Line Current Measurement at Dual-Breaker Terminals: Challenges and Solutions

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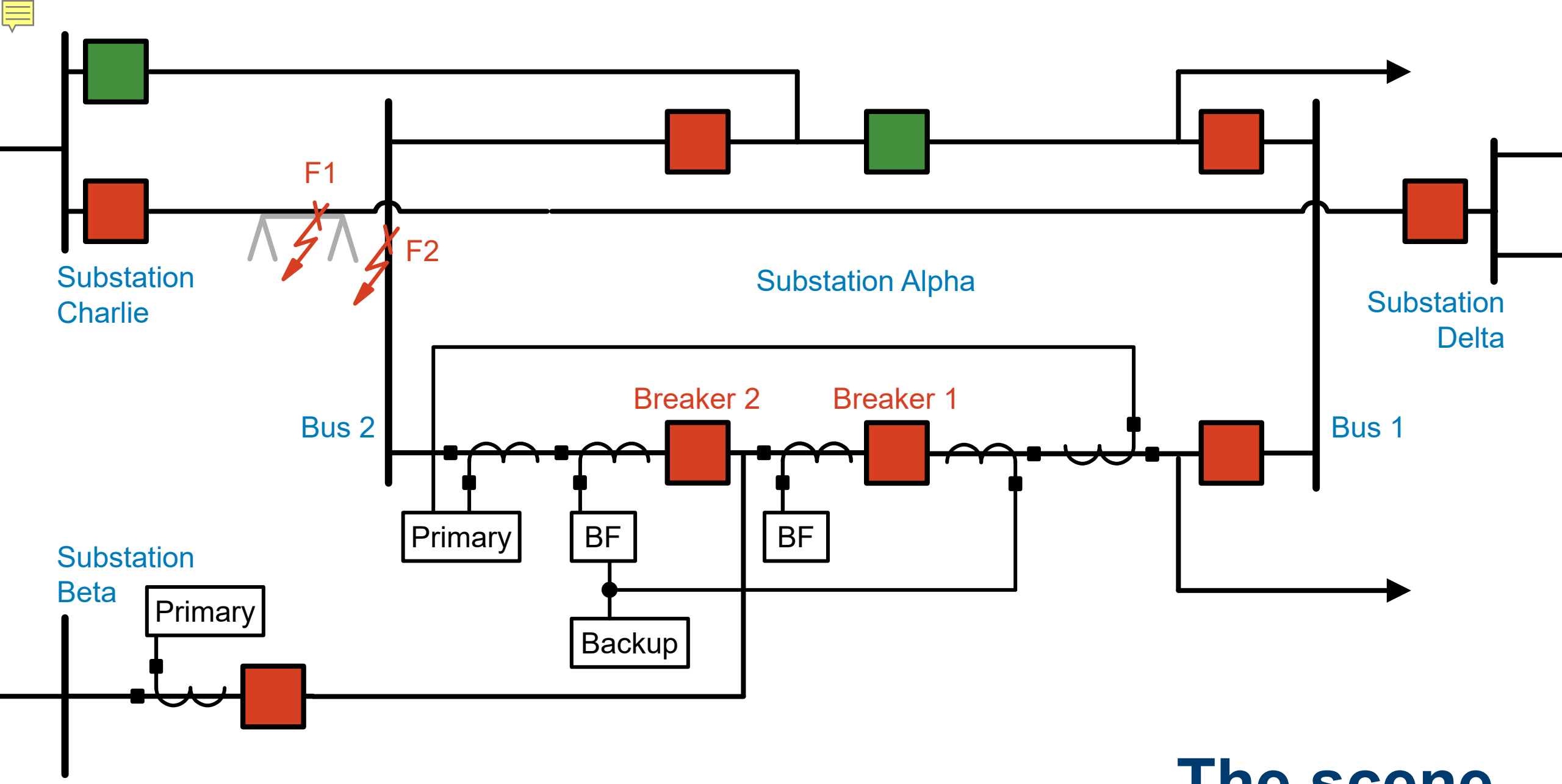
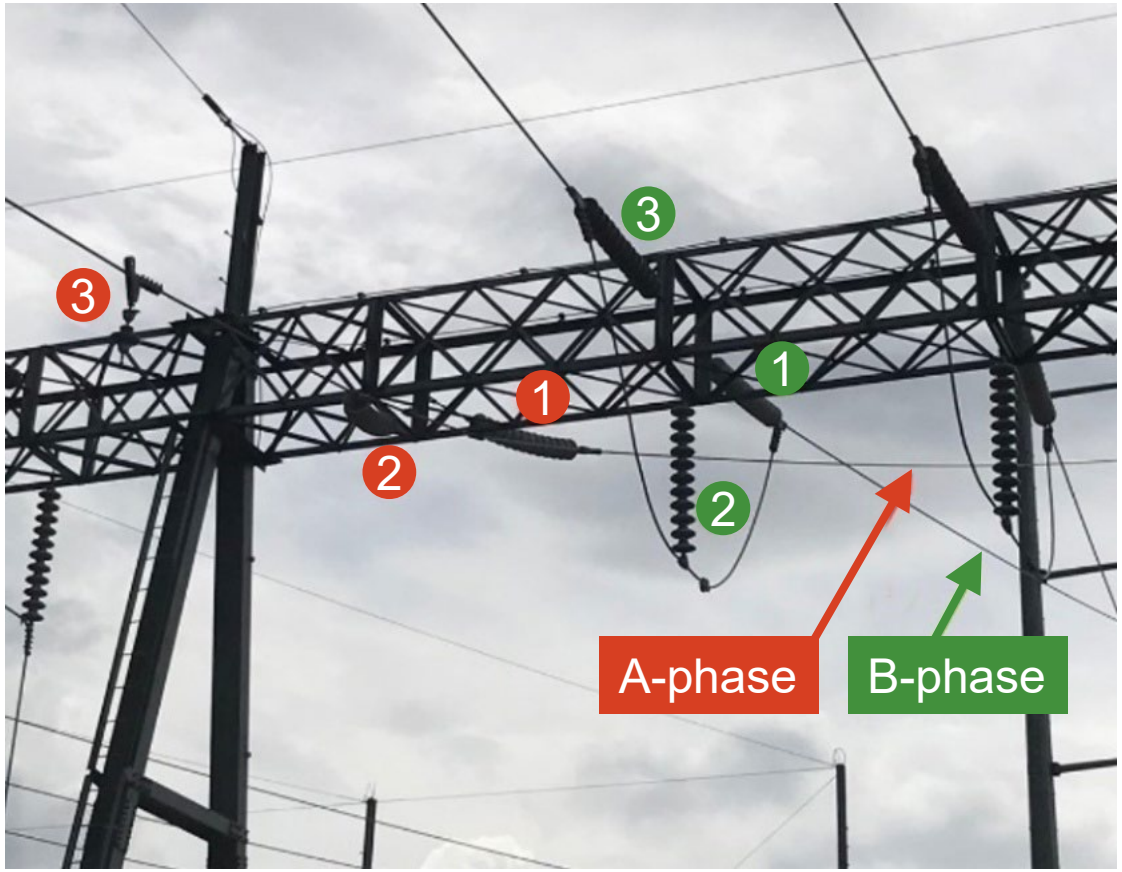
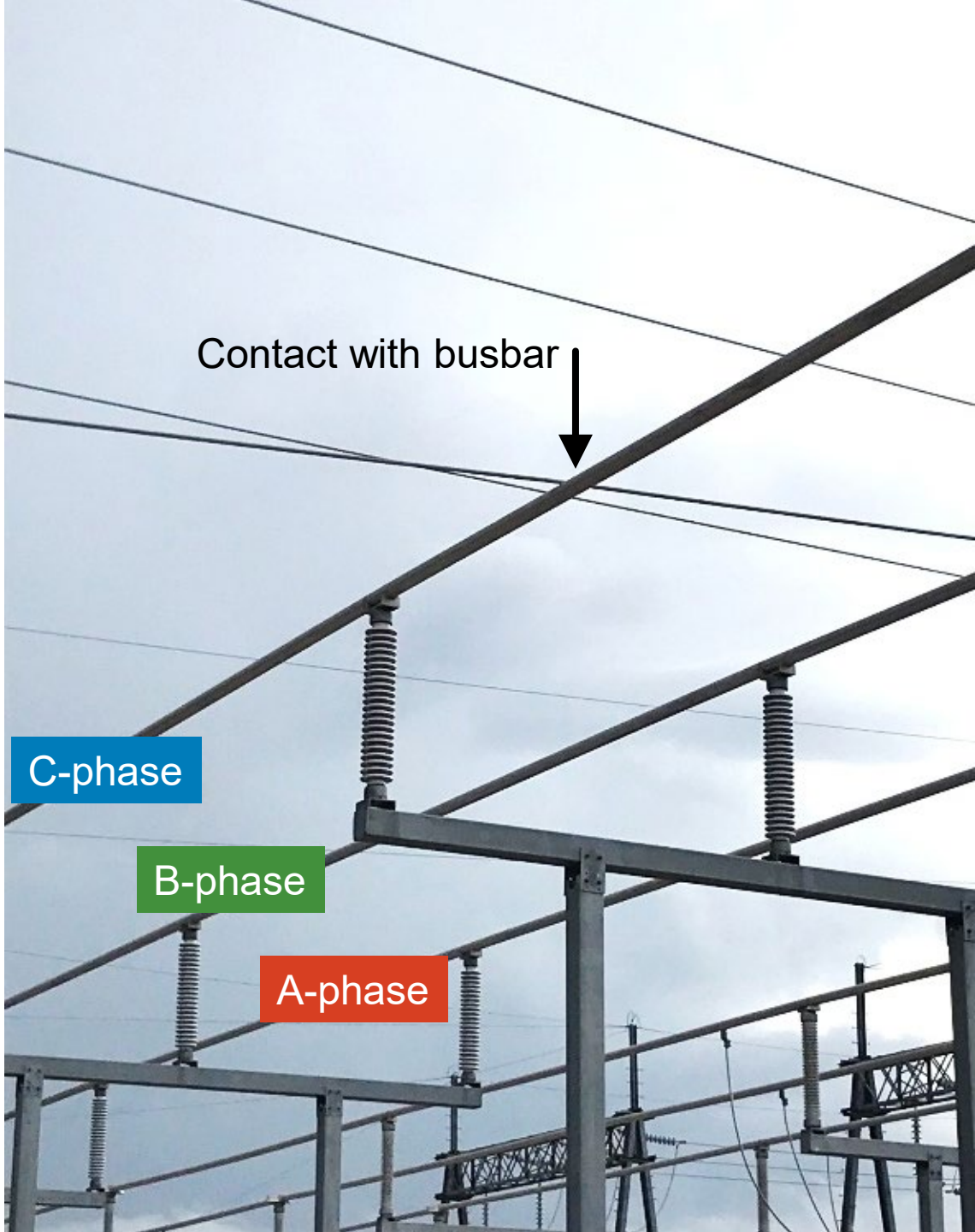

