Summary of Revision C37.119-2016

IEEE C37.119-2016 Guide for Breaker Failure Protection of Power Circuit Breakers.

K5 Membership

- Roger Whittaker, Adi Mulawarman, Jeff Barsch, Bob Beresh, Brian Boysen, Alla Deronja, Michael Fleck, Craig Hiemenz, Alex Lee, Jeff Long, Bruce Mackie, Alexis Mezco, Dean Miller, Roy Moxlee, Pratap Mysore, Claire Patti, Jeff Pope, Dan Reckerd, Lubomir Sevov, Phil Tatro, Michael Thompson, Ian Tualla,

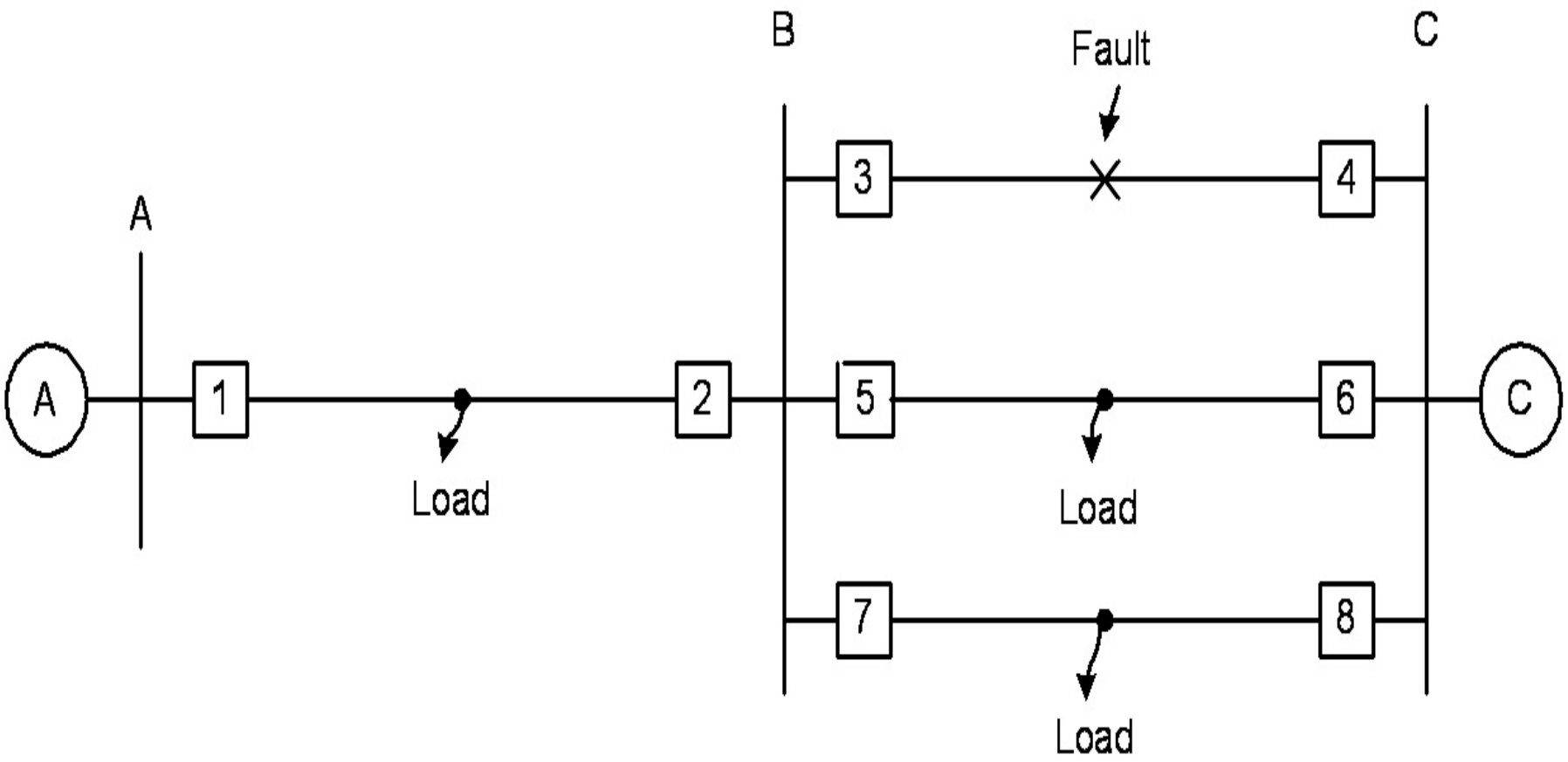
- Eric Udren, Johan Van Den Berg, Jun Verzosa, Don Ware, Ray Young, Rich Young, Rick Gamble, Jacob Lien, Don Lukach, Heather Malson, Sam Sambasivan, Charles Sufana, Dennis Tierney, Joe Uchiyama, John Wang, Phil Zinc, Charles Henville, Aaron Martin

BFP definition:

- A form of protection that is designed to detect failure of a circuit breaker to operate or interrupt a fault. Upon detection of a breaker failure during a fault condition the scheme is designed to take appropriate action to clear the fault. Upon detection of a breaker failure during a non-fault condition, the scheme may take other appropriate action.

Need for BFP

- Protection equipment failures happen
- Reach of remote backup, distance and overcurrent varies by condition
- Operation of remote backup removes much equipment from service and is delayed


B
Fault
C
A
3
4
A
1
2
5
6
C
Load
Load
7
8
Load

Remote backup disadvantages vs advantage

- It does not know exactly when bkr is supposed to open (ie at subs B).
- More widespread impact
- Longer fault clearing time
- Difficult to set considering infeed and loadability requirement.

However, it is independent.

Local Backup advantages vs disadvantage

- Know exactly when bkr is supposed to open
- Minimal impact on system outage
- Faster clearing time
- With pilot, we can add DTT
- It may suffer from common mode failure

Why BFP?

- Mitigate protection system failures that would otherwise cause degradation of
  - Sensitivity
  - Selectivity
  - Speed

Breaker failure mode (during fault clearing or reclosing after fault clearing)

