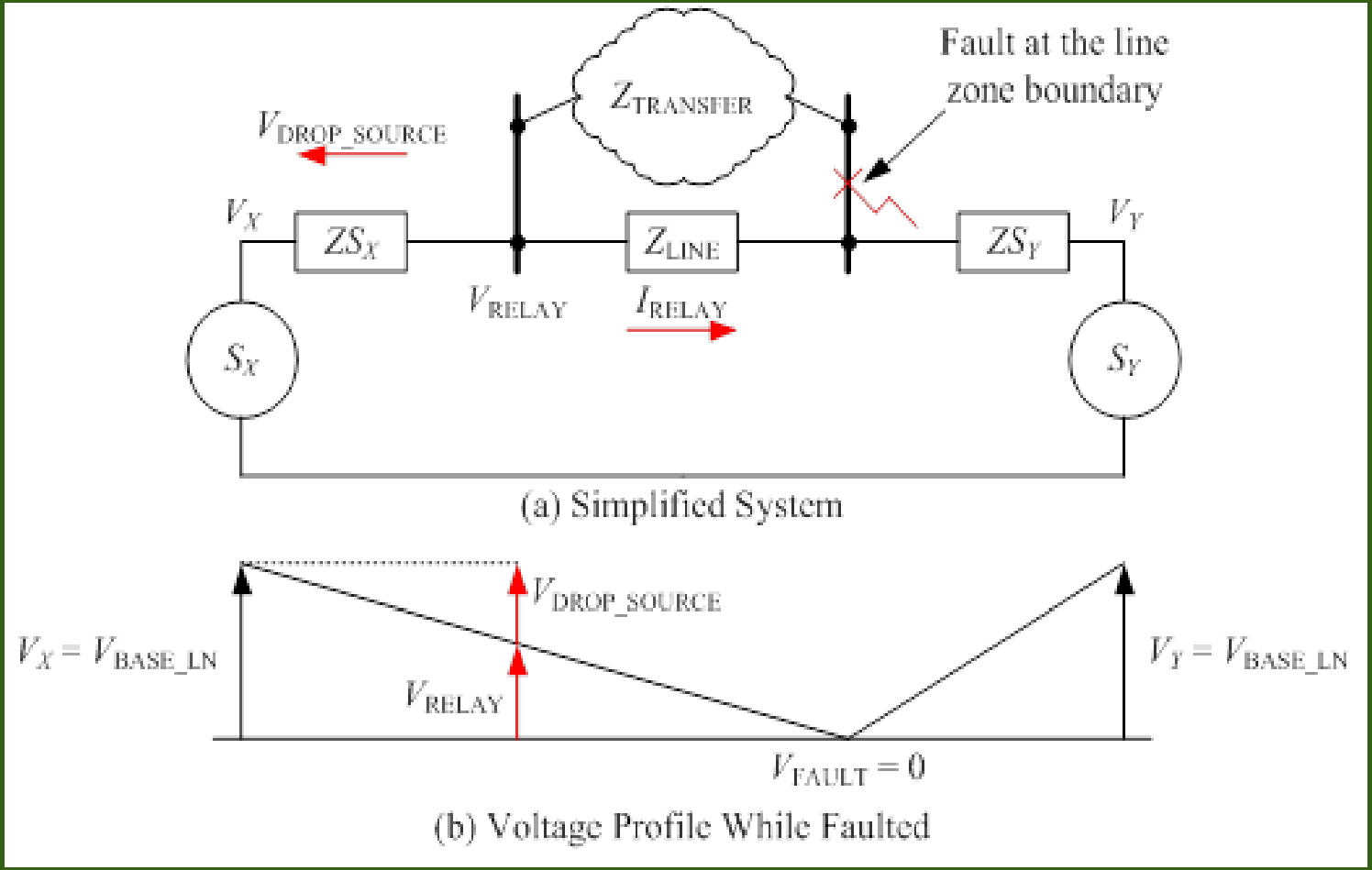


Line length considerations and SIR

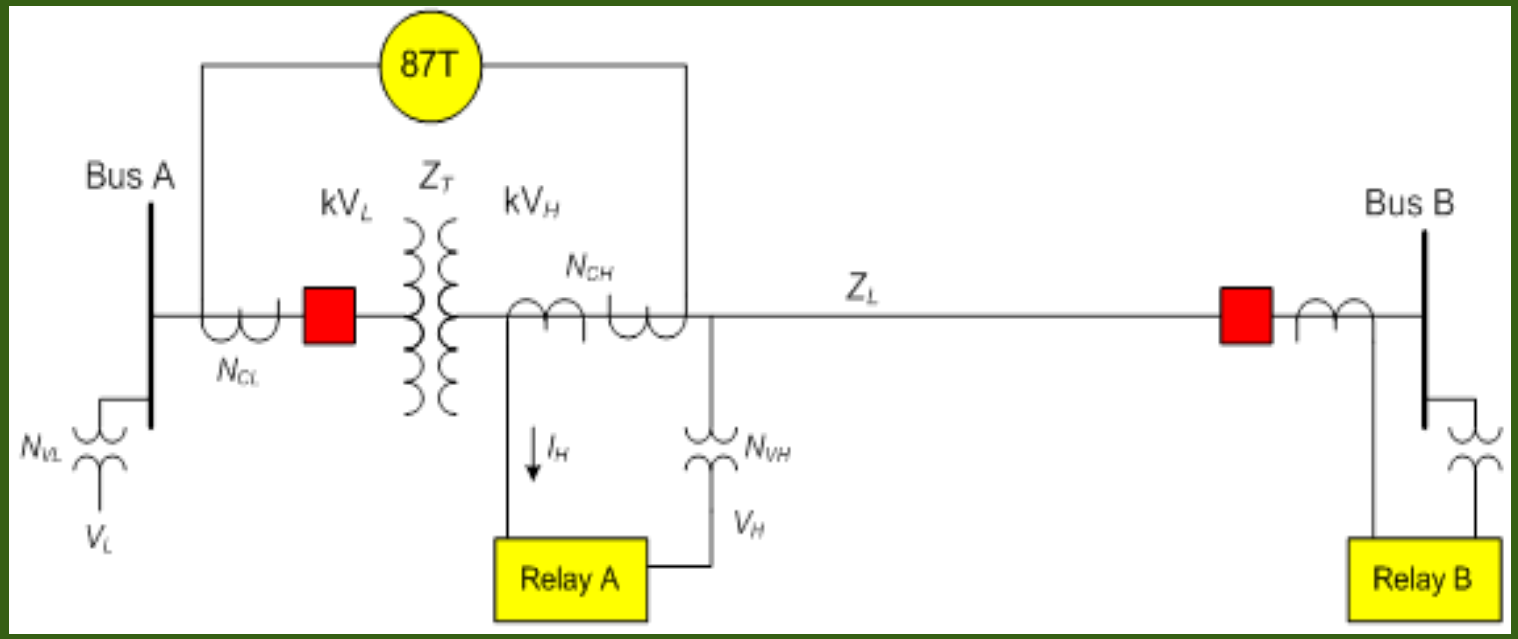
- SIR > 4 ; short line
- 0.5 <= SIR <= 4 ; medium line
- SIR < 0.5 ; long line

