BUS BAR PROTECTION
A New and Reliable Approach

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Bus Protection

Agenda/ Содержание

• The need of Bus Protection/ Назначение защиты шин
• Brief Description: Known Bus Protection Methods and Their Limitations/ Краткий обзор: Известные методы и их ограничения.
• Introducing a New & Reliable Approach:/ Введение в новый принцип защиты:
  ❖ What has to be considered? / Что должно быть учтено?
  ❖ How is the scheme developed, tested, and validated? / Как расширить, проверять и подтвердить на соответствие требованиям?
  ❖ What is the result? / Какие получены результаты?
  ❖ How to further improve the scheme? / Как в дальнейшем улучшить схему защиты
• Conclusion / Заключение
**Bus Protection**

**Conventional Method – Arc Flash Detection**

- Microprocessor relay combining with fiber loops or fiber point sensors located strategically throughout the switchgear to detect the light discharge caused by an arc hazard event.
- The fastest operation on SWGR bus arc faults.
- Potentially insensitive to non-arc type bus faults.
- Only applicable towards enclosed switchgear.

![Diagram of Arc Flash Detection System](image)
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Conventional Methods – Low Impedance Differential
Традиционный метод – дифференциальный низко-импедансный

- Kirchoff’s Current Law - summation of CT secondary currents flowing into the junction point is monitored by an overcurrent relay
- CT saturation may be a concern
- To improve security, the pickup setting may need to be desensitized or a time delay may need to be added
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Conventional Method – High Impedance Differential

- Kirchoff’s Current Law - with a high impedance relay
- Improved security - negating CT response dissimilarities by imposing the CT secondary currents through the high impedance component
- Requires a rigorous engineering study to properly account for CT specifications and proper junction point wiring
- Does not offer flexibility for the addition of new loads or sources to the existing bus
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Conventional Method – High Impedance Differential

Традиционный метод – дифференциальный высокоимпедансный
Conventional Method – Differential Spot

Традиционный метод – дифференциальный высокоимпедансный (не рассмотрены: логический и суммарный методы защиты шин)
Introducing a new and reliable approach

Введение в «новый» и надежный метод метод 3Ш
Utilization of directional overcurrent elements of feeder protection relays

- Reliable: operates only against faults on the protected bus
  - All contributing breakers are tripped and block-closed
  - Acceptable operating speed

- Secured: able to distinguish external (through) faults
  - Allows the individual breaker to trip first
Unique Features

• Flexible to multiple incoming/contributing sources
• Dedicated bus protection relay is not required
• The bus protection is accomplished by each breaker’s associated relay, which is usually already existing, i.e. feeder protection relay and breaker failure relay
• A “master” relay is assigned to perform the bus protection scheme with a “backup” relay automatically assuming the “master” relays operation during relay failure
• All contributing relays are communicating to the “master” and “backup” relays via Ethernet based IEC61850 GOOSE communication
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Scheme Development

- IEC61850 compliant and capable of GOOSE communication
  - If the constant integrity/quality check of the GOOSE communication is bad, the scheme shall be disabled and an alarm is issued immediately
- Two phase and ground directional overcurrent elements:
  - 67P/N-1 as reverse direction (REV) for detecting fault current flow into the bus
  - 67P/N-2 as forward direction (FWD) for both detecting and tripping fault current flow out of the bus (through) fault
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Principle of Operation (Internal Bus Fault)
Принцип действия (Внутренние повреждения)

- Bus fault occurs
- At least one reverse direction (REV) element is detected
- Not any forward direction (FWD) element is pending
- The “master” relay trips and block-closes all contributing breaker via GOOSE
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Principle of Operation (External Through Fault)

Принцип действия (Внешние повреждения)

- An external/through fault occurs, i.e. on Feeder #2
- Feeder #2 relay FWD detected
- The rest of relays either see REV or not FWD
- Feeder #2 breaker trips
Logic Diagram (Логическая схема)

Legend: GOOSE Signal

- FWD
- REV
- CB_OPEN

Master Relay

Peer Relay

AND

OR

AND

GOOSE_VALID

ALARM

TRIP_BUS

0 ms

R

S

Q

Legend: GOOSE Signal

- FWD
- REV
- CB_OPEN
### Scheme Validation Testing Results

#### Bus Protection

#### Подтверждение требований по результатам тестов

##### Operating Times for Internal Bus Fault

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<td>Average</td>
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##### Operating Times for External Through Fault

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Benefits versus Conventional Schemes

«Плюсы» по сравнению с «традиционными схемами»

• Adaptable towards increases in system fault levels without the need to upgrade system components
• Flexible to new bus additions of loads and sources without labor intensive scheme changes versus conventional schemes.
• Reduction of wiring versus conventional schemes and potentially removes the requirements for dedicated bus CTs
• Improved scheme security by being immune to the effects of CT saturation
• Capable of protecting “double-bus single-breaker” arrangement without the need for additional relaying equipment
• “Free” backup bus protection scheme
• Communication redundancy
Backup bus protection

Legend: GOOSE Signal
Communication redundancy

Резервирование связи

Source #1

Source #2

Feeder #1

Feeder #2

Ethernet Switch

Ethernet Switch
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Conclusion (Заключение)

• Accurate performance with acceptable operating speed
• Essentially low cost or no additional cost of bus protection relay
• Can be implemented in any bus configurations: single, double, one-and-a-half, double-bus-single-breaker, etc.
• Can be applied to either switchgear bus or open air substation bus
• Immune to CT saturation
• Flexible to future bus expansion/modification
• If a bus protection already exists, KEEP IT!
Спасибо за внимание!

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