F1
F2
Substation
Charlie
Substation Alpha
Substation
Delta
Bus 2
Breaker 2
Breaker 1
Bus 1
Primary
BF
BF
Substation
Beta
Primary
Backup

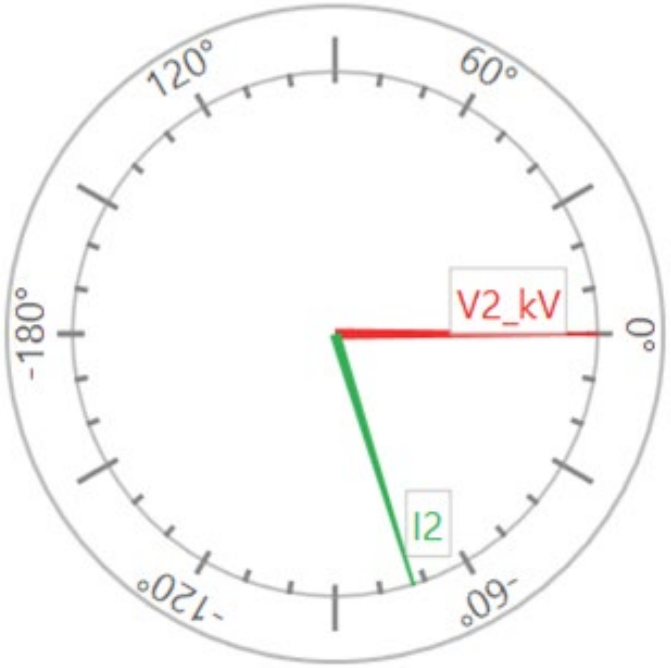
The scene

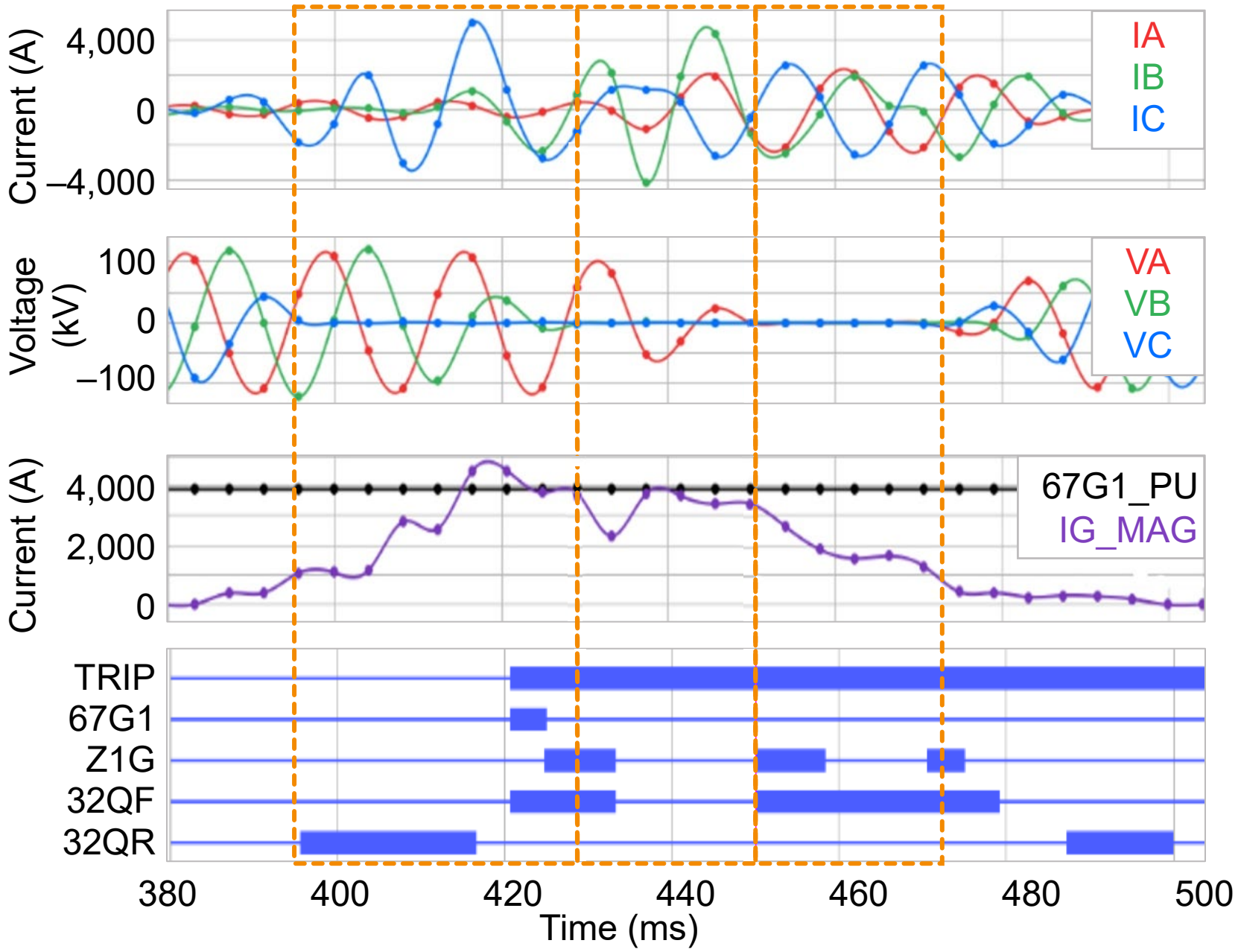