- Short lines pose challenge for line protection

Line length considerations and SIR

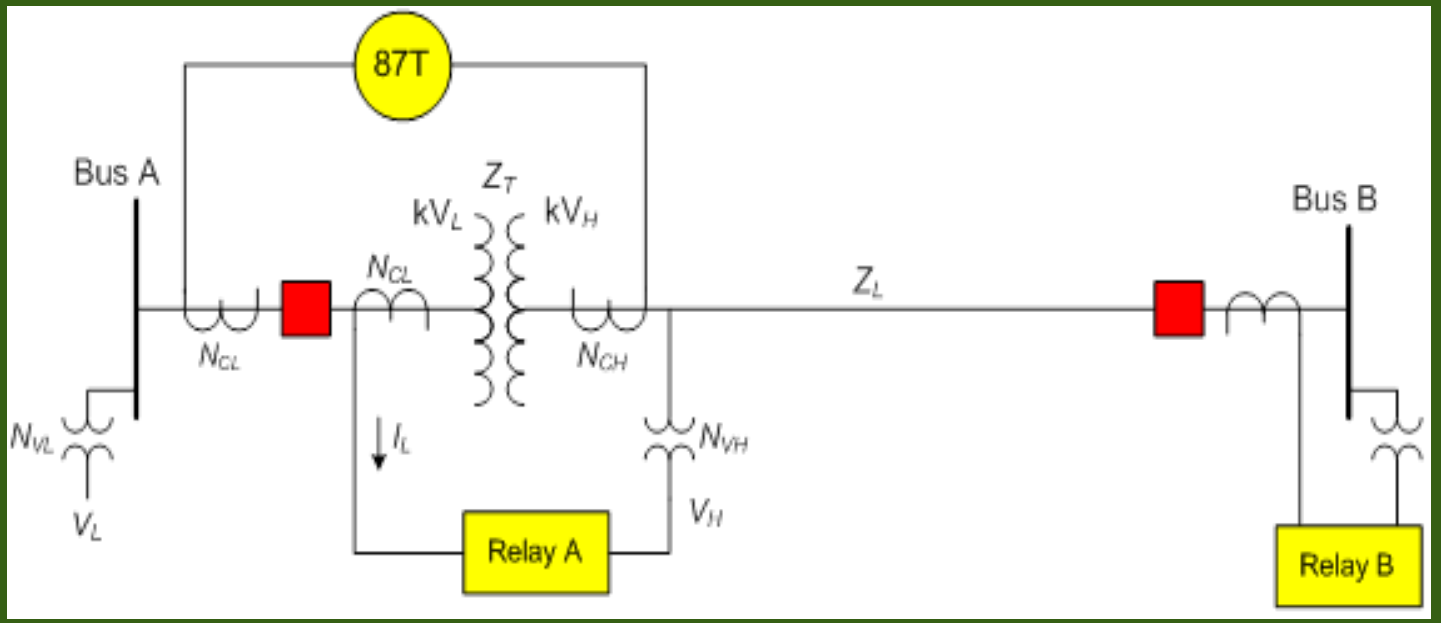


Considerations for Line Distance Applications



Preferred scheme for a line terminated into a transformer – Use V_H and I_H

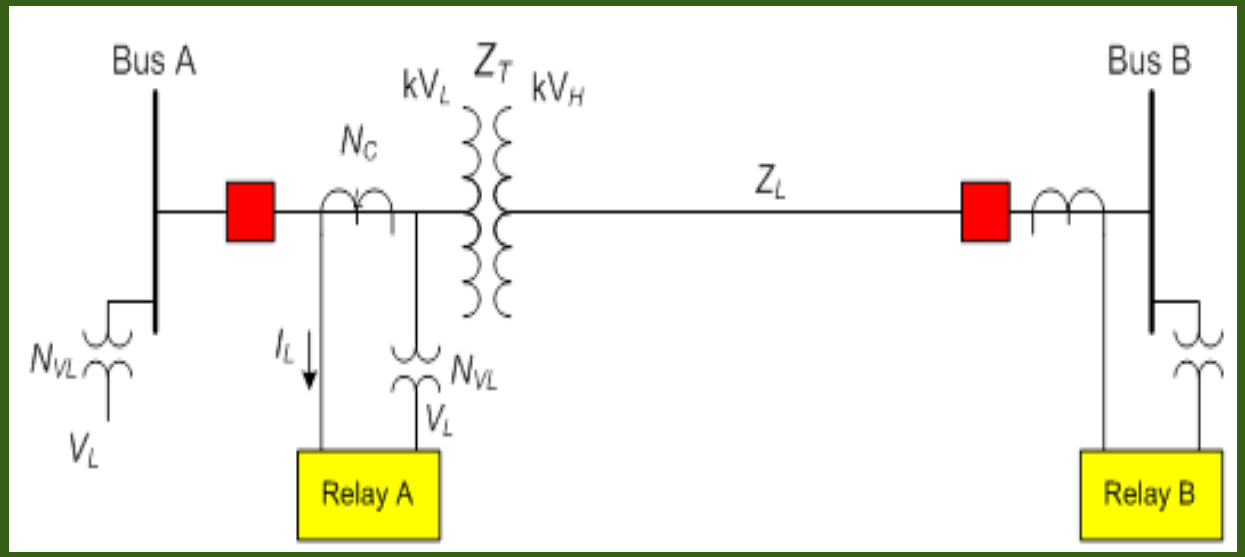
Considerations for Line Distance Applications