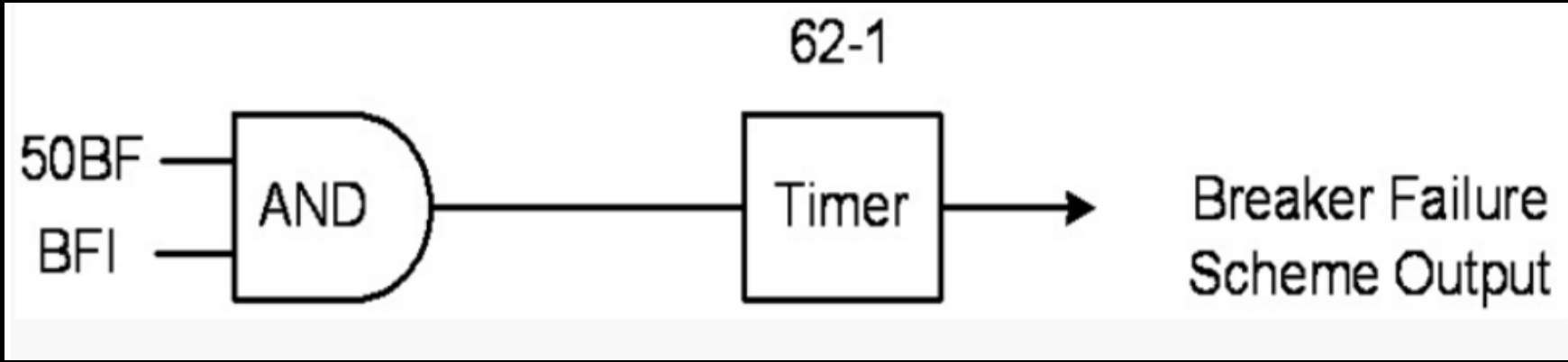
- Failure to Trip
- Failure to Clear

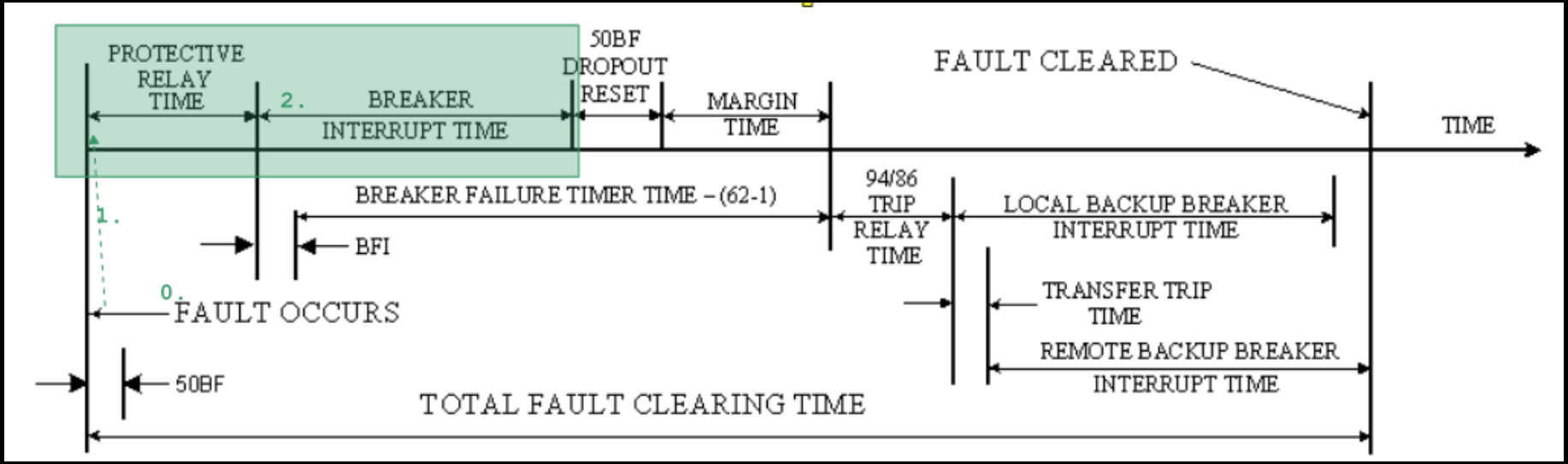
Other failure that can happen during non-fault clearing operation

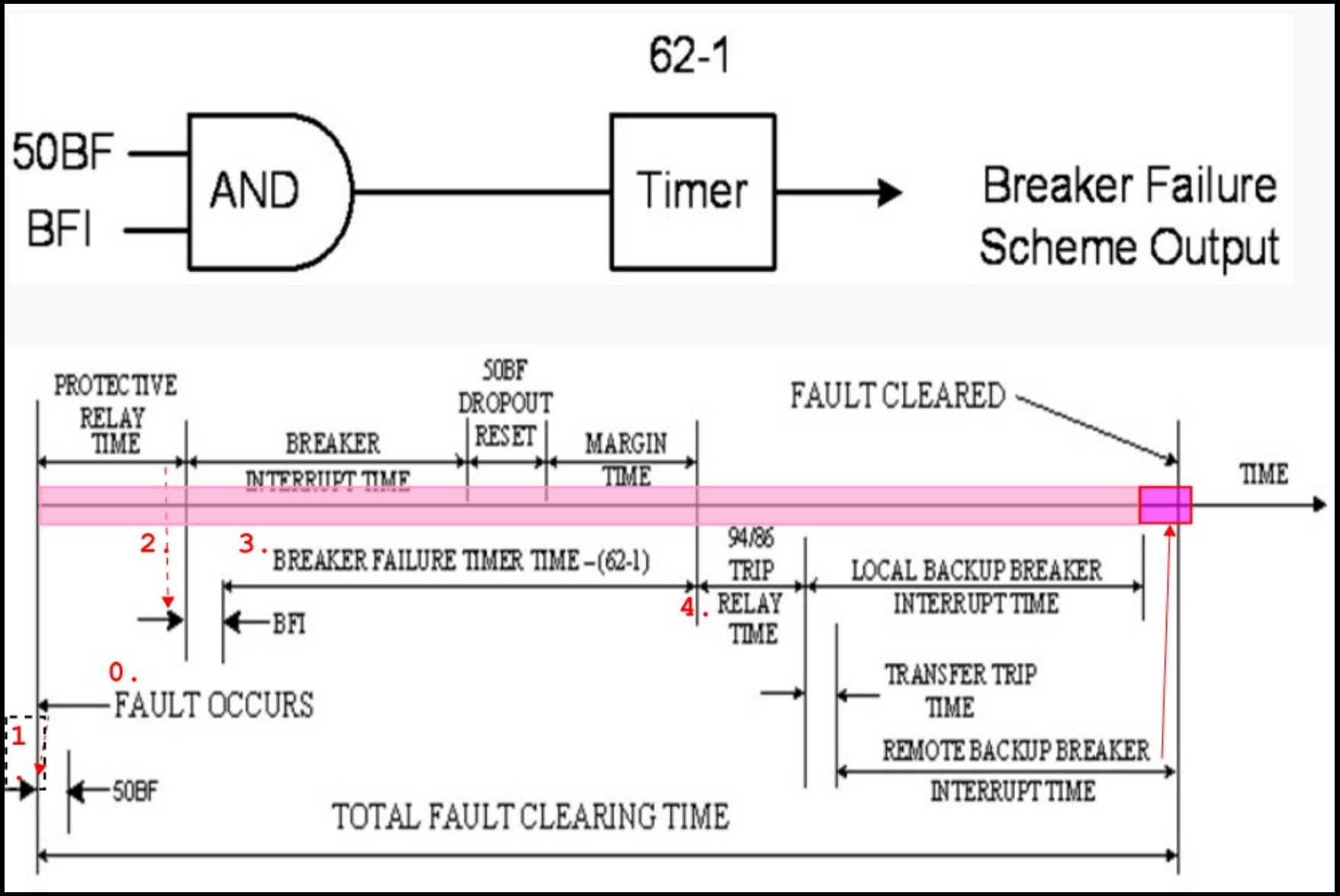
- Loss of dielectric or mech. energy.
- Contact flash over
- Slow closing mechanism.
- Other mechanical failure.

Basic BFP scheme

- Initiation by breaker trip signal BFI
- Current (50BF)
- Timer
- Means to trip and close interlock adjacent breakers
- Optional
  - Retrip
  - DTT to lockout option

