FUNDAMENTALS OF BUS PROTECTION

Kevin Wright
Senior Protection Engineer
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WHAT IS A BUS?

• All connections are at the same voltage.

• Made of bus bar such as in switchgear or, overhead transmission line conductor or tube such as in open air substations.
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• Node

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• Made of bus bar such as in switchgear or, overhead transmission line conductor or tube such as in open air substations.
• Node
• Zero Impedance

BUS CONFIGURATIONS

Single Bus/Single Breaker
BUS CONFIGURATIONS

Single Bus/Single Breaker
Breaker and A Half

BUS CONFIGURATIONS

Single Bus/Single Breaker
Breaker and A Half
Double Bus/Double Breaker
BUS CONFIGURATIONS

Single Bus/Single Breaker
Breaker and A Half
Double Bus/Double Breaker
Main and Transfer

MAIN AND TRANSFER
BUS PROTECTION CHALLENGES

- Variety of configurations
- Large number of connections

For an external fault, one set of current transformers (CTs) will see total current.
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- Variety of configurations
- Large number of connections
  - For an external fault, one set of current transformers (CTs) will see total current

![Diagram of BUS PROTECTION CHALLENGES]

All CT ratios = 1:200.5

BUS PROTECTION CHALLENGES

- Variety of configurations
- Large number of connections
  - For an external fault, one set of current transformers (CTs) will see total current
- High available fault current
  - CT saturation

![Diagram of CURRENT TRANSFORMER EQUIVALENT CIRCUIT]
TYPES OF BUS PROTECTION

- Overcurrent
- Trip Blocking Schemes
- Communication-Based Schemes
- High-Impedance Current Differential
- Low-Impedance Current Differential
- Distance
- Linear Coupler
- Arc Flash Detection
DIFFERENTIAL PROTECTION

• Current differential protection verifies that all current that flows into a piece of equipment also flows out.
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- Current differential protection verifies that all current that flows into a piece of equipment also flows out.
  - High-Impedance bus differential protection can accommodate any number of terminals. Minimizes saturation effect.
DIFFERENTIAL PROTECTION

• Current differential protection verifies that all current that flows into a piece of equipment also flows out.
  – Low-impedance bus differential protection can accommodate a variety of current transformer ratios, but has a limited number of current inputs.

LINEAR COUPLER

Voltage Differential
  – Air-Core Mutual Reactors
  – Couplers are connected in series
  – No saturation due to air core
### PROS AND CONS

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<thead>
<tr>
<th>TYPE</th>
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<th>CONS</th>
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<tbody>
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<td>Overcurrent</td>
<td>Simple Inexpensive</td>
<td>Slow Not highly selective</td>
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<tr>
<td>Trip Blocking Schemes</td>
<td>High speed Selective</td>
<td>Additional wiring Dependence on other relays</td>
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### ARC-FLASH DETECTION

- Overcurrent Simple
- Inexpensive
- Slow
- Not highly selective

- Trip Blocking Schemes
- High speed
- Selective
- Additional wiring
- Dependence on other relays

- Communication-Based Schemes
- High speed
- Selective
- Microprocessor-based relays required

- Trip Blocking Schemes
- High speed
- Selective
- Additional wiring
- Dependence on other relays
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<td>High speed, Selective, Easy to set, Easily expandable</td>
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<td>High speed, Selective, Can use shared unmatched CTs Flexible</td>
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References