Relay uses V_H and I_L

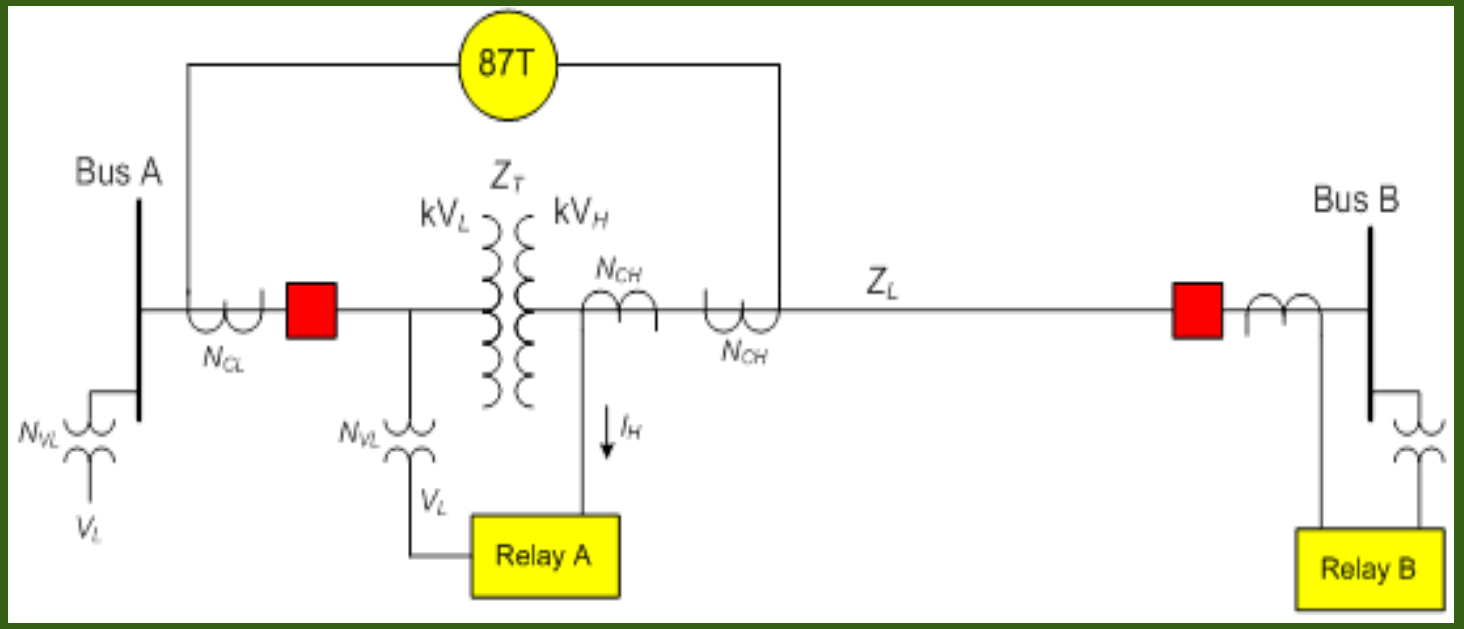
$$Z_{SEC} = \frac{N_{CL}\frac{kV_L}{kV_H}}{N_{VH}} Z_{PRI}$$

Considerations for Line Distance Applications



Relay uses V_L and I_L

Considerations for Line Distance Applications



Relay uses V_L and I_H

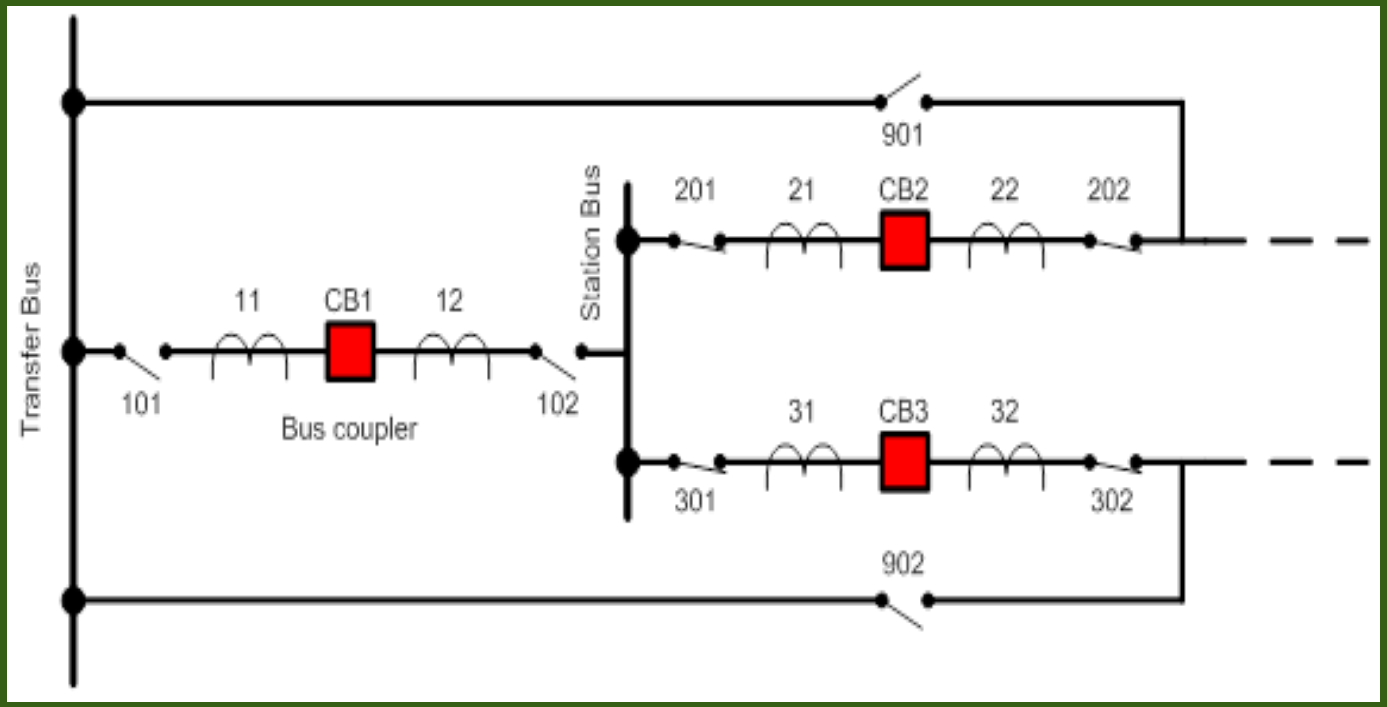
$$Z_{SEC} = \frac{N_{CH}\dfrac{kV_H}{kV_L}}{N_{VL}} Z_{PRI}$$

