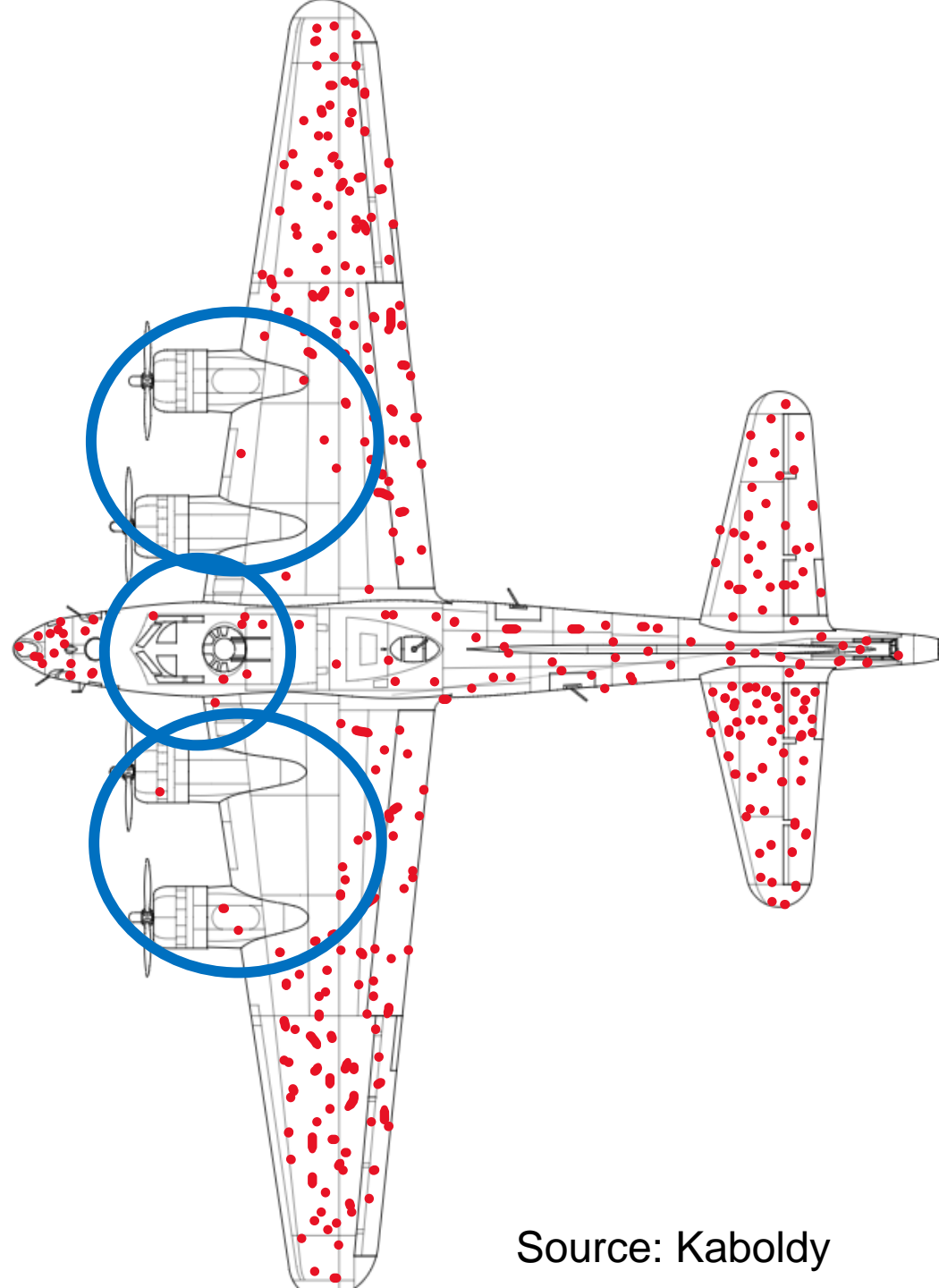# Advancements in Relay Contact Output Self-Testing and Trip Circuit Monitoring Capabilities