Lightning strike causes two faults



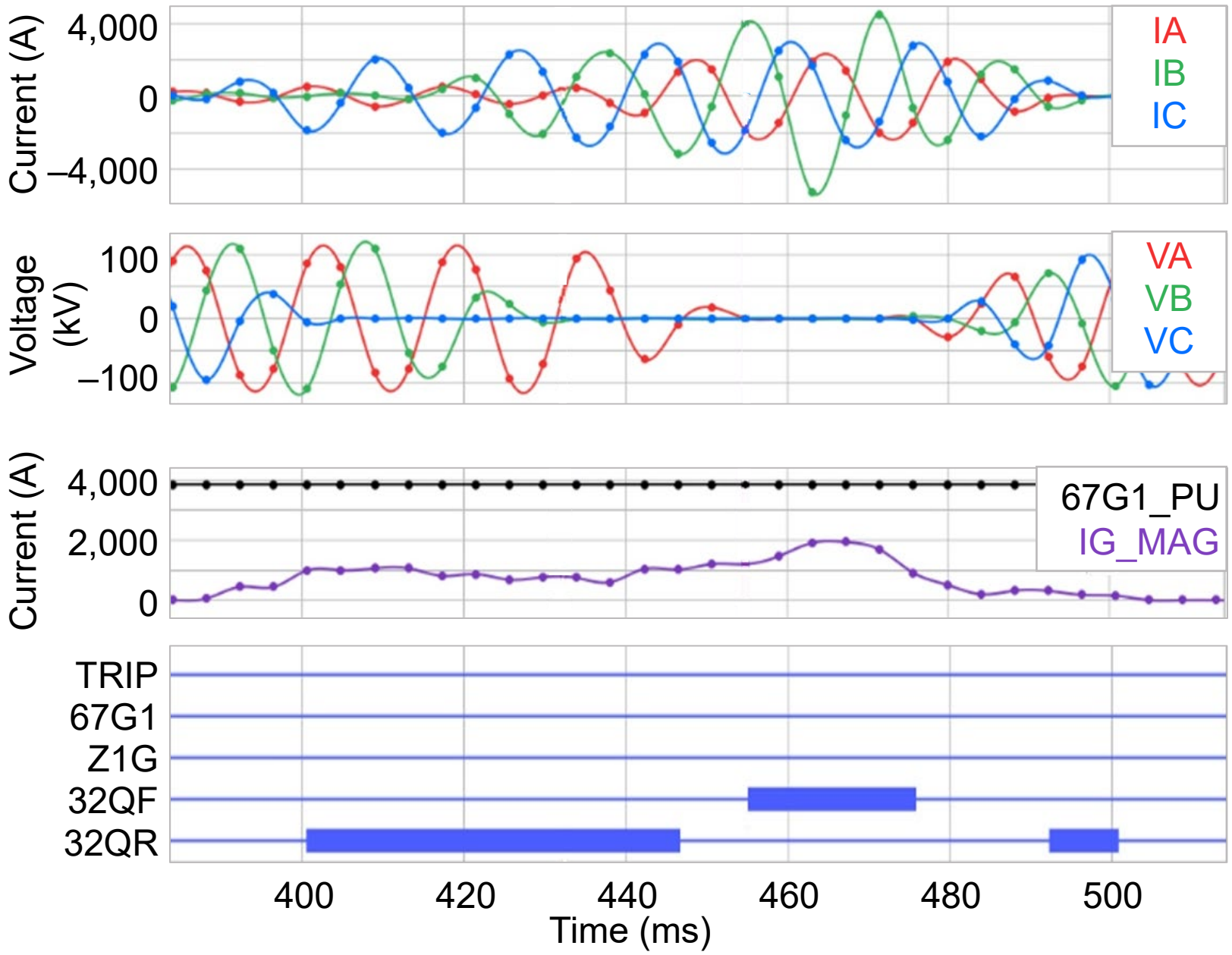


Backup relay currents are questionable

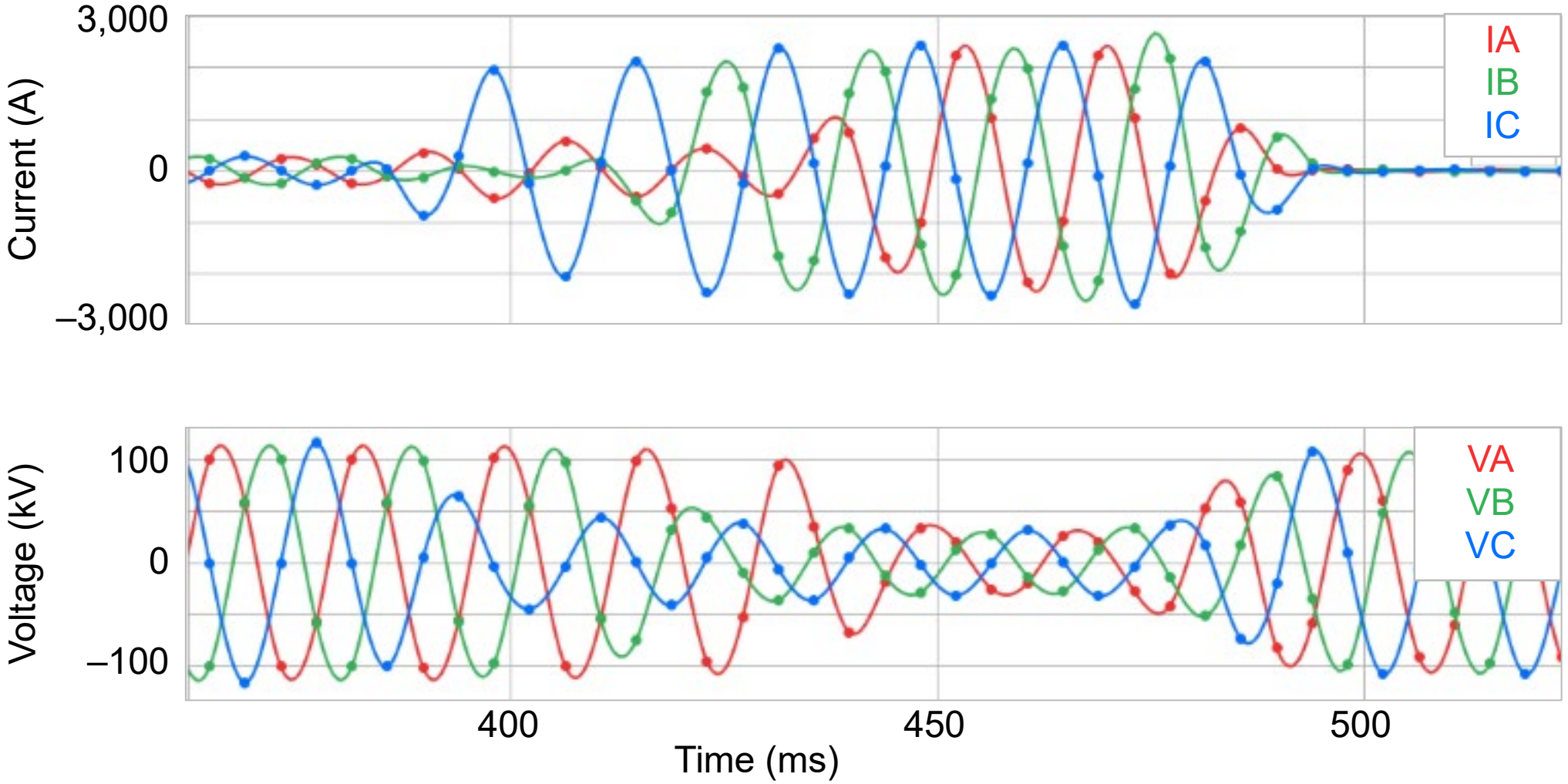




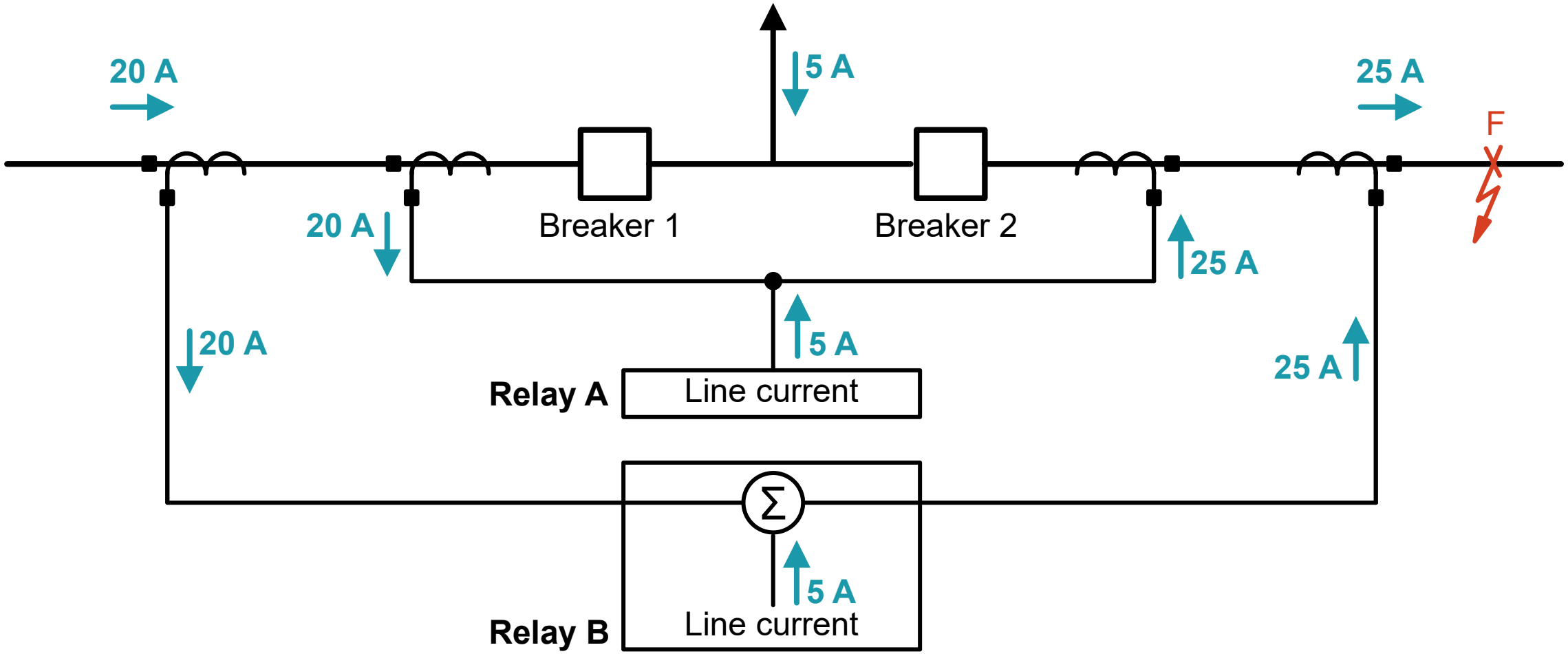
Primary relay currents are also questionable