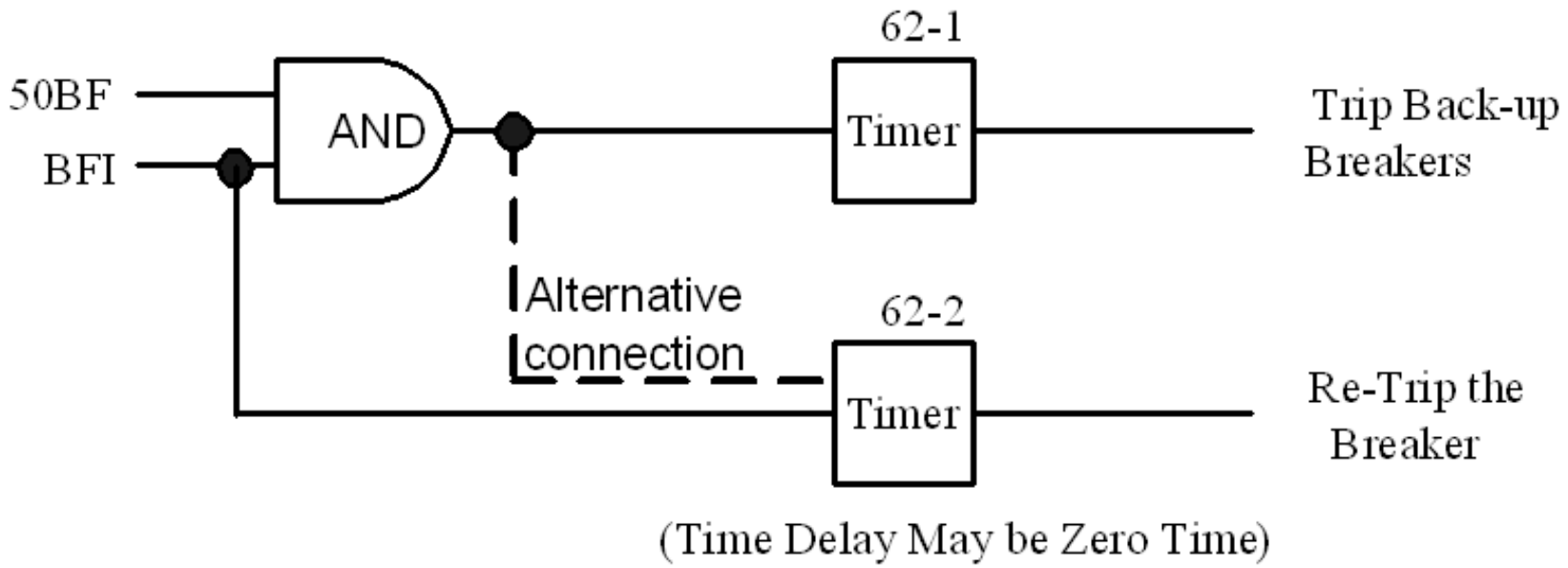

62-1
50BF
BFI
AND
Timer
Breaker Failure
Scheme Output


PROTECTIVE
RELAY
TIME
2.
BREAKER
INTERRUPT TIME
50BF
DROPOUT
RESET
MARGIN
TIME
FAULT CLEARED
TIME
1.
BREAKER FAILURE TIMER TIME – (62-1)
94/86
TRIP
RELAY
TIME
LOCAL BACKUP BREAKER
INTERRUPT TIME
BFI
0.
FAULT OCCURS
TRANSFER TRIP
TIME
REMOTE BACKUP BREAKER
INTERRUPT TIME
50BF
TOTAL FAULT CLEARING TIME

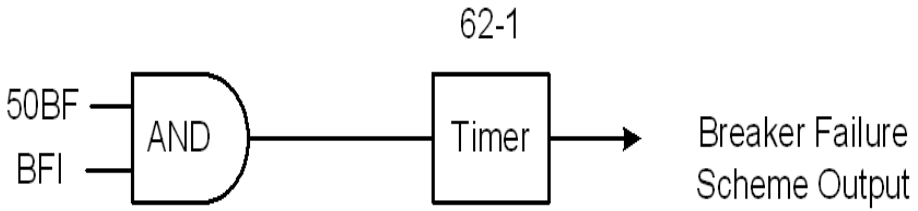

62-1
50BF
BFI
AND
Timer
Breaker Failure
Scheme Output
PROTECTIVE
RELAY
TIME
BREAKER
INTERRUPT TIME
50BF
DROPOUT
RESET
MARGIN
TIME
FAULT CLEARED
TIME
2
3.
BREAKER FAILURE TIMER TIME – (62-1)
94/86
TRIP
RELAY
TIME
4.
LOCAL BACKUP BREAKER
INTERRUPT TIME
BFI
0.
FAULT OCCURS
TRANSFER TRIP
TIME
1
REMOTE BACKUP BREAKER
INTERRUPT TIME
50BF
TOTAL FAULT CLEARING TIME

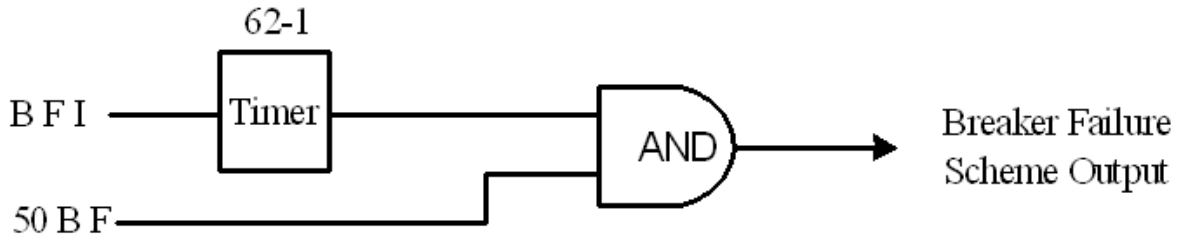
15 different BFP schemes (6 new)_

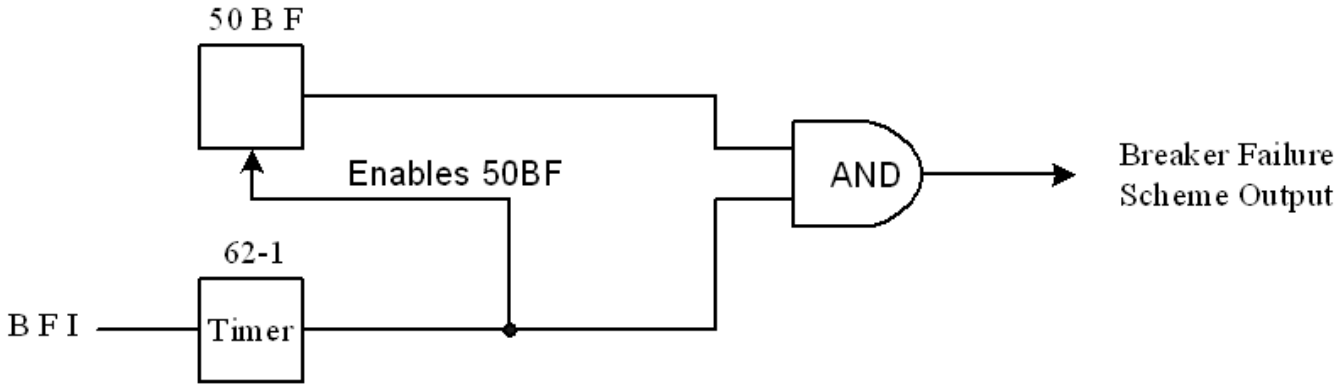
BFP *Retrip* logic:



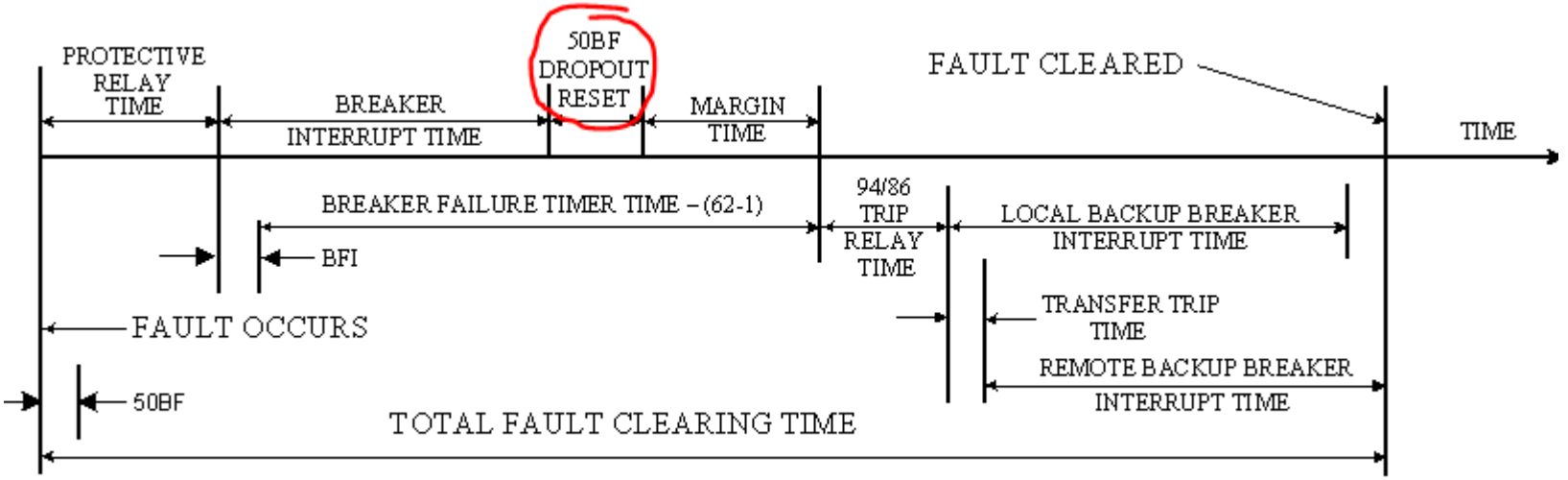
Other examples of BFP schemes

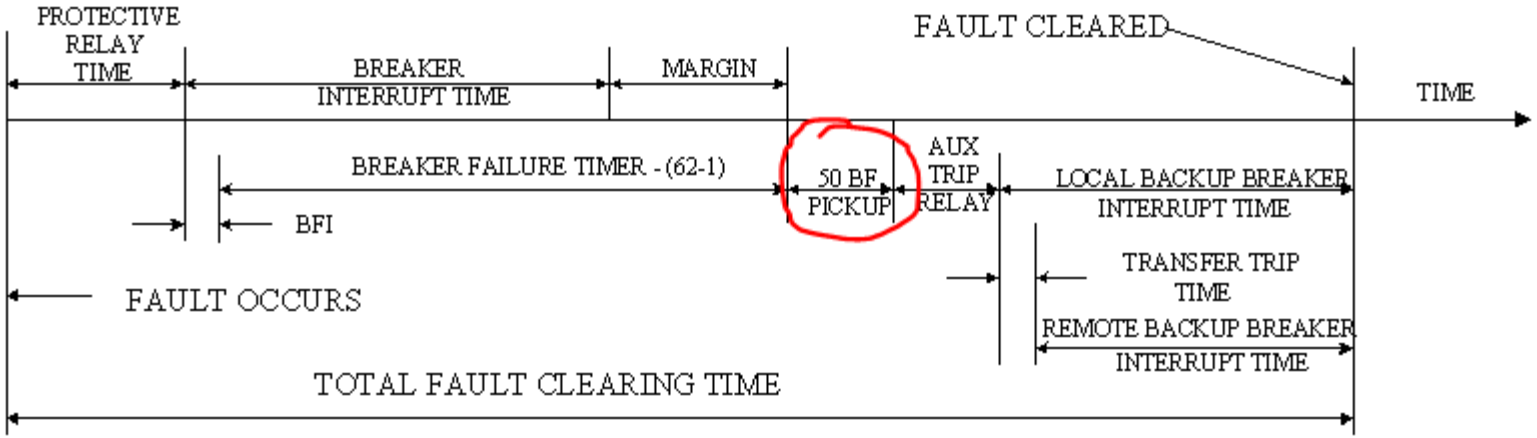




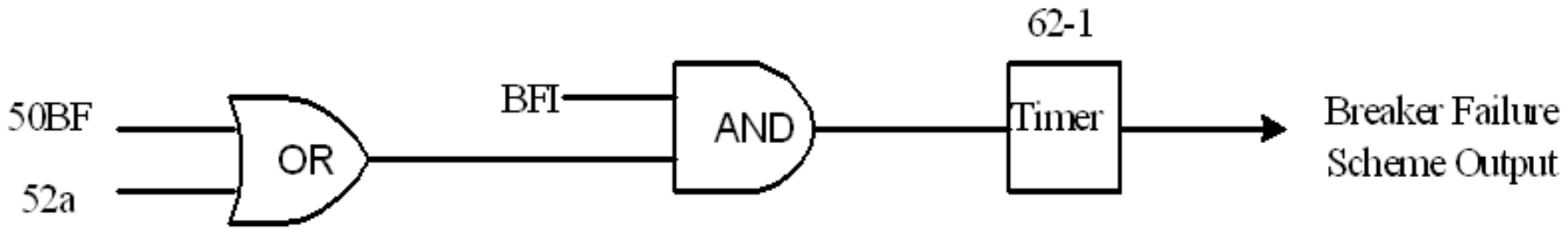


Different timing charts

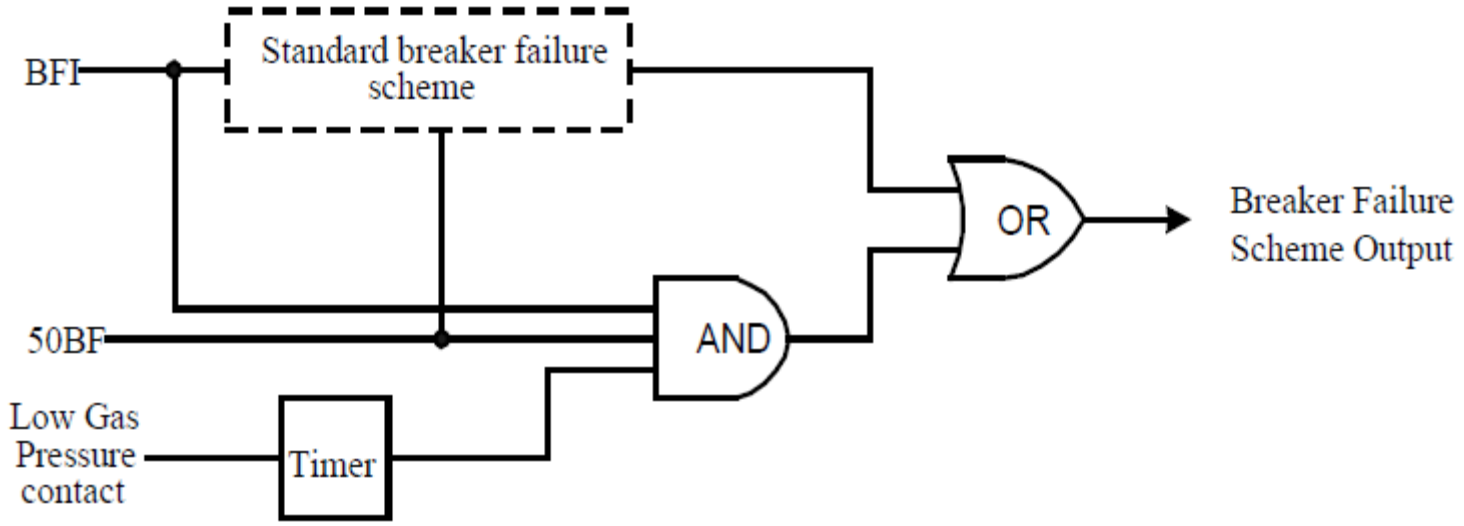