Austin Wade, David Schmidt, Brandon Nafsinger, and Jordan Bell
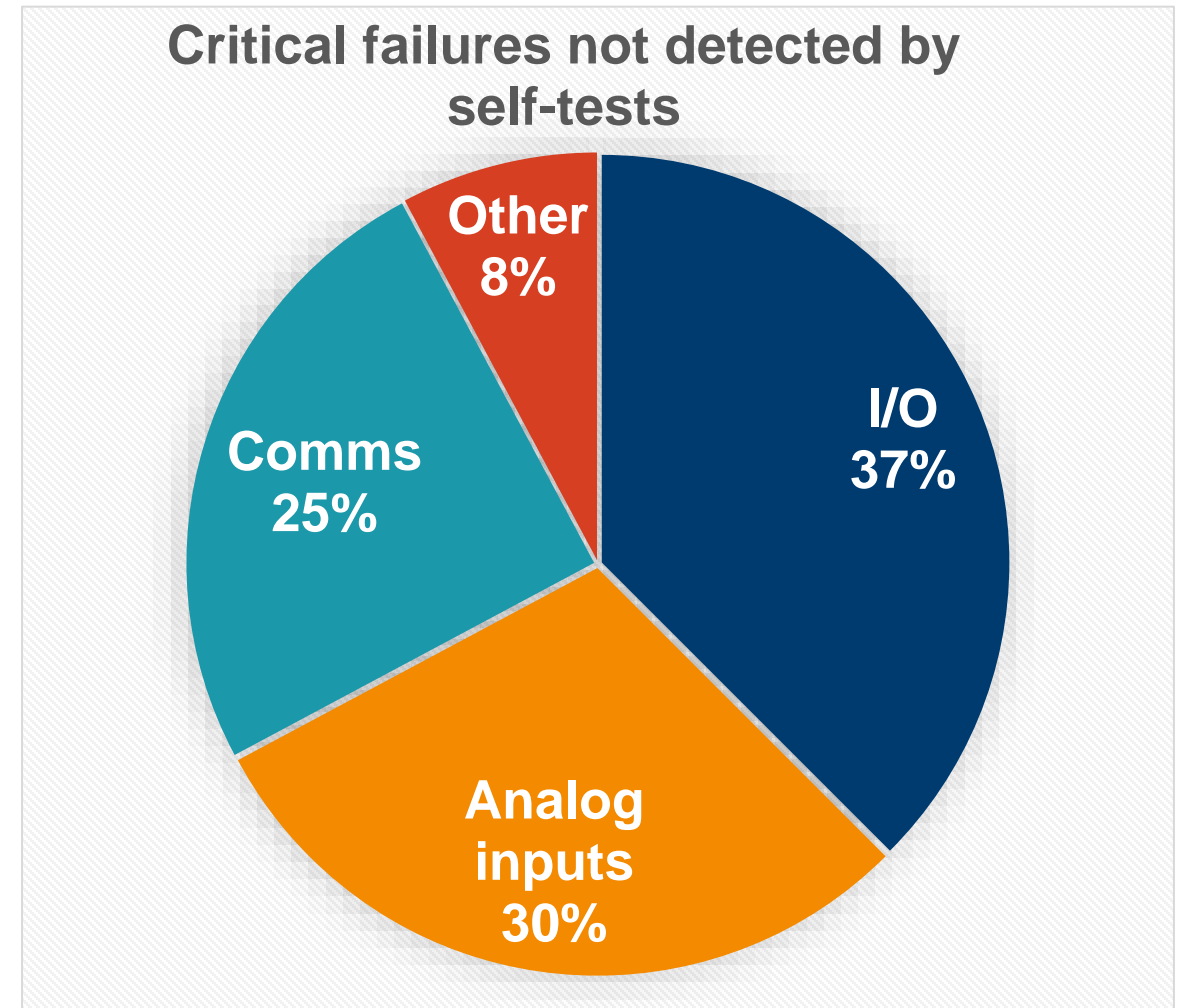Schweitzer Engineering Laboratories, Inc.

