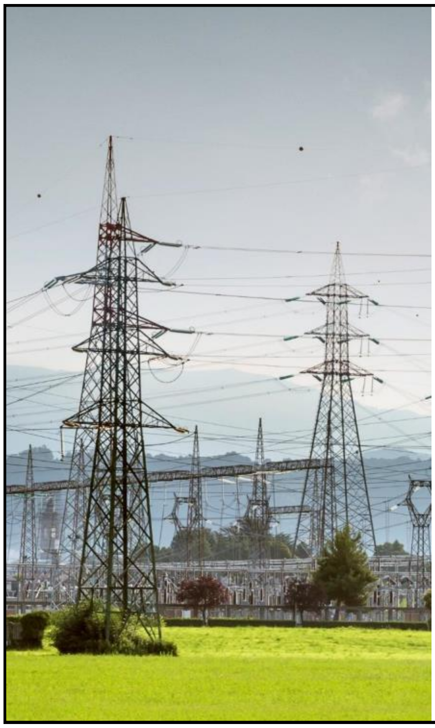

Permissive or Blocking Pilot Protection Schemes? How to Have It Both Ways

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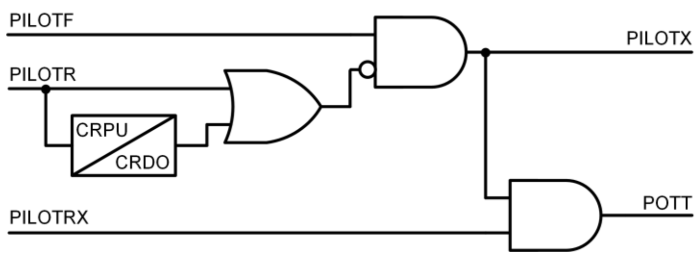
Overview

- Pilot scheme fundamentals
- Pilot logic – built-in or freely programmed?
- Unified pilot logic
- Application considerations
- Crossover permissive-blocking scheme

Pilot scheme fundamentals

- Pilot scheme trips instantaneously and selectively by comparing fault direction at all line terminals
- Single-bit channel conveys fault direction
- Two basic scheme types are in use
  - **Permissive**
    Trip if the relay and all remote relays see the fault as forward
  - **Blocking**
    Trip if the relay sees the fault as forward and none of the remote relays see the fault as reverse

Permissive pilot logic



PILOTF
user-selected forward-looking overreaching protection elements

PILOTR
reverse-looking protection elements matching PILOTF selection

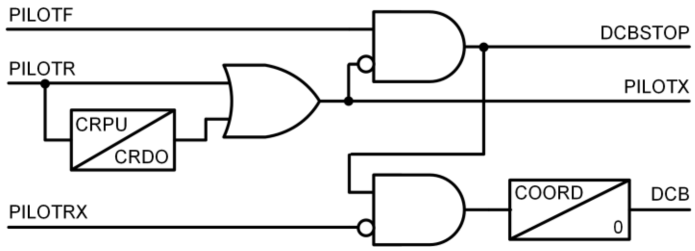
CRPU/CRDO
current-reversal blocking coordination timer

PILOTX
pilot signal transmitted (permission)

PILOTRX
pilot signal received (permission)

POTT
POTT scheme operation (trip)

Blocking pilot logic



PILOTF and PILOTR
forward- and reverse-looking protection elements

CRPU/CRDO
current-reversal blocking coordination timer

PILOTX and PILOTRX
pilot signal transmitted and received (blocking)

COORD
DCB coordination timer

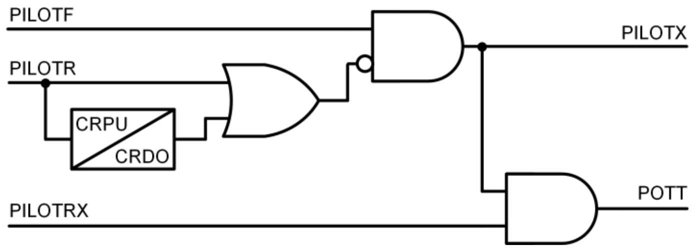
DCB
DCB scheme operation (trip)