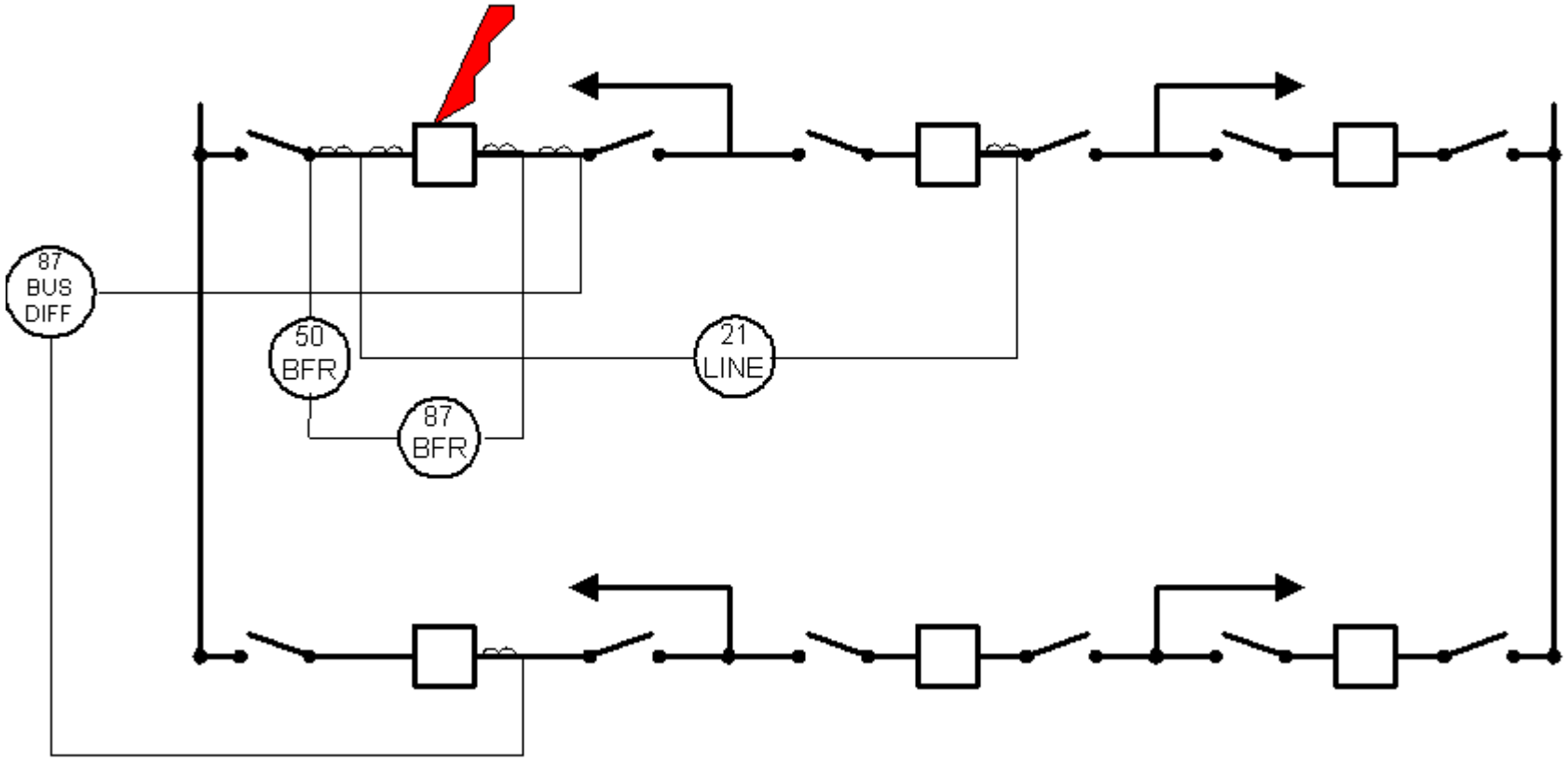
Minimum fault current scheme



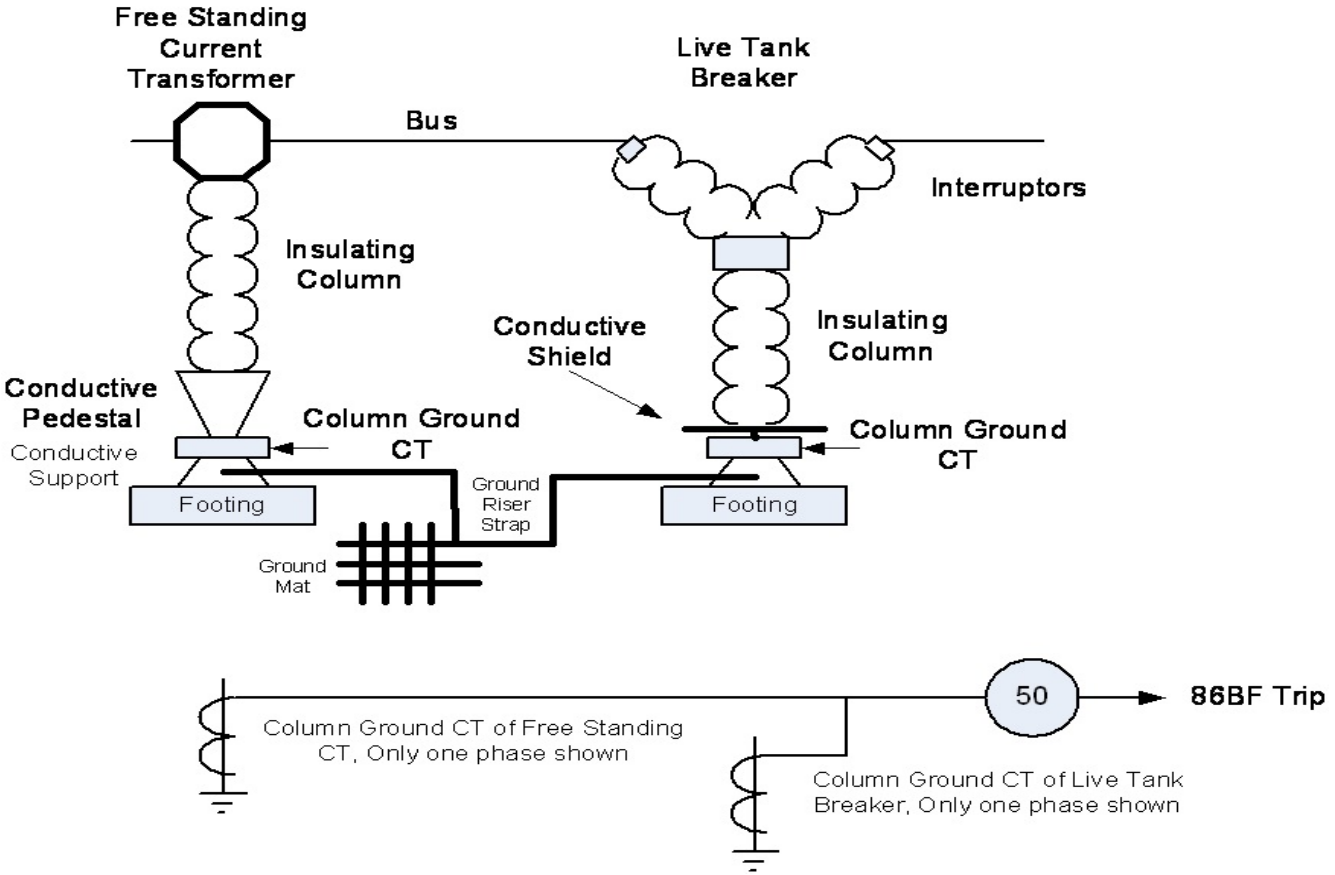
Breaker failure timer bypass scheme



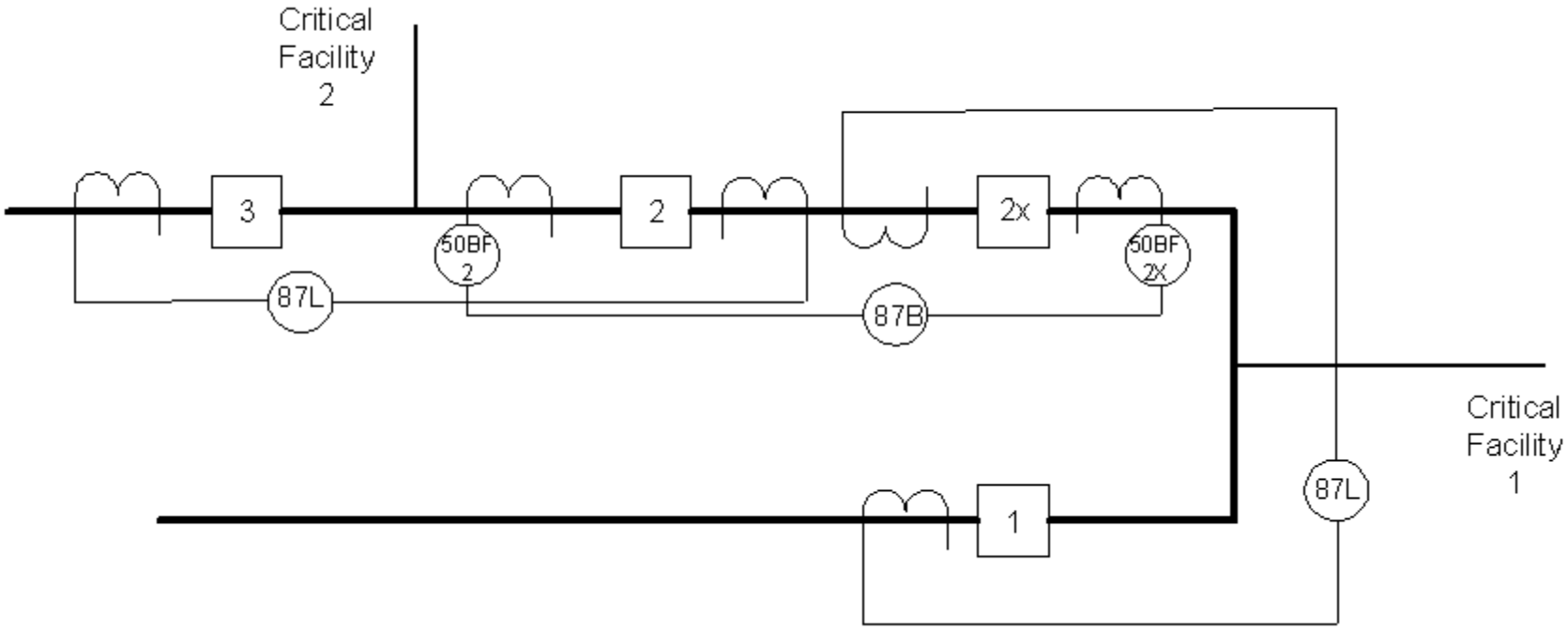
Current differential breaker failure protection