Source: Kaboldy

Self-testing limitations

Do we have areas in our protection systems that have failed, yet we are missing the data?
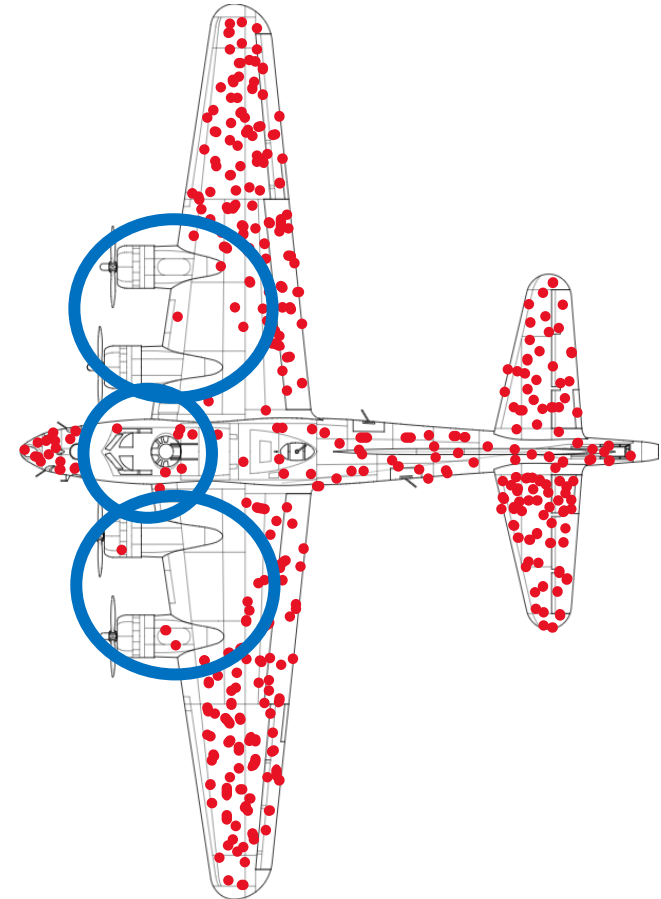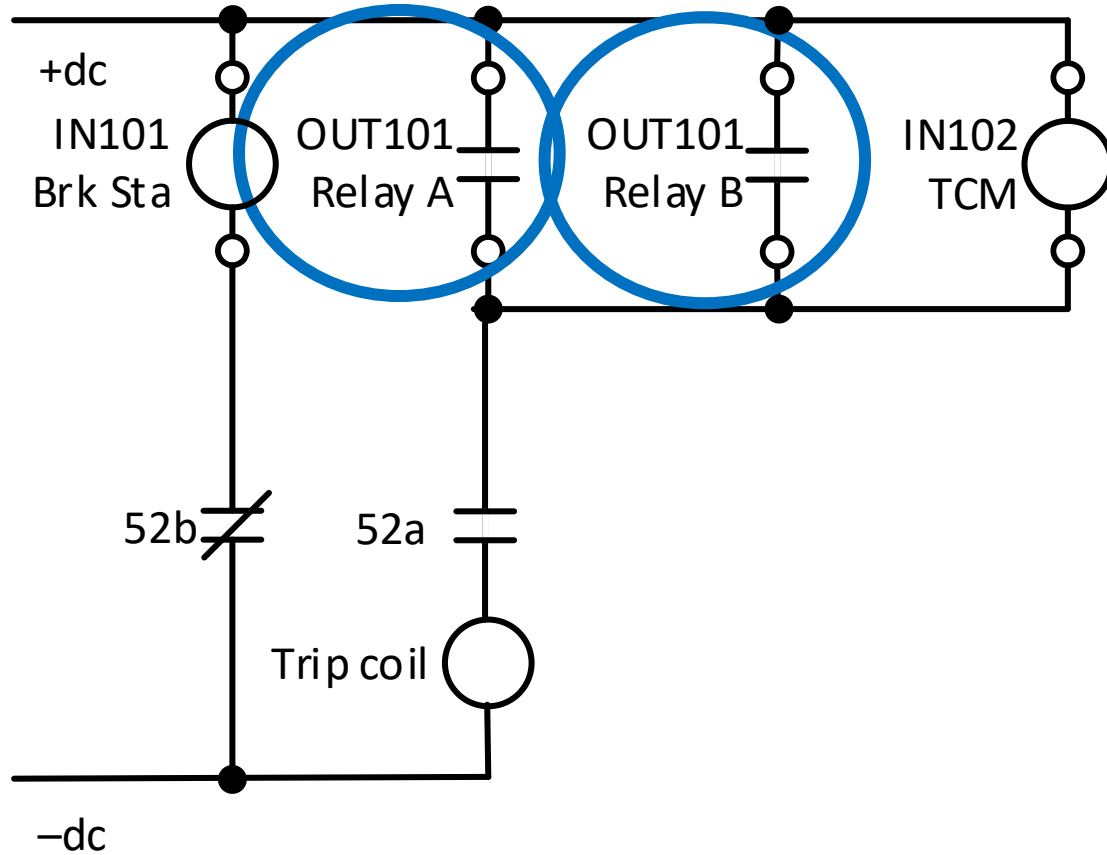
Field-returned data demonstrates self-testing effectiveness