DCBSTOP
Stop signal for ON/OFF channels

Dependability and security

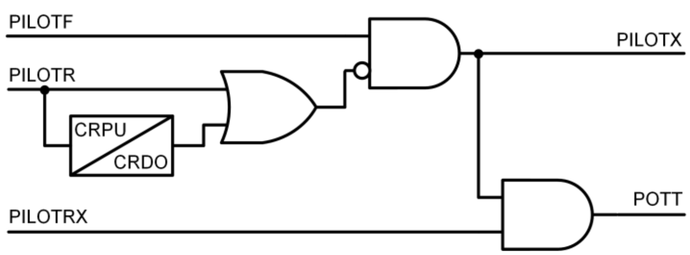
- Permissive and blocking schemes
  - Perform almost identically under normal conditions
  - Respond differently only under failure modes
- Failure modes
  - Failed equipment
    (relay, channel, PT, test switch left open)
  - Unusual or stressed system condition
    (weak infeed, open breaker, settings issue)
- Permissive schemes may miss faults
- Blocking schemes may overtrip

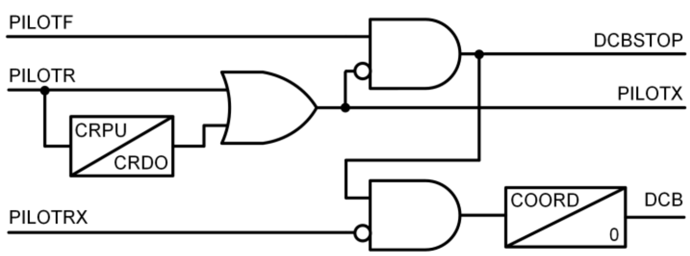
Pilot logic – built-in or freely programmed?



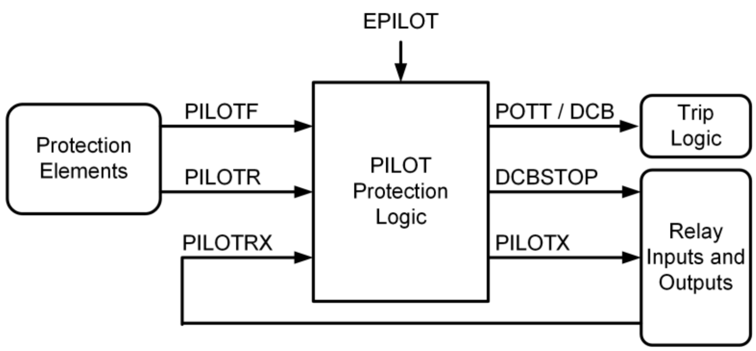
Consideration	Built-In	Freely Programmed
Multivendor consistency	✘	✓
Longevity throughout installation lifecycle	✘	✓
Familiarity and ease of testing and troubleshooting	✘	✓
Initial engineering and testing	✓	✘
Maximizing product capability	✓	✘
Single-pole tripping	✓	✘

Can we unify permissive and blocking logic?





Unified pilot logic



EPILOT
enable setting (POTT or DCB)

PILOTF
user-selectable list of forward-looking protection elements (level/zone 2)