Current differential applications for lines terminated into transformers

- No issues if current I_H is used

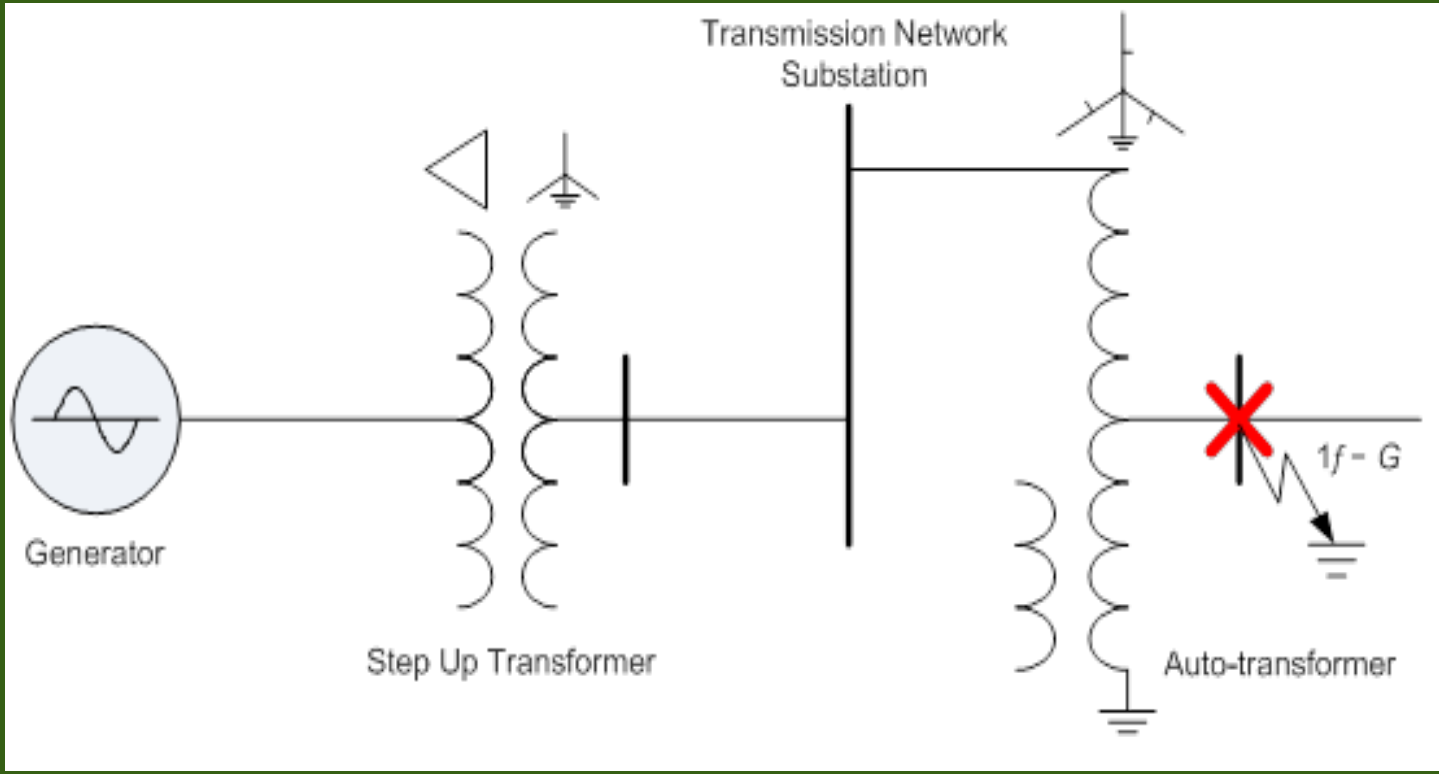
- If I_L is used, consider:
  - Phase shift correction
  - Zero-sequence filtering