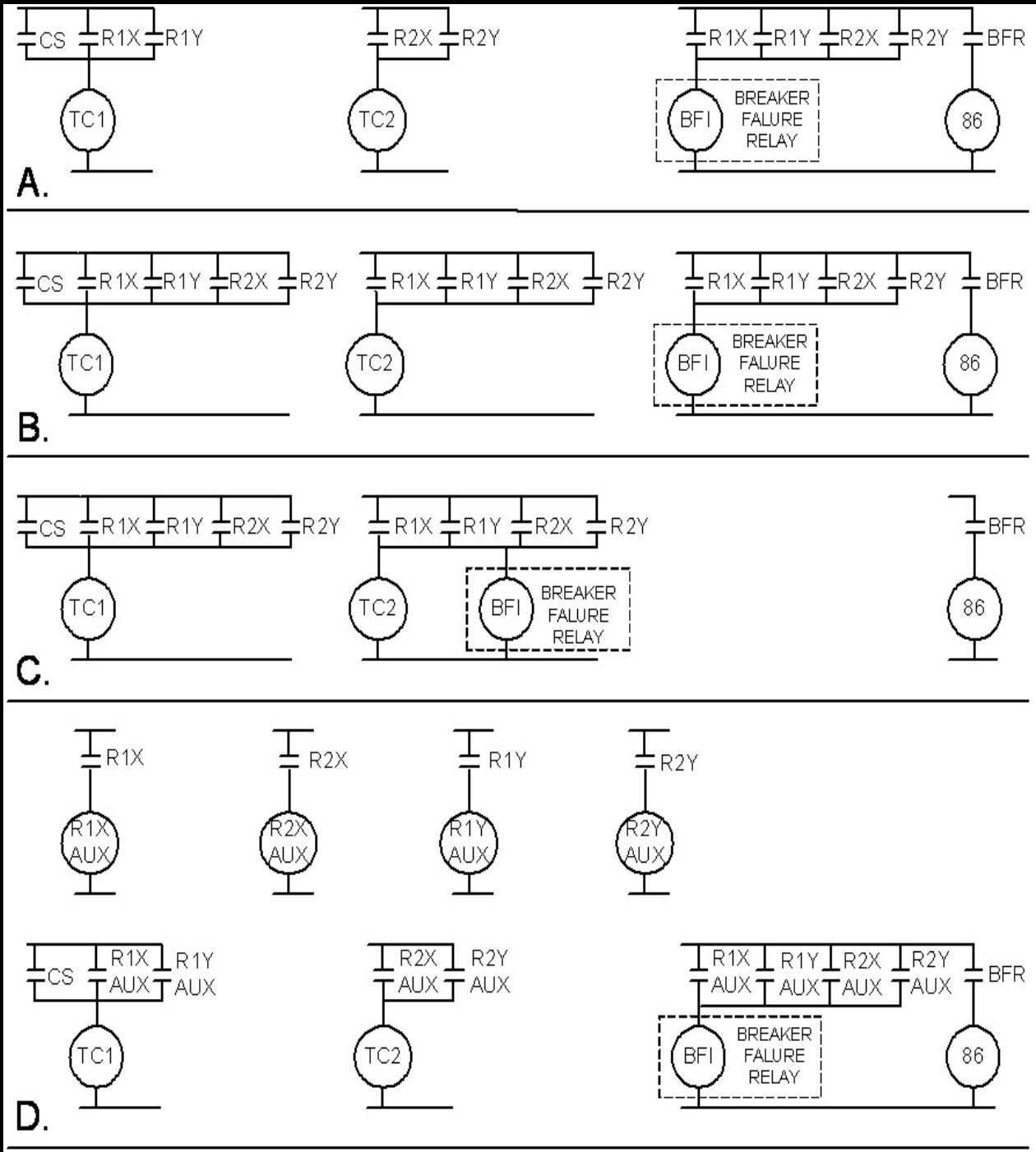
Ground fault BF on both live tank ckt bkr and CT column failure

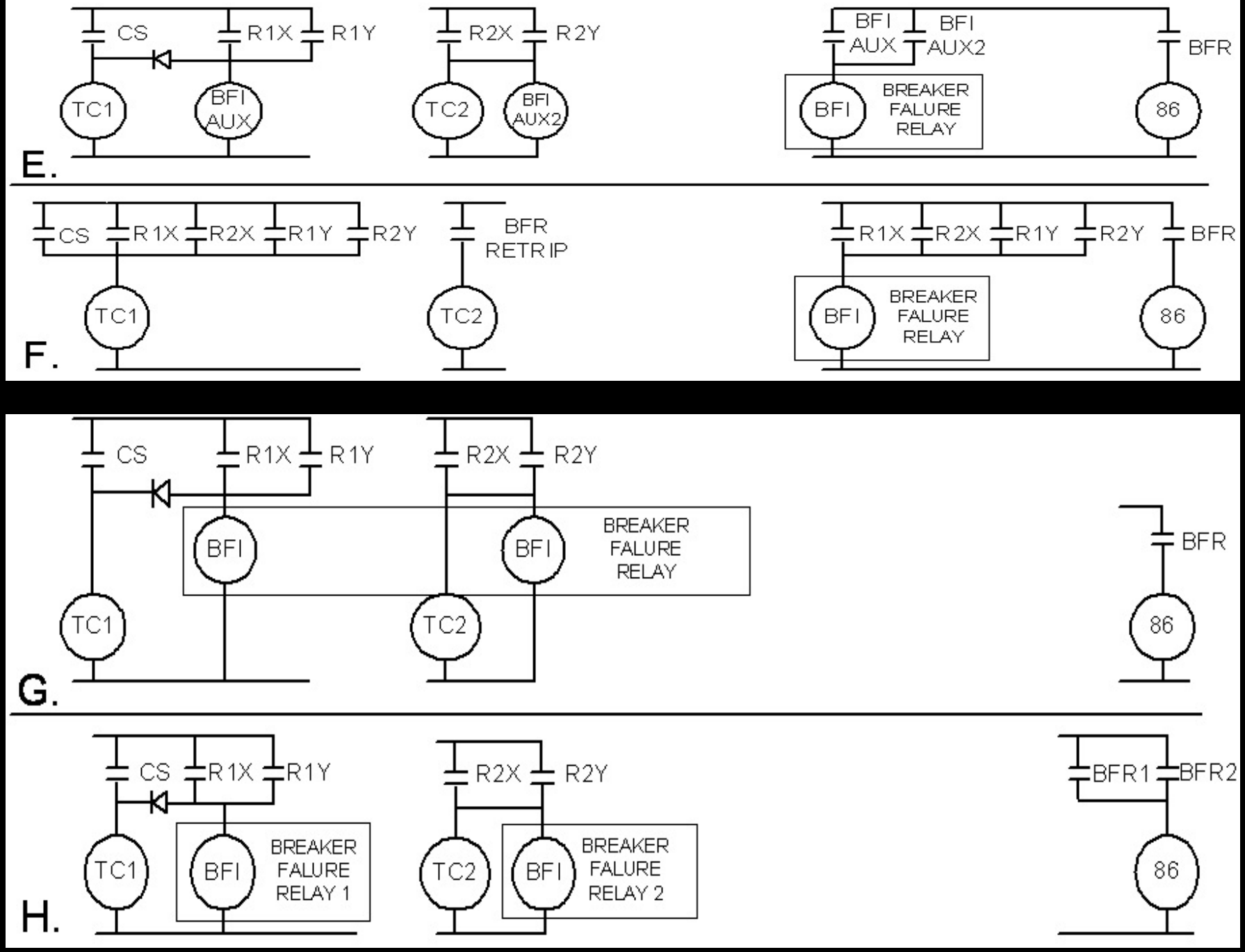


Series (tandem) breakers



Expanded Design Considerations


CS
R1X
R1Y
TC1
R2X
R2Y
TC2
R1X
R1Y
R2X
R2Y
BFR
BFI
BREAKER
FALURE
RELAY
86
A.
CS
R1X
R1Y
R2X
R2Y
TC1
R1X
R1Y
R2X
R2Y
TC2
R1X
R1Y
R2X
R2Y
BFR
BFI
BREAKER
FALURE
RELAY
86
B.
CS
R1X
R1Y
R2X
R2Y
TC1
R1X
R1Y
R2X
R2Y
TC2
BREAKER
FALURE
RELAY
BFI
BFR
86
C.
R1X
R1X
AUX
R2X
R2X
AUX
R1Y
R1Y
AUX
R2Y
R2Y
AUX
CS
R1X
AUX
R1Y
AUX
TC1
R2X
AUX
R2Y
AUX
TC2
R1X
AUX
R1Y
AUX
R2X
AUX
R2Y
AUX
BFR
BFI
BREAKER
FALURE
RELAY
86
D.