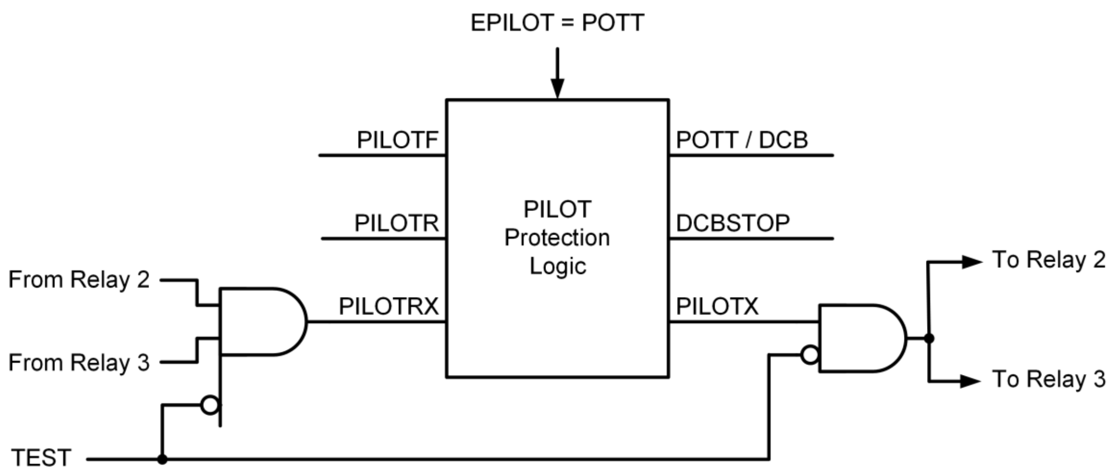
PILOTR
relay-matched list of reverse-looking protection elements (level/zone 3, 4, or 5)

PILOTX and DCBSTOP
output bits freely configurable to drive any relay outputs

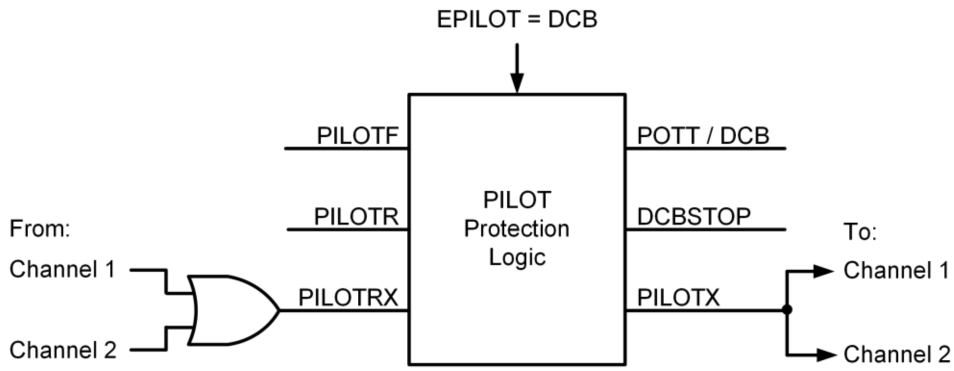
PILOTRX
programmable equation to receive pilot signal from any relay input