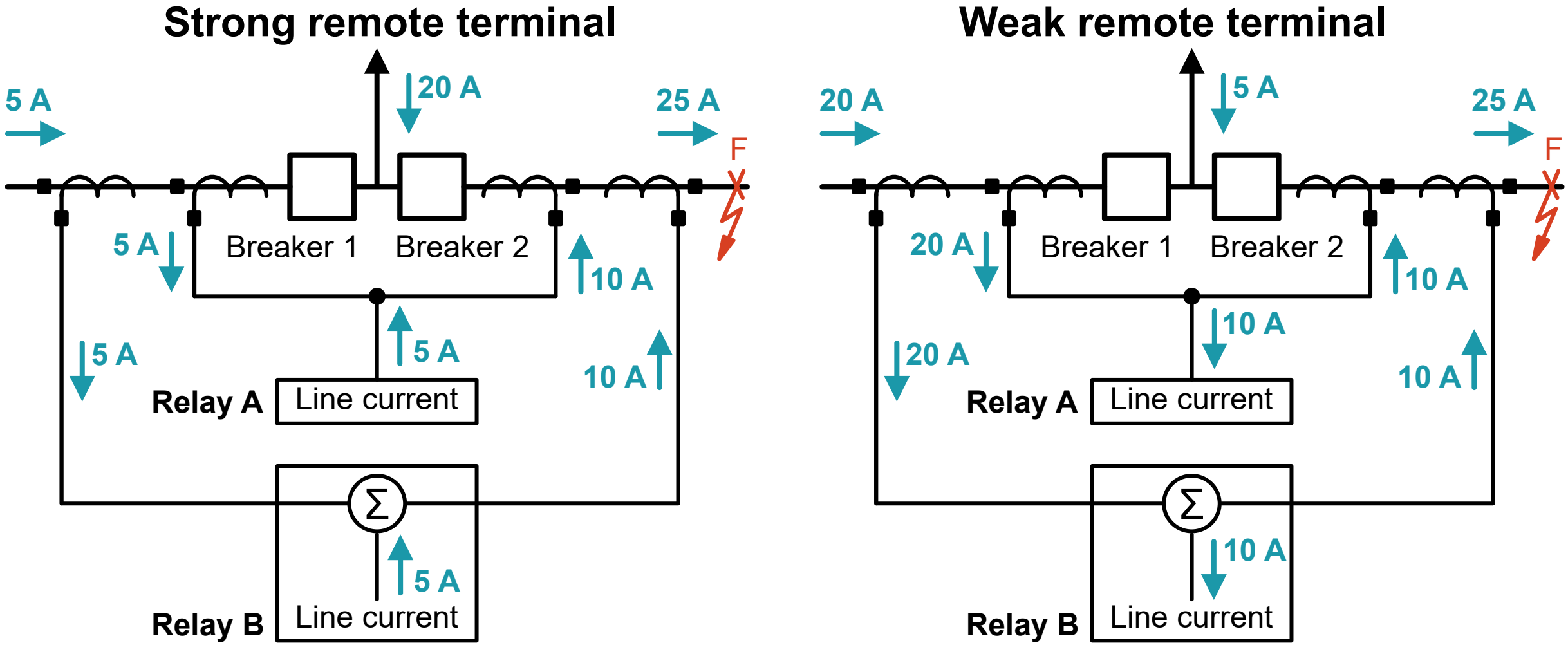
Remote relay currents bring clarity



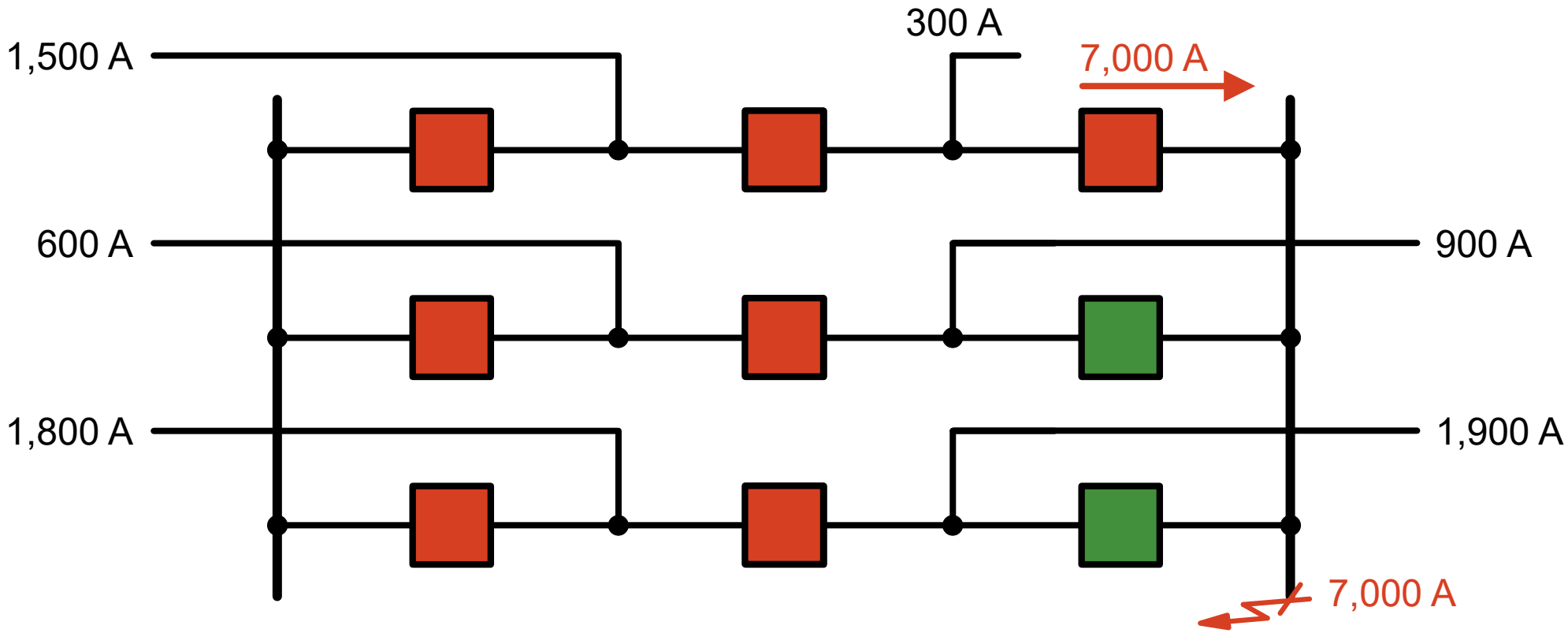