E.
CS
R1X
R1Y
TC1
BFI AUX
R2X
R2Y
TC2
BFI AUX2
BFI AUX
BFI AUX2
BFR
BFI
BREAKER FALURE RELAY
86
F.
CS
R1X
R2X
R1Y
R2Y
TC1
BFR RETRIP
TC2
R1X
R2X
R1Y
R2Y
BFR
BFI
BREAKER FALURE RELAY
86
G.
CS
R1X
R1Y
R2X
R2Y
BFI
BFI
BREAKER FALURE RELAY
TC1
TC2
BFR
86
H.
CS
R1X
R1Y
TC1
BFI
BREAKER FALURE RELAY 1
R2X
R2Y
TC2
BFI
BREAKER FALURE RELAY 2
BFR1
BFR2
86

False BFI from DC grounds

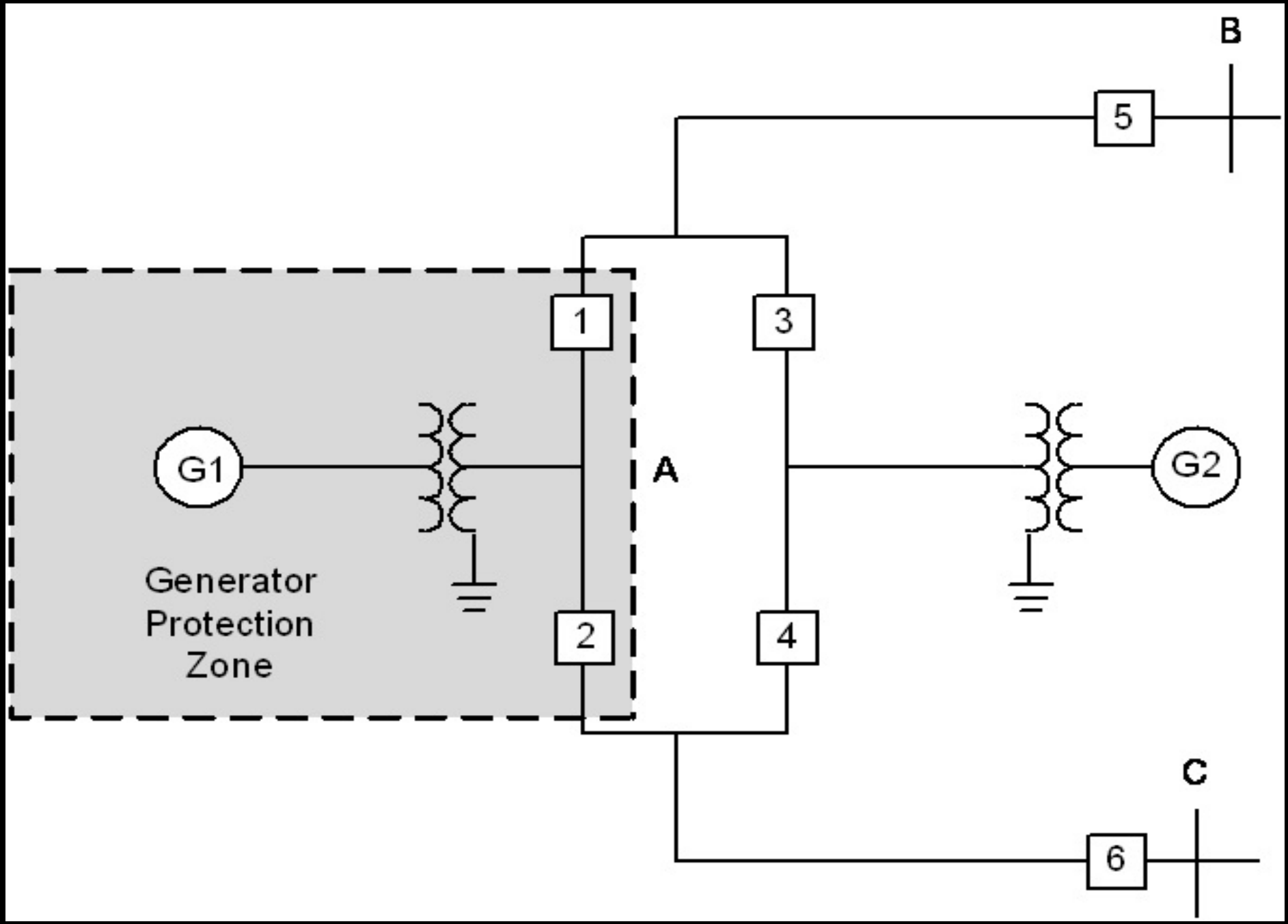
- BFI respond above half battery voltage
- Minimize cable run length/capacitance
- Convey the BFI signal using GOOSE
- Binary inputs comply to Clause 7.2.7 of IEC 60255-26 (EMI)
-

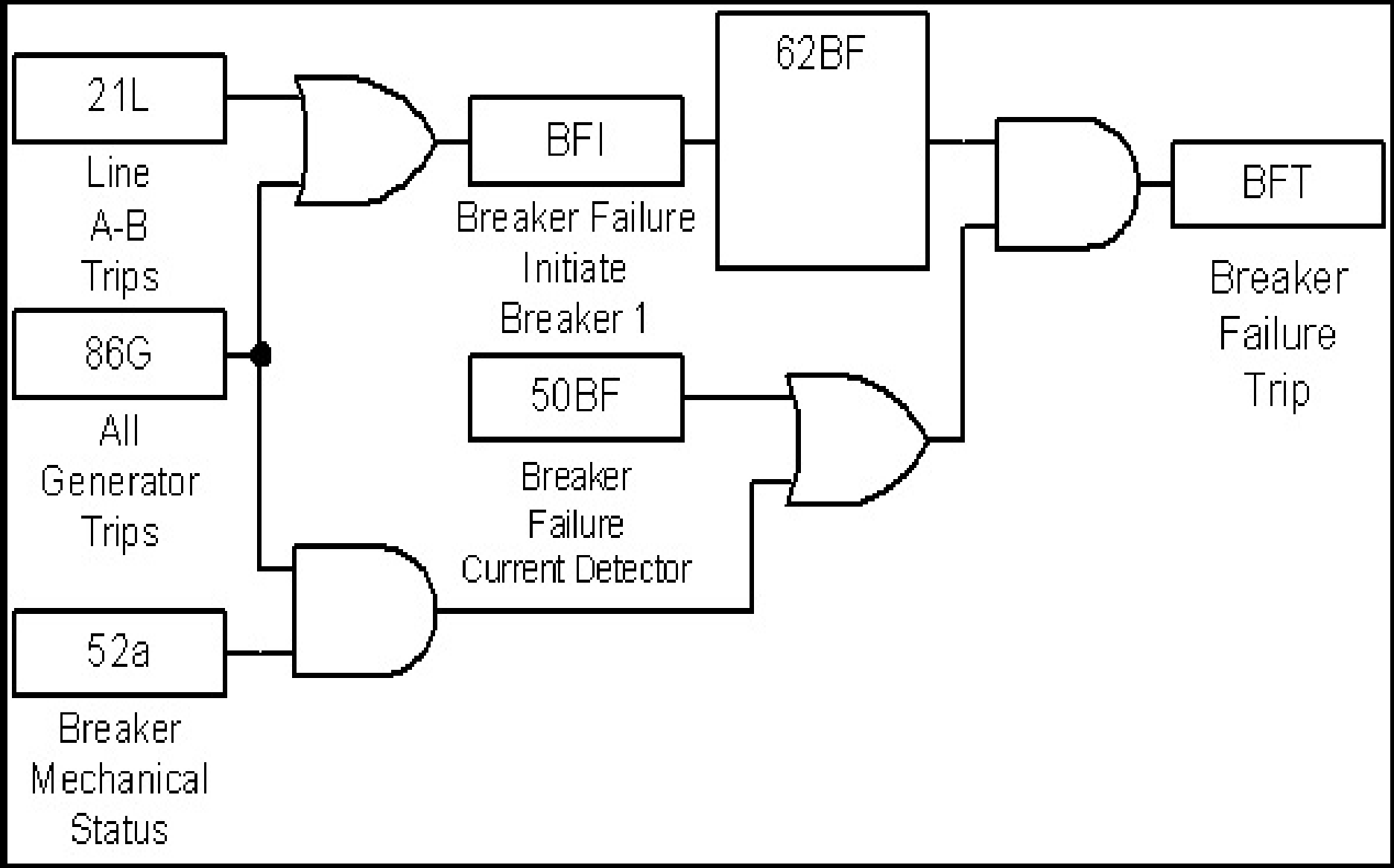
Generator BFP (New!)