POTT / DCB
POTT or DCB operation signal

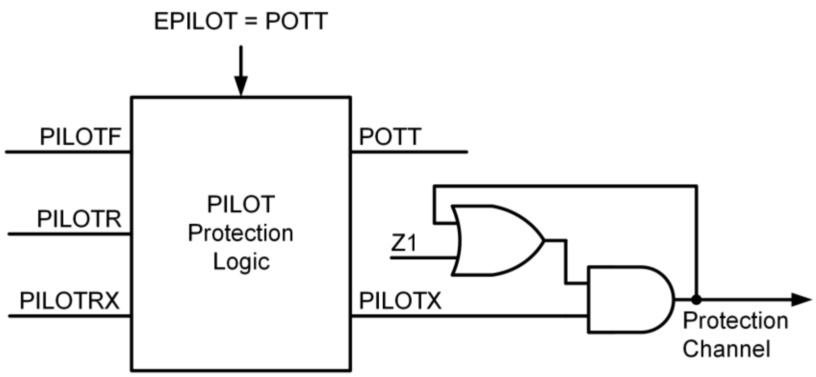
Three-terminal POTT with test bit



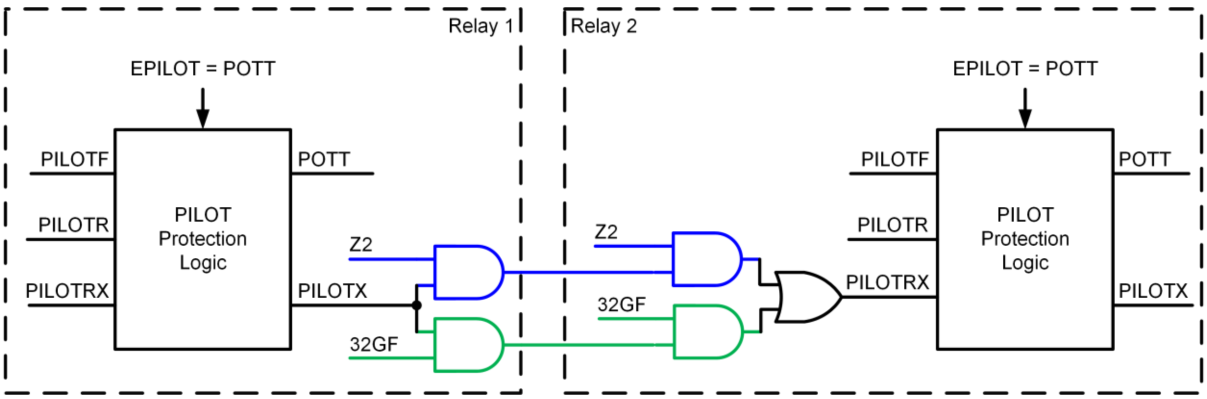
Two-terminal DCB with redundant channels



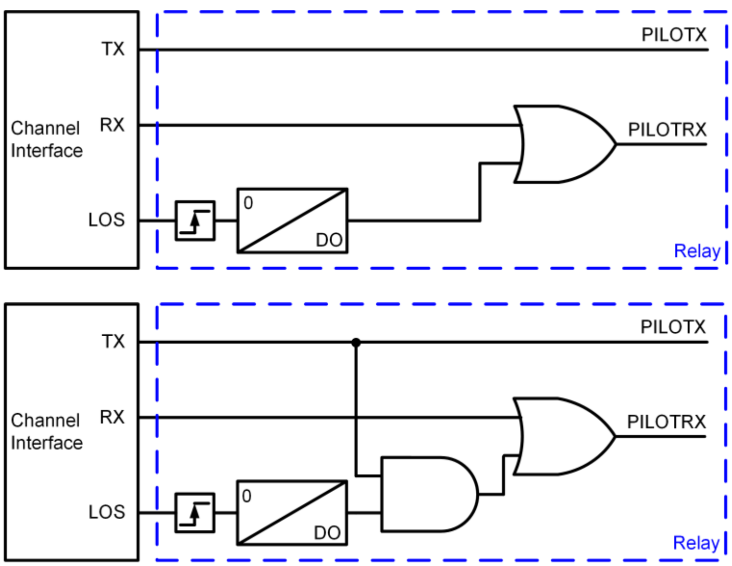
PUTT application



Separating permissive bits



POTT channel failure considerations

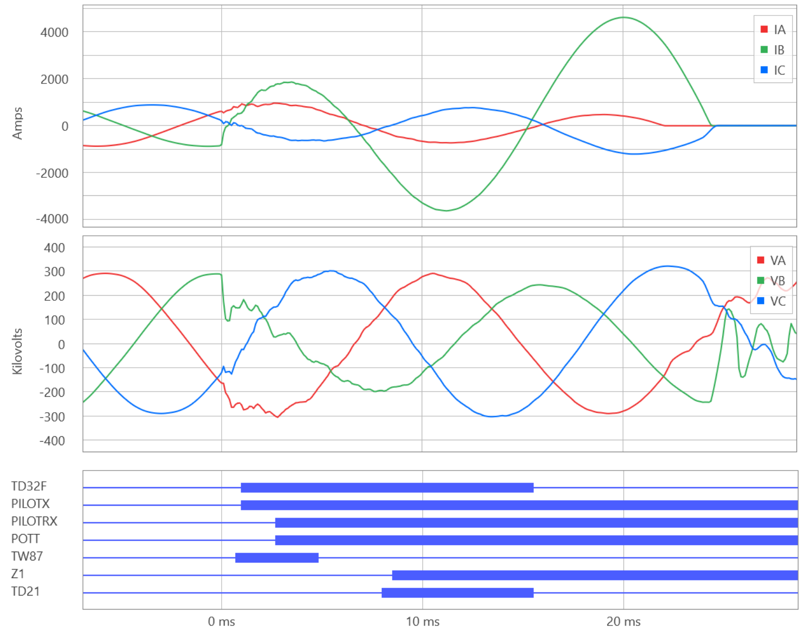


Channel Failure
Key Logic
("DCUB")