- Assessed 3,300 relays

- Monitored communications and analog inputs

- Proposed no self-testing solution for I/O failures

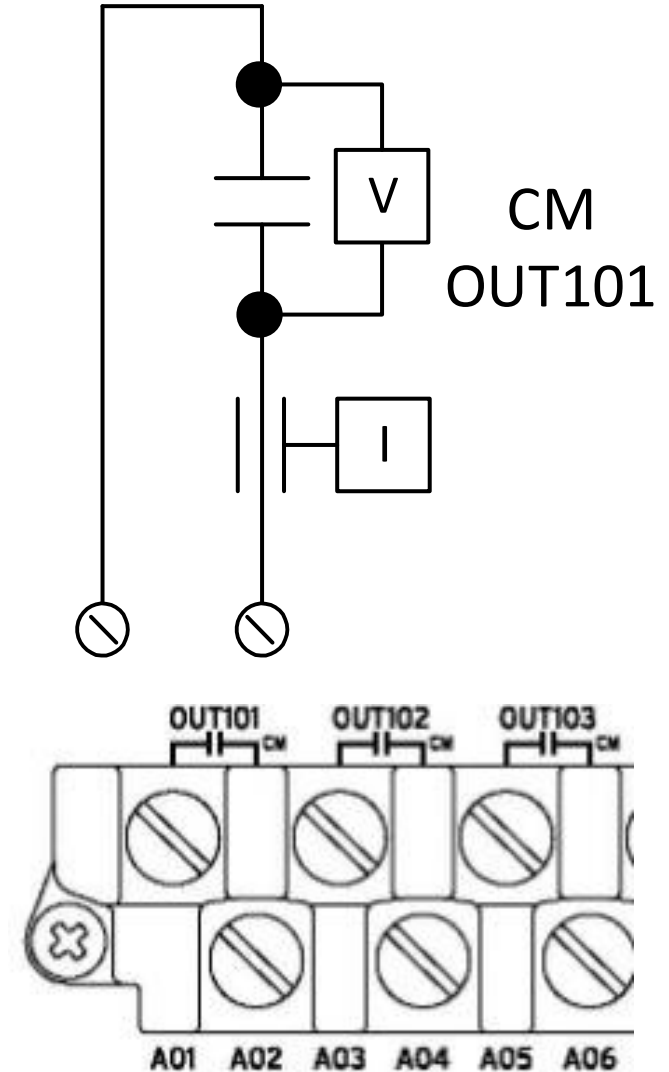- Recognized I/O as one of the last self-testing gaps