Transfer bus and stub bus configurations

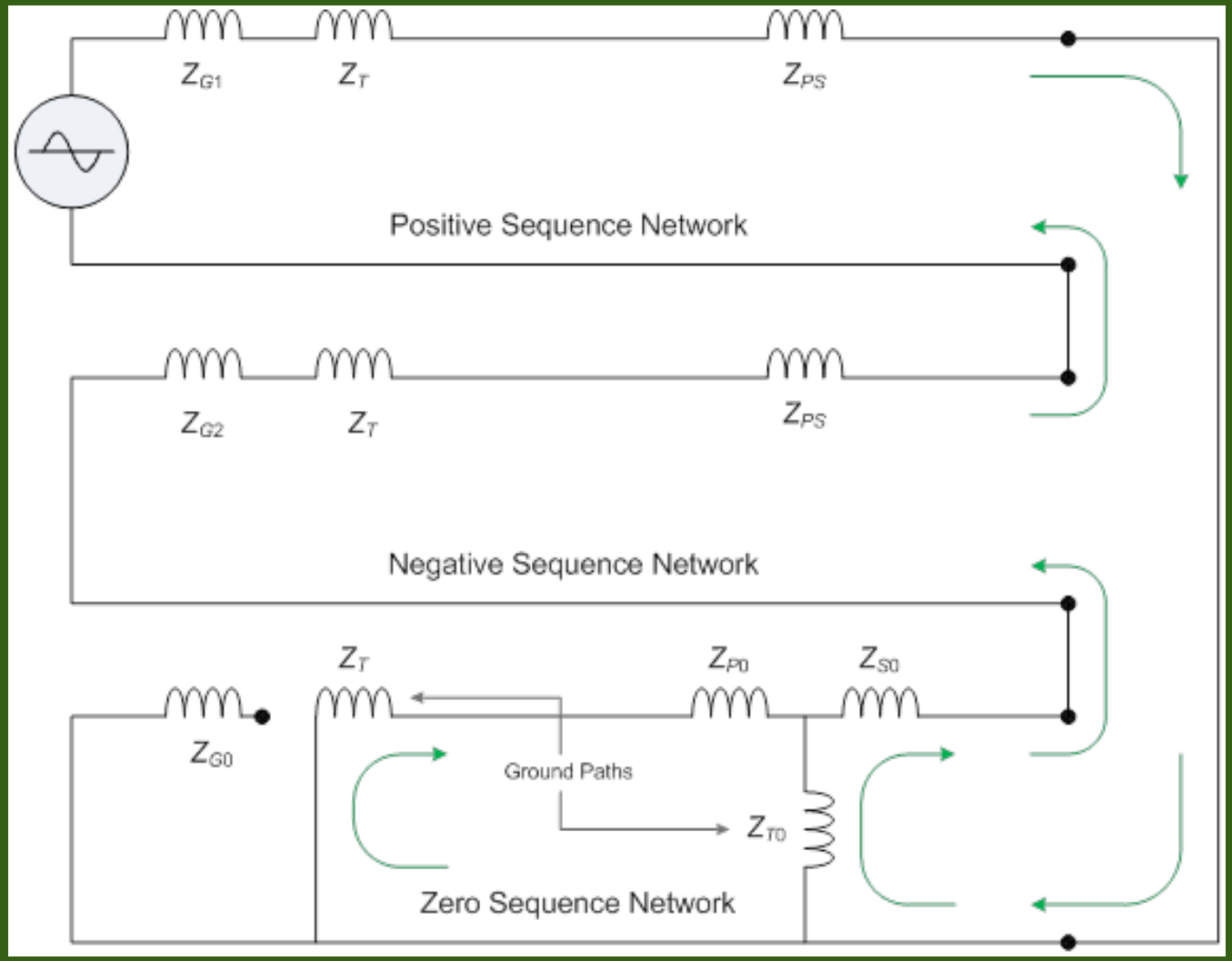


Transfer bus configuration

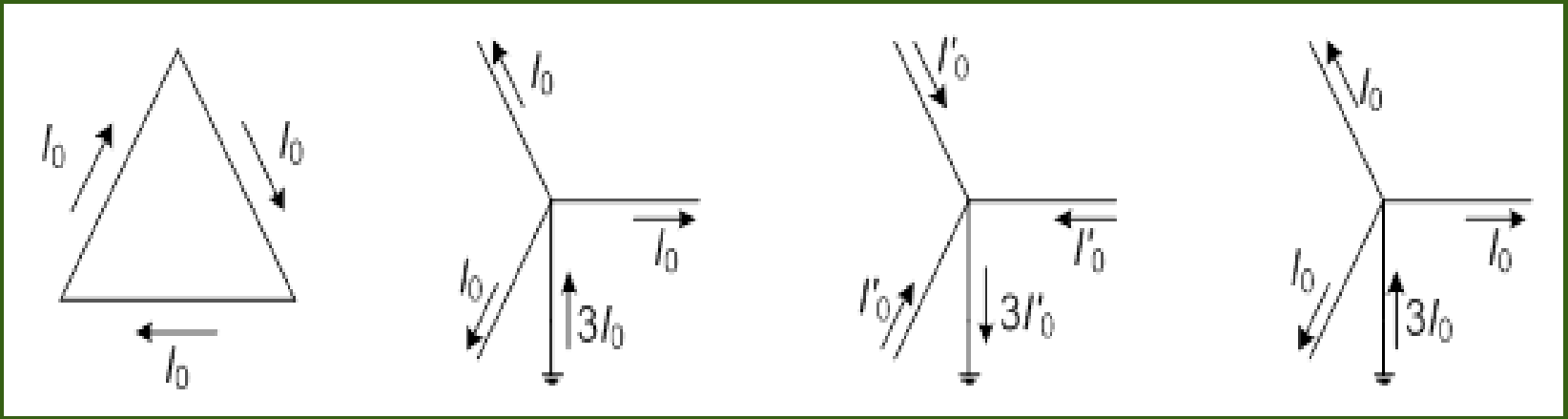
Ground path configurations



Symmetrical component diagram



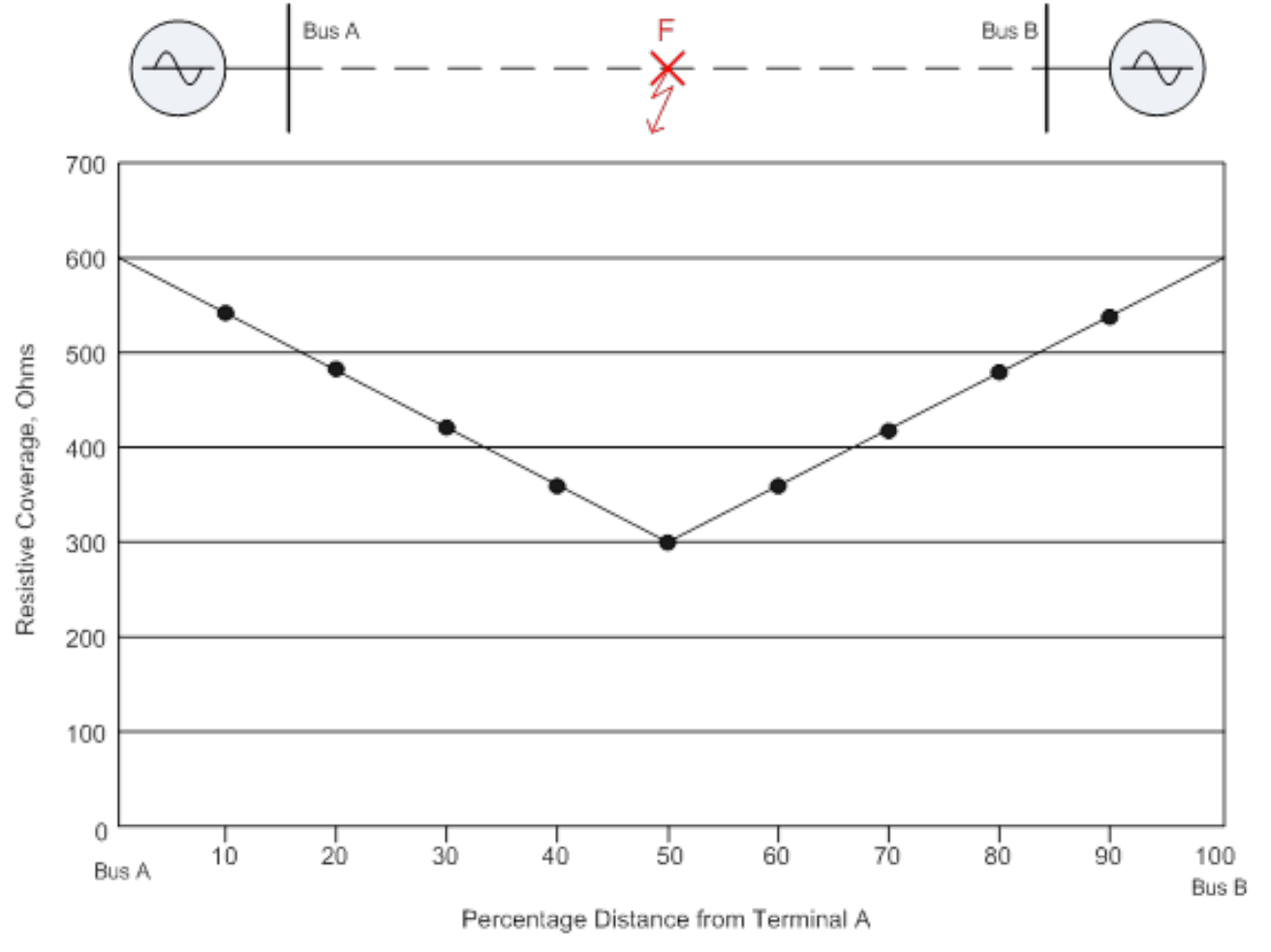
Zero-sequence current flow



(a)
Delta to wye-grounded transformer

(b)