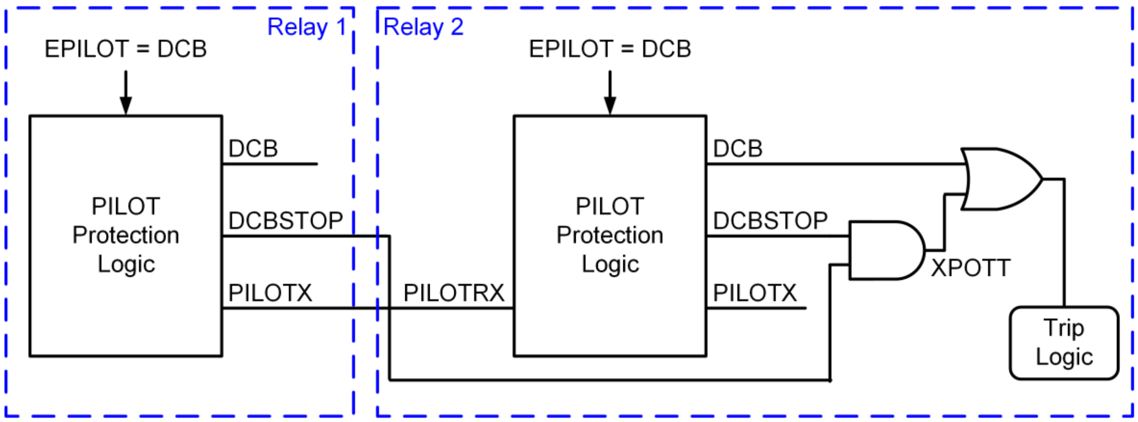
Channel Failure
Echo Logic

POTT schemes just got much faster!

- 09/12/2019 fault on a 345 kV, 109 mi line
- TD32 asserted in 1 ms (PILOTX sent)
- PILOTRX received in 2.6 ms
- POTT tripped in 2.6 ms
- TW87 tripped in 1 ms
- Fault cleared in 25 ms



Crossover permissive-blocking scheme



Crossover scheme benefits

- Simple engineering and settings
  - No need for open-breaker echo logic (DCB trips)
  - No need for weak-infeed logic (DCB trips)
  - No need for channel failure or echo logic (DCB trips)
  - Generous DCB coordination time setting (DCB security)
- Fast operation (POTT trips)
- Dependable operation (DCB trips)
- Requires one more input, output, and channel bit
- Caution: reverse elements must be set carefully

Key takeaway

- If you are a permissive scheme user, consider the crossover scheme to simplify your application
- If you are a blocking scheme user, consider the crossover scheme for speed of operation

Blocking Bit ↘ ↙ Permissive Bit

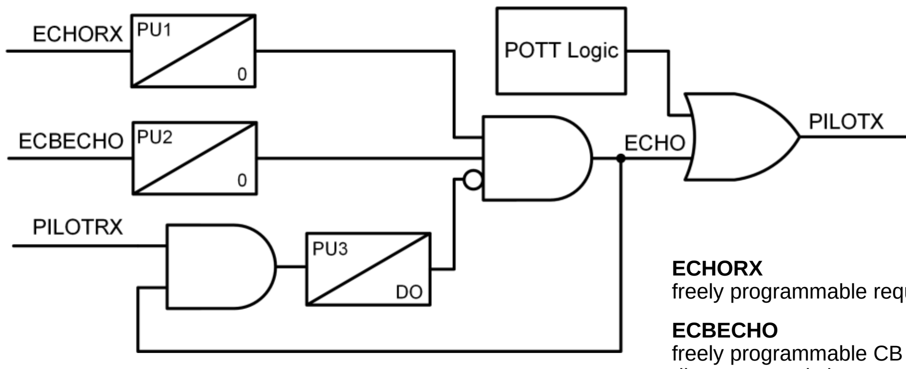
00	DCB trip
01	POTT trip (faster)
10	No trip (external fault)