Measuring line current at dual-breaker terminals



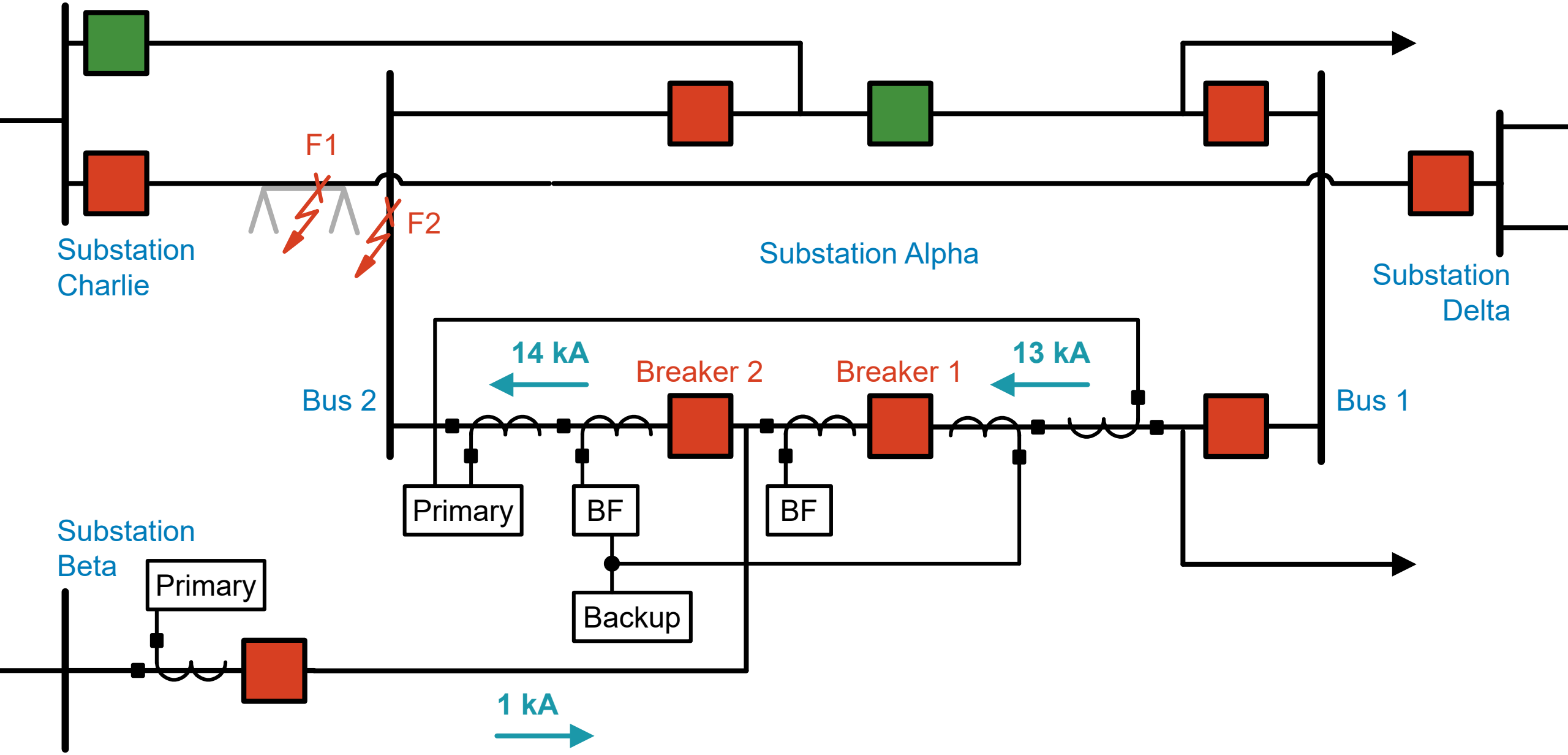
CT saturation + weak remote terminal = trouble!