Wye-grounded to wye-grounded transformer

Effects of high grounding resistance on operation of line protection



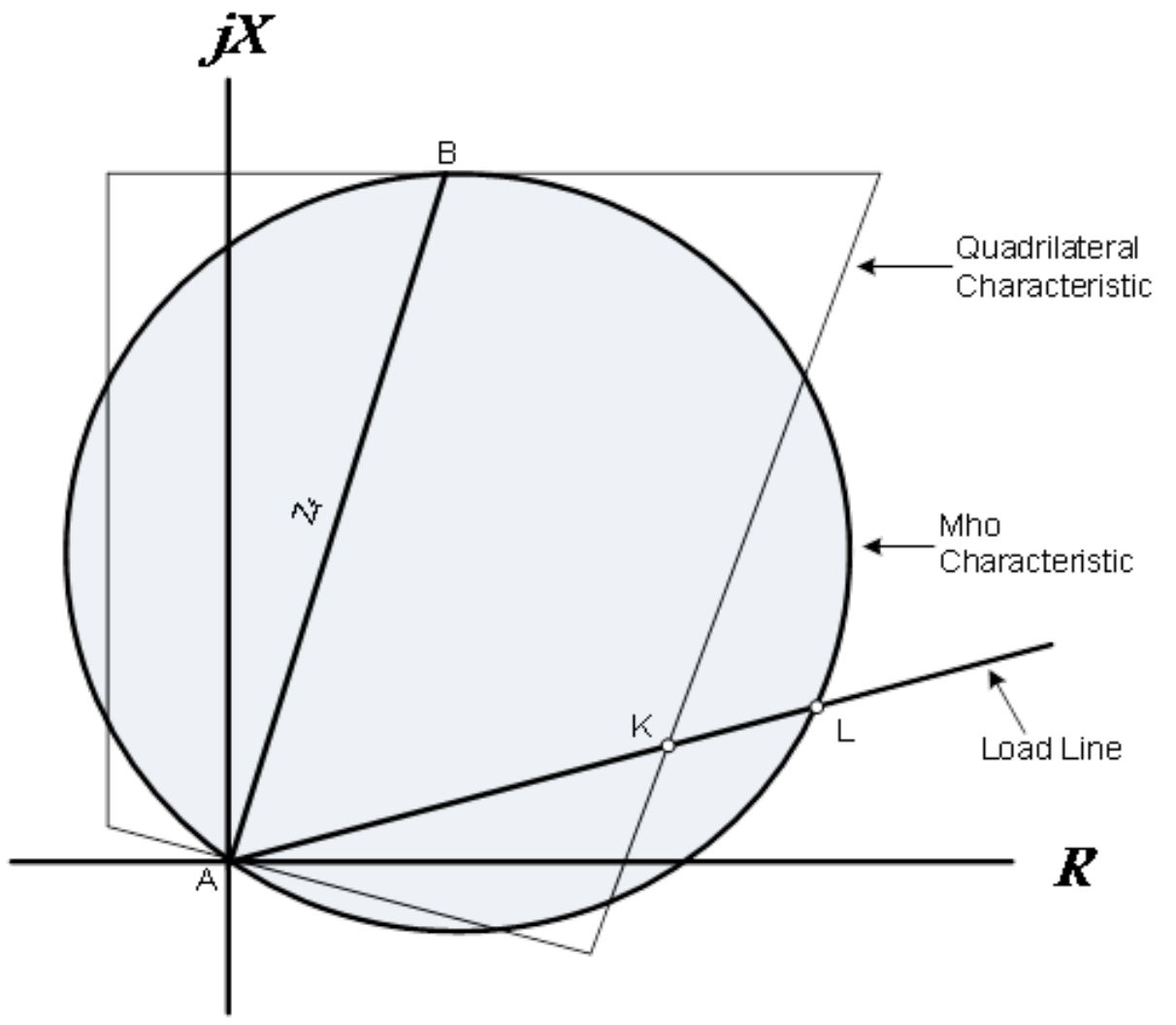
Relay elements in step distance schemes

- Use positive-sequence impedance in step distance schemes
- Three relay elements are needed for detecting multiphase or single-phase-to-ground faults