Critical failures not detected by self-tests

Category	Percentage
I/O	37%
Analog inputs	30%
Comms	25%
Other	8%

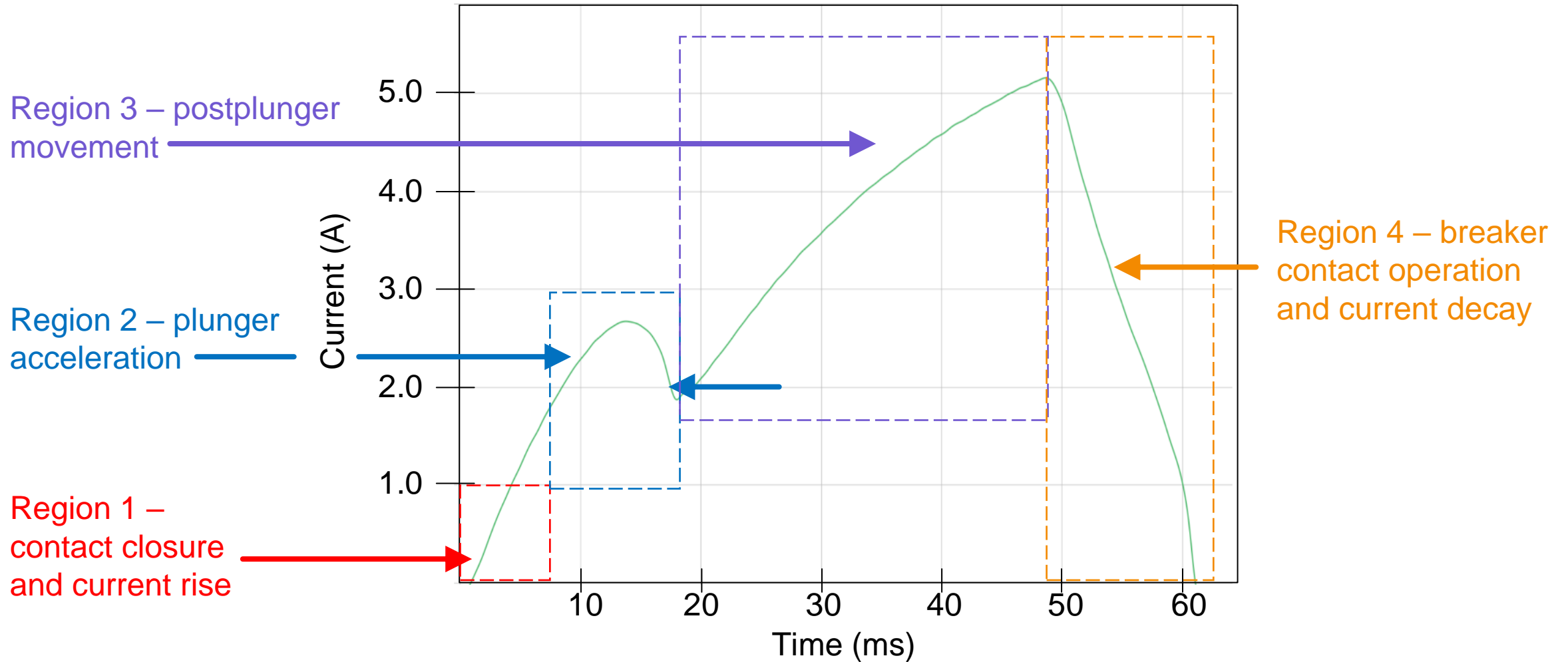# Trip circuit is critical to power system operation