- Abnormal non-fault conditions of the generator can be damaging.
- Remote backup is of no benefit for non-fault.
- Industry re-regulation, transmission personnel less familiar with generator protection
- Convey the BFI signal using GOOSE
- Binary inputs comply to Clause 7.2.7 of IEC 60255-26 (EMI)
-

Generator BFP consideration

- Breaker status
- CT location critical
- Breaker arrangement critical
-


B
5
1
3
G1
A
G2
Generator
Protection
Zone
2
4
C
6


21L
Line
A-B
Trips
86G
All
Generator
Trips
52a
Breaker
Mechanical
Status
BFI
Breaker Failure
Initiate
Breaker 1
50BF
Breaker
Failure
Current Detector
62BF
BFT
Breaker
Failure
Trip

Failure to close detection

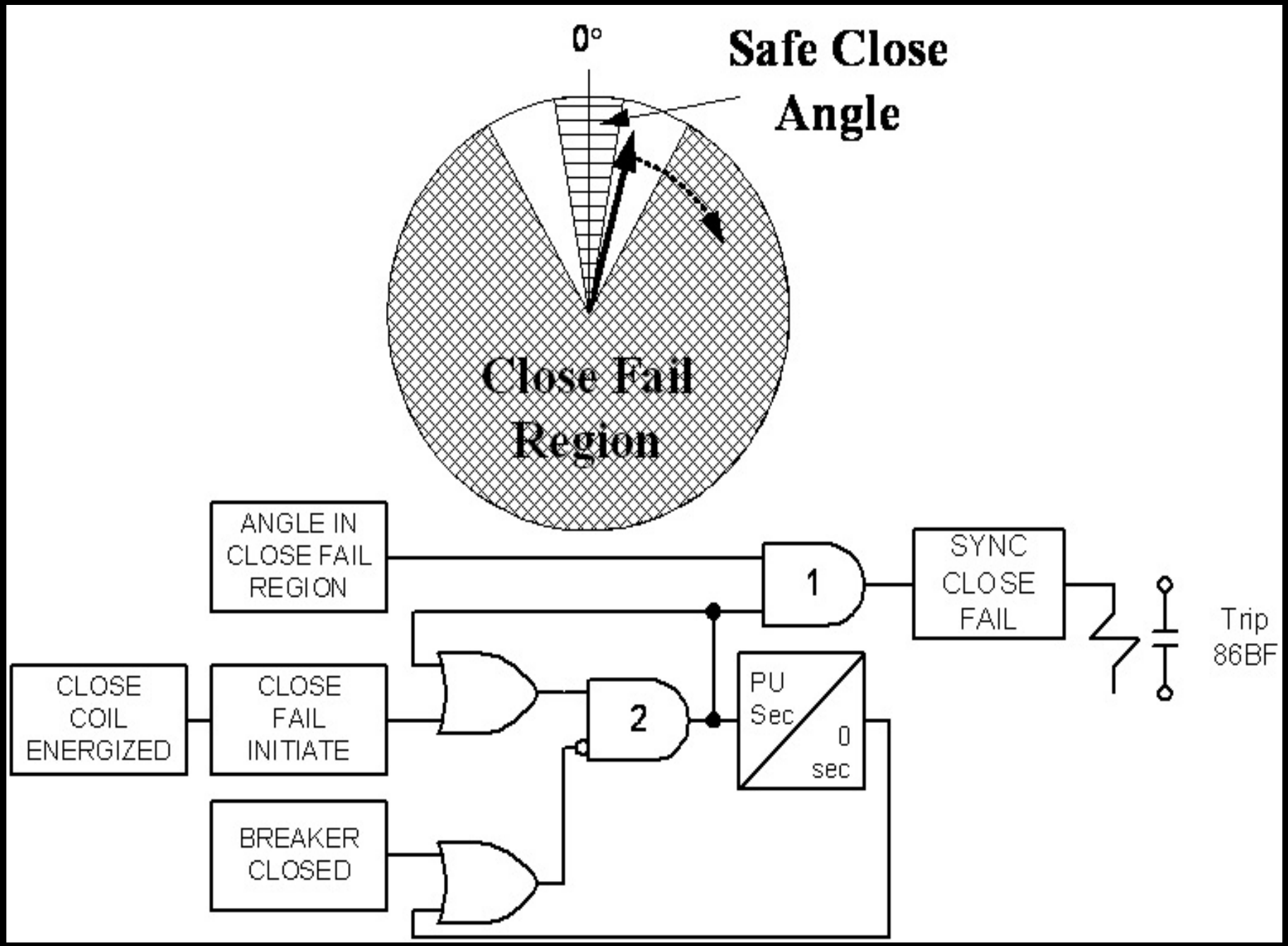
- C37.119 scope is expanded to cover performance failures of the breaker other than fault clearing failure such as failure to operate, either tripping or closing.
-

Synchronizing breaker failure-to-closea

- Slow closing from differences in speed(slip), voltage, and angle across the breaker can twist shafts, fracture turbines, and fail windings (heat).

- Synchronizing system must account for slip rate, and breaker close speed to give close command in advance

-


0°
Safe Close Angle
Close Fail Region
ANGLE IN CLOSE FAIL REGION
CLOSE COIL ENERGIZED
CLOSE FAIL INITIATE
BREAKER CLOSED
1
2
PU
Sec
0
sec
SYNC CLOSE FAIL
Trip 86BF

BFR Settings

- Current detectors 50BF are per phase but can also include a ground current element
- Set 50BF sensitive enough to respond to any fault condition. Some prefer to set above max load yet min fault can be below the max load
-

BFR Settings

- Set timer long enough to allow successful fault clearing including some margin for subsidence
- If min fault current is quite low or non fault protection is needed then a 52a scheme might be applied
-

Communications based BFP

- Direct transfer trip is applied to trip and block closing of remote adjacent breakers via leased telephone lines, power line carrier, microwave, or fiber. Must be dependable and secure

- IEC 61850 based peer to peer Ethernet communications might be applied for BFP

-

Testing ensures BFP integrity

- Tests relays that initiate BFP
- Tests BFR timer
- Tests current detector pickup and reset

- Commission to verify each initiate signal and each lockout operational including breaker trip checks.

-

- IEEE C37.119-2016 Guide for Breaker Failure Protection of Power Circuit Breakers describes industry best practices when applying BFP

- Avoid single points of failure in the protection system to enhance reliability

- Learn peculiarities of how and why BFP is applied to generator breakers

- Learn how BF re-trip can mitigate consequences of testing error

- Learn about tandem breaker schemes, column ground protection, breaker differential protection, communication based schemes and testing of BFP

- Become familiar with C37.119-2016 to improve your understanding of BFP!

Q&A