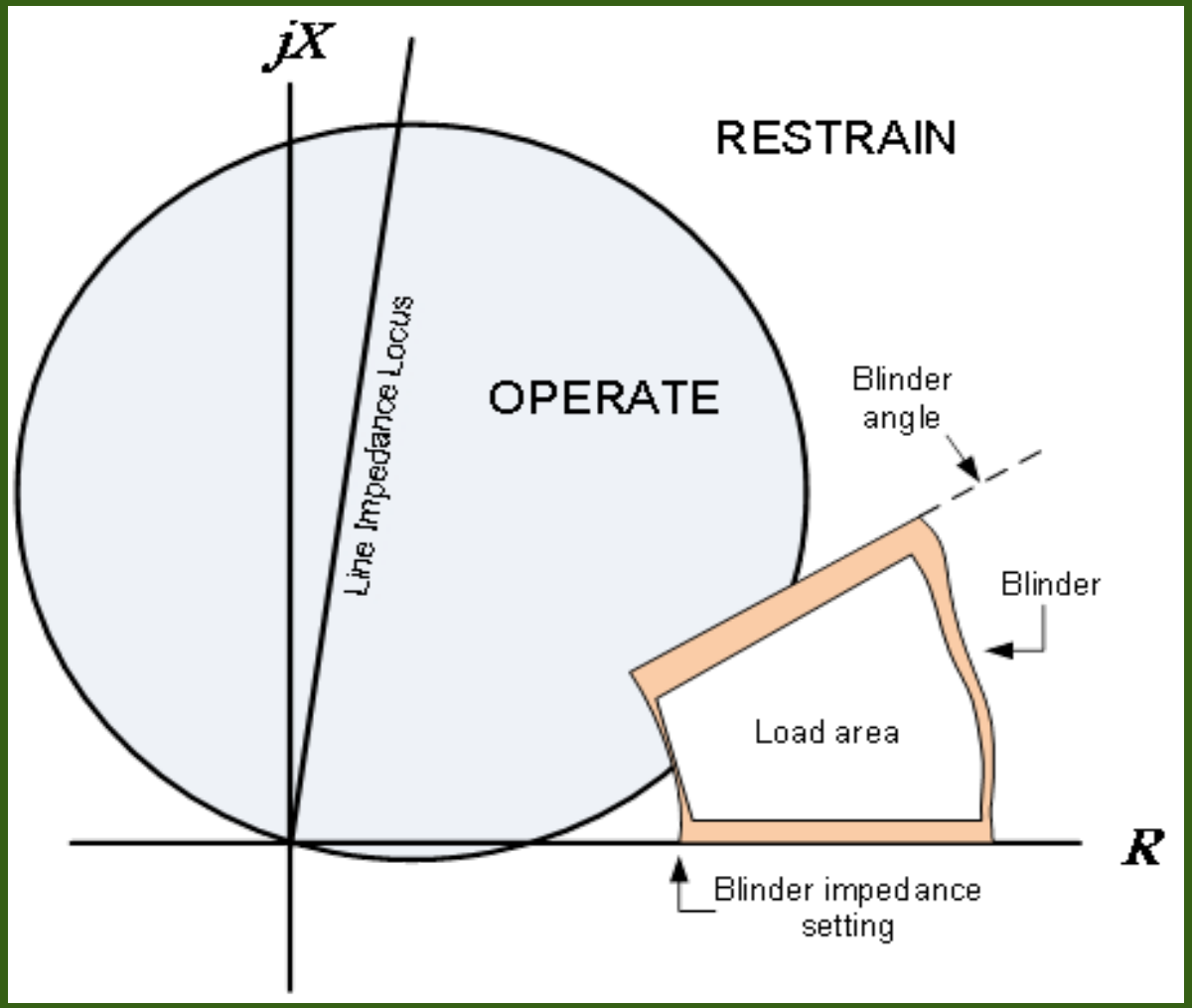
Relay element	Type of fault	Voltage applied	Current applied
1	A-ground	V_A	$I_A + 3I_0k$
2	B-ground	V_B	$I_B + 3I_0k$
3	C-ground	V_C	$I_C + 3I_0k$