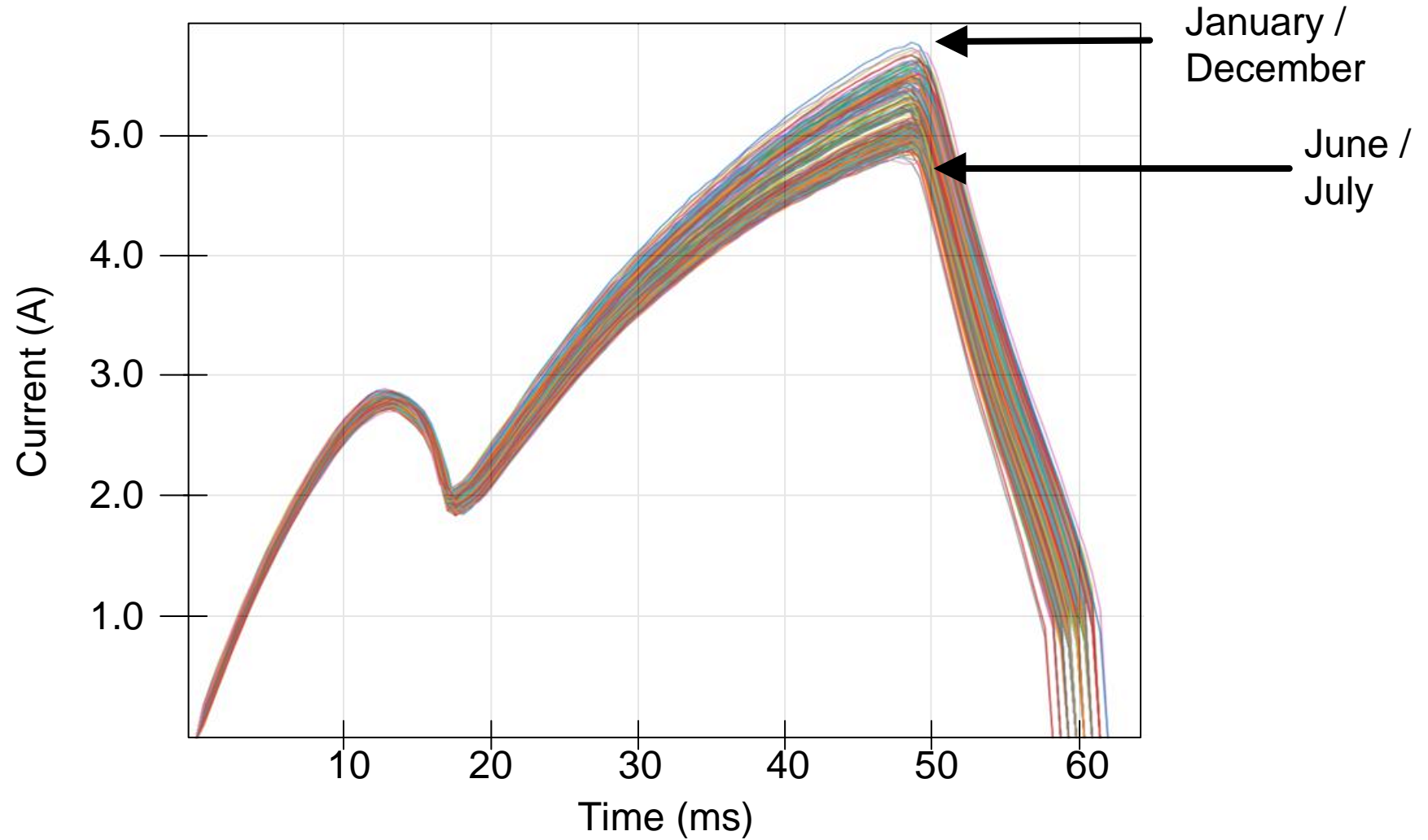# How do we verify outputs operated?