Summary

- Programmable logic equations allow good compromise between using built-in logic and the need to customize
- Test bits, redundant channel logic, multiterminal line logic, and channel failure logic are best left to programmable logic equations
- Crossover permissive-blocking scheme offers good compromise between speed, security, and dependability

Backup slides for discussion

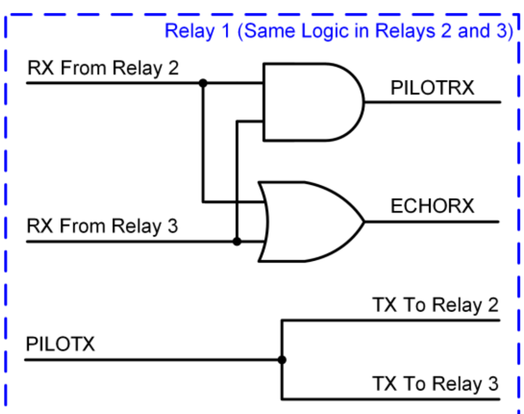
POTT open-breaker echo logic



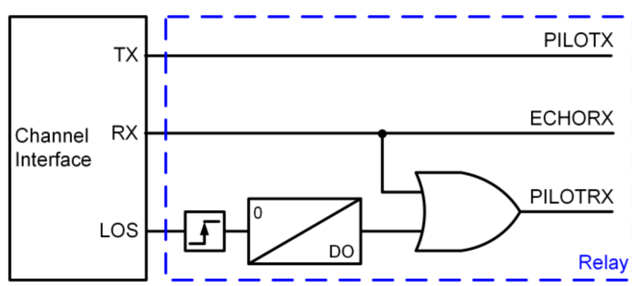
ECHORX
freely programmable request to echo

ECBECHO
freely programmable CB open, disconnect switch open, or stub-bus condition bit

Open-breaker echo applications

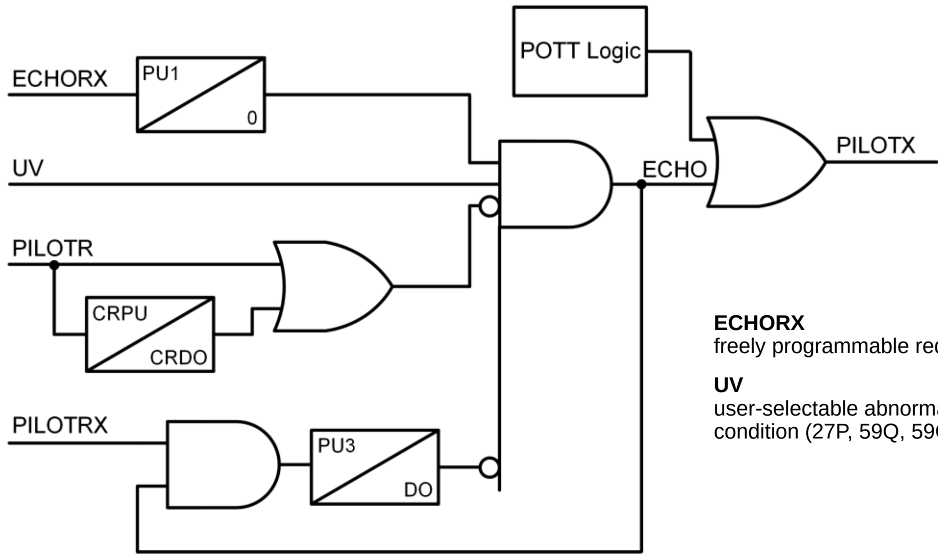


Three-Terminal Line Application



Channel Failure Echo Logic

POTT weak-infeed echo logic



ECHORX
freely programmable request to echo

UV
user-selectable abnormal voltage condition (27P, 59Q, 59G)