Do I need to worry about this?



Yes, if… $\dfrac{\text{Minimum remote line current}}{\text{Maximum bus fault current}} < 50\%$

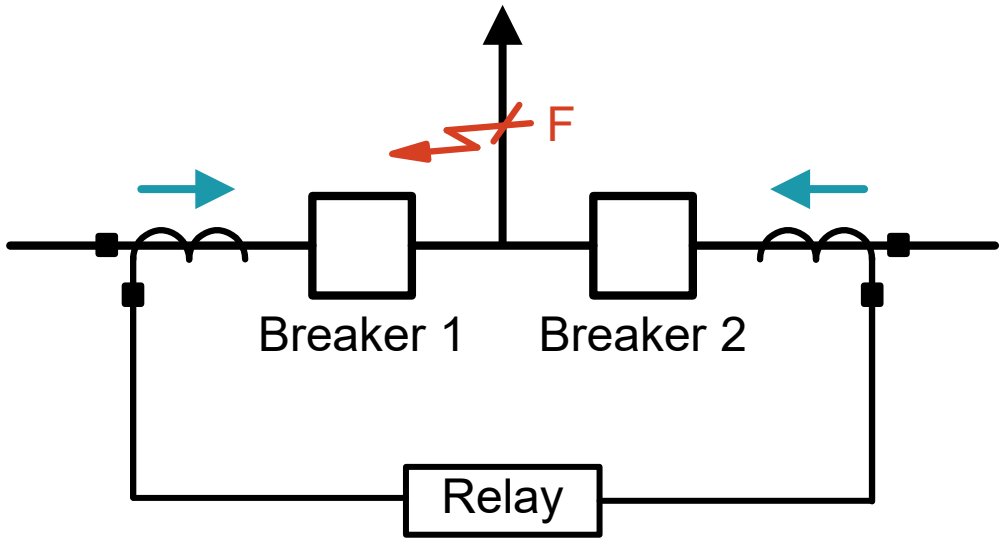

F1
F2
Substation
Charlie
Substation Alpha
Substation
Delta
14 kA
13 kA
Breaker 2
Breaker 1
Bus 2
Bus 1
Primary
BF
BF
Substation
Beta
Primary
Backup
1 kA

What can I do about it?

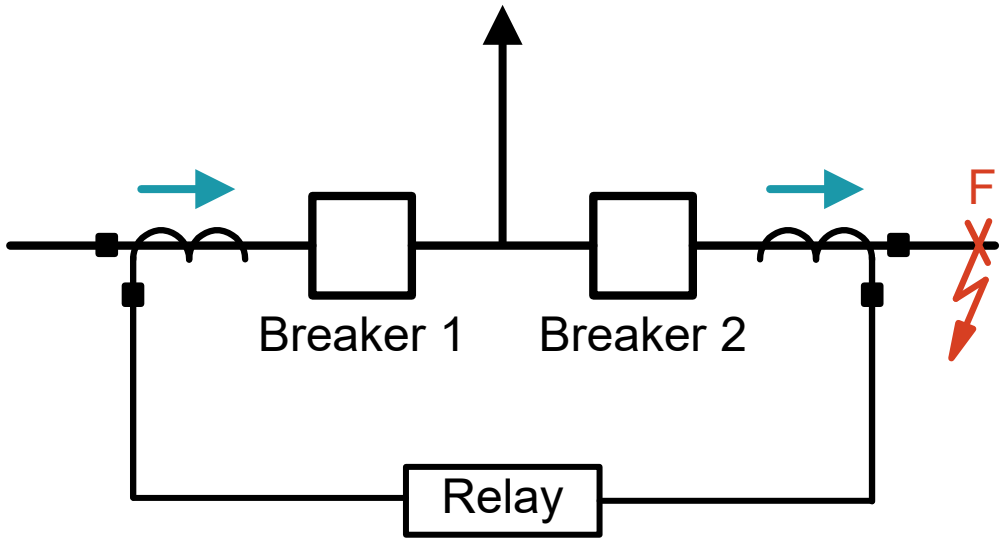
- Size CTs properly
- Use relay settings to add security
  - Raise pickup or add delay to instantaneous 67 elements
  - Set fault detectors correctly for 21 elements
- Use dual-current input relay with reverse fault security logic