- CM catalogs the following
  - High speed
  - High current
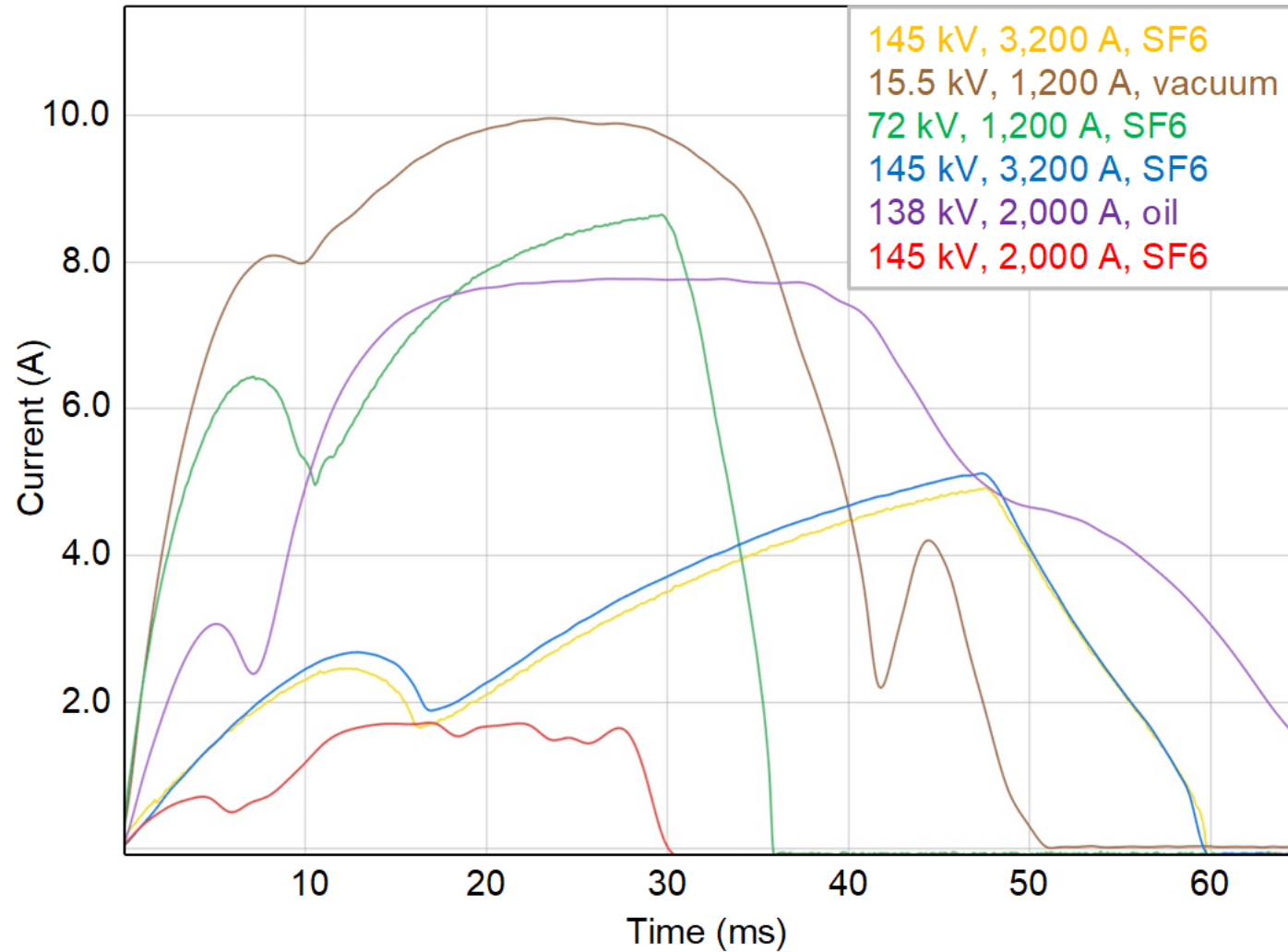 - Voltage
  - Current
- Why do we want to