$$k = (Z_0 - Z_1) / (3Z_1)$$

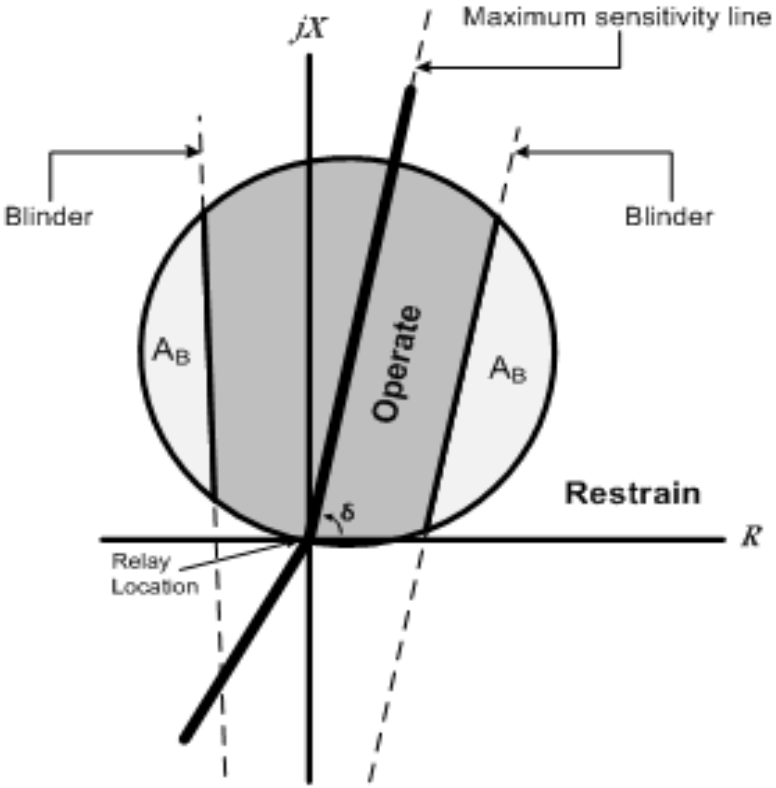
Specially shaped characteristics



Cone-type load blinder

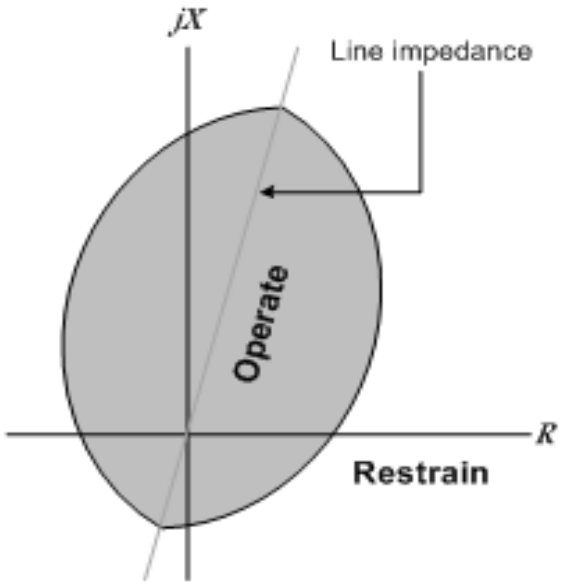


Load blinders and lenticular characteristic



AB is the area of characteristic blocked to accommodate load encroachment

(a) Mho relay with two load blinders



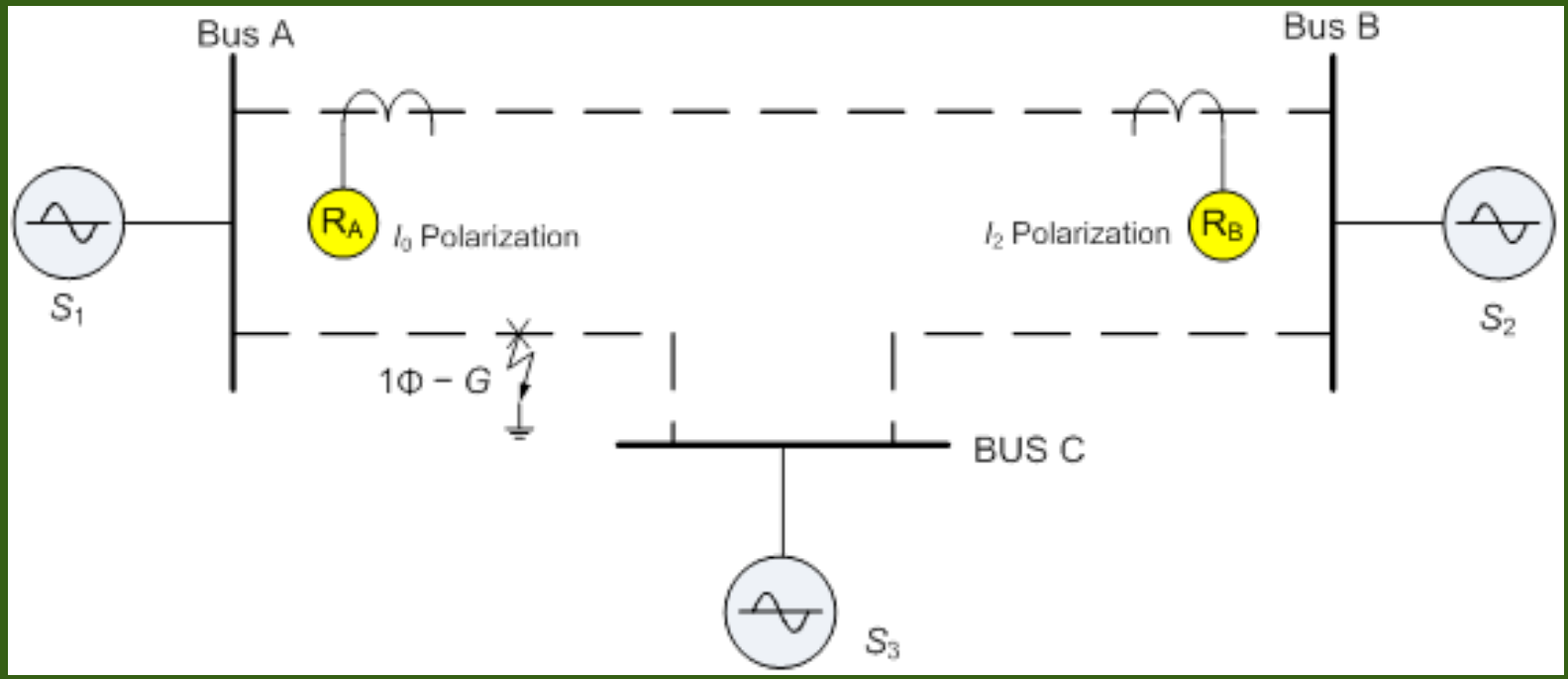
(b) Lenticular characteristic

Sensitive ground OC fault protection

- High impedance faults pose challenge for distance relays
- Directional ground OC relays must balance sensitivity and security
- Considerations when using OC relays
- Coordination requirements

Directional ground overcurrent relay polarization methods

- Various methods are discussed
- Importance of using matching polarizing methods



Role of directional ground OC relays with ground distance relays

- Directional ground OC can provide sensitive protection for ground faults
  - Directional comparison pilot schemes
- Load and system imbalance
- A secure approach is to coordinate all ground elements with each other

Autoreclosing methods

- IEEE Std C37.104
- Discusses criteria used for selecting autoreclosing schemes
- High-speed and time-delayed are discussed

Single-phase tripping and reclosing

- SLG fault -> Trip faulted phase
- Multi-phase fault -> Trip all phases
- Benefits:
  - Typically improves stability and power transfer capability
  - Improved system response
  - Lower power surges for generators
  - Do not need to check for synchronism on reclose
  - Reduced switching overvoltages

Single-phase tripping and reclosing – Special considerations

- Faulted phase selection
- Arc deionization
- Automatic reclosing considerations
- Pole disagreement
- Effects of unbalances currents
- Extra requirements for circuit breakers and relays

Existing PSRC D Subcommittee Guides

No.	Approval Date	Reaffirmation Date	PAR Date	PAR Exp	Revise or withdraw	PSRC SC	Title
C37.230	2007				2018	D	Guide for Protective Relay Applications to Distribution Lines
C37.104	2012				2022	D	IEEE Guide for Automatic Reclosing of Line Circuit Breakers for AC Distribution and Transmission Lines
C37.113	2015				2025	D	IEEE Guide for Protective Relay Applications to Transmission Lines
C37.114	2014				2024	D	Guide for Determining Fault Location on AC Transmission and Distribution Lines
C37.243	2014				2025	D	Guide for Application of Digital Line Current Differential Relays Using Digital Communications

- C37.230 - 100 pages
- C37.104 - 72 pages
- C37.113 – 141 pages
- C37.114 – 76 pages
- C37.243 – 72 pages

Standard can be purchased from the IEEE Standard Association

https://standards.ieee.org/findstds/standard/C37.113-2015.html