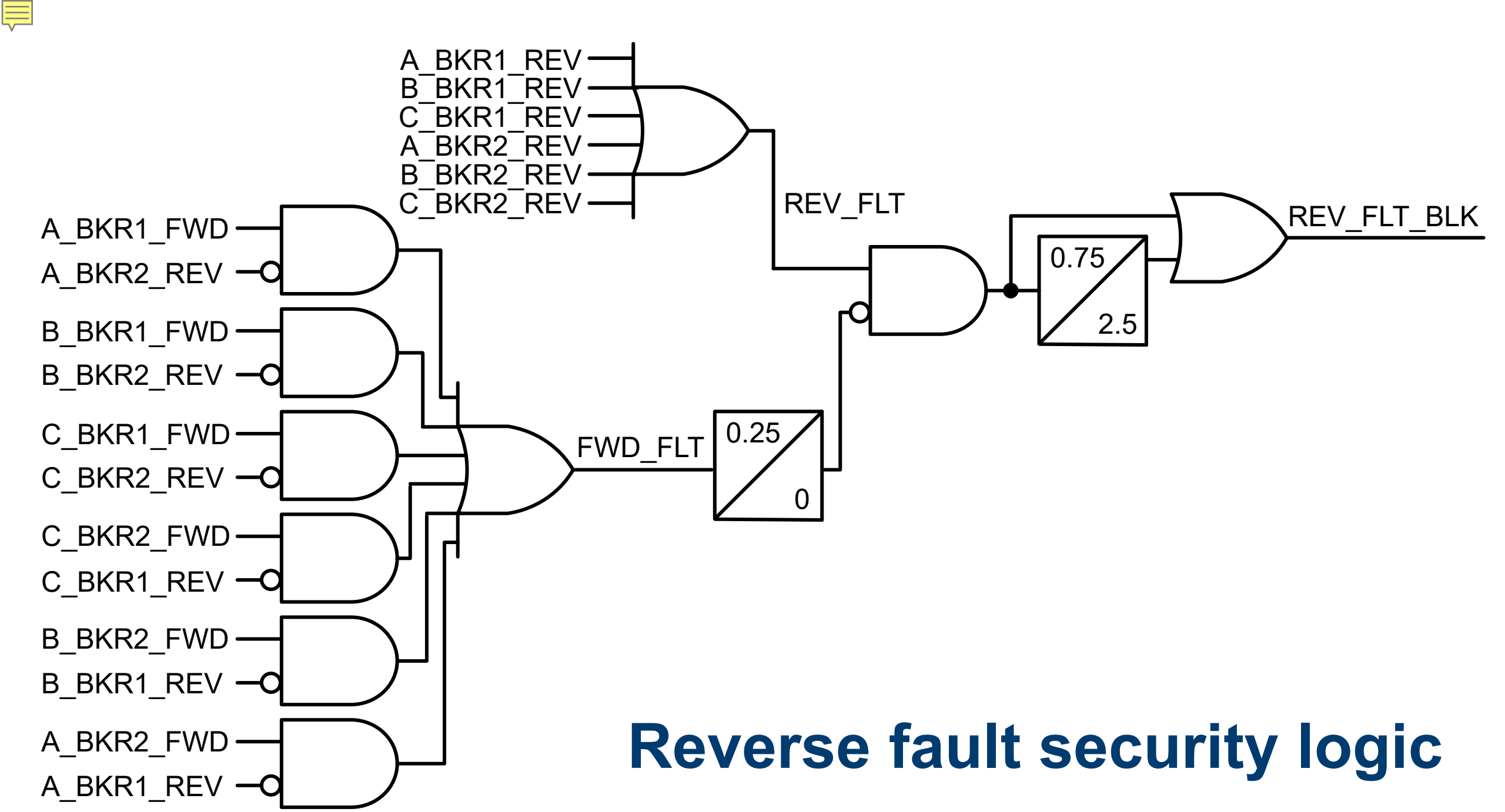
Principle of reverse fault security logic

Both directions forward = internal fault



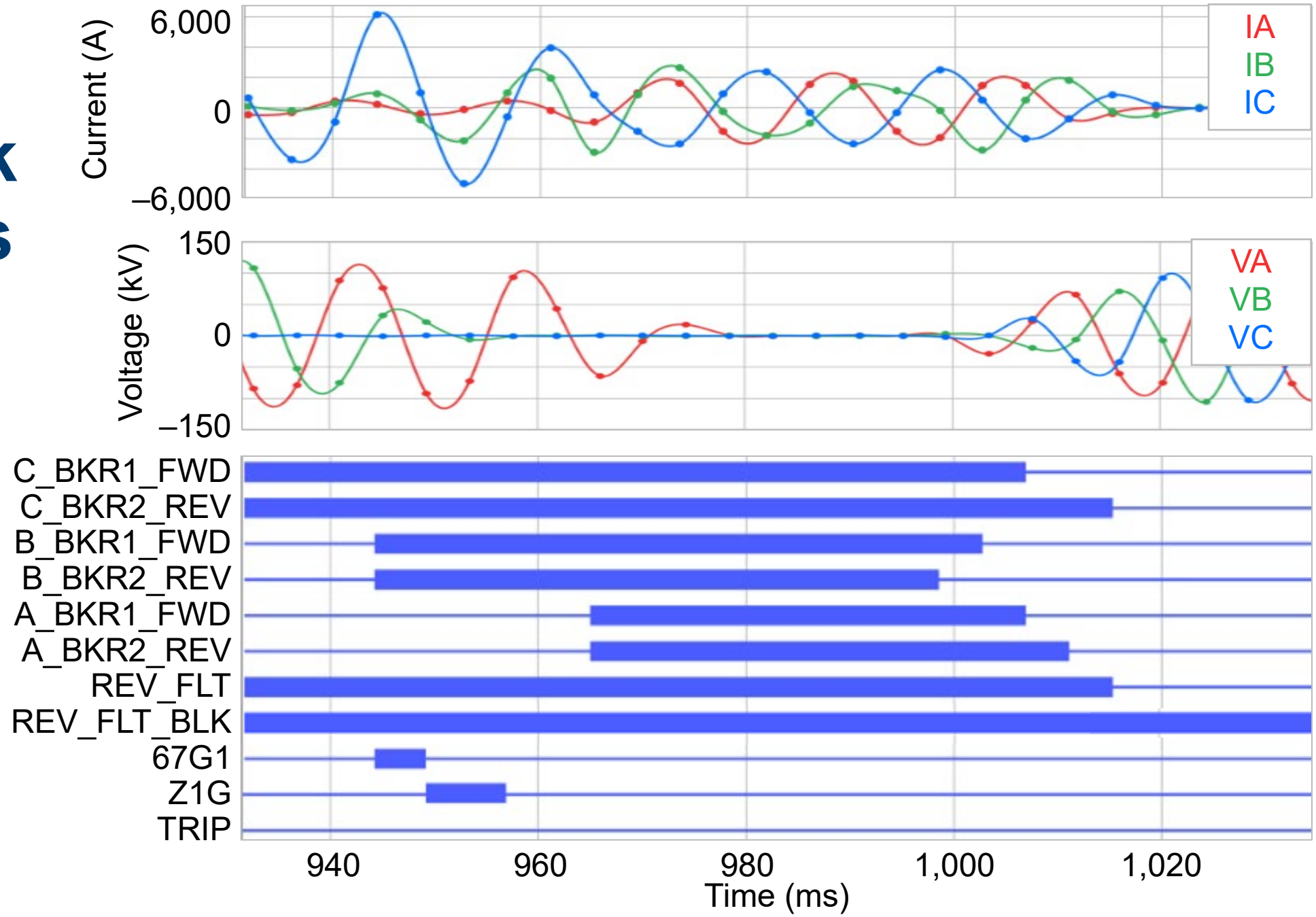
Any direction reverse = external fault





Reverse fault security logic

Event playback confirms security



Conclusion

- Line current direction at dual-breaker terminal can be challenged if CTs saturate and remote source is weak
- Incorrect direction compromises security of sensitively set instantaneous elements

Corrective actions are

- Size CTs properly
- Use relay settings to add security
- Use dual-current input relay with reverse fault security logic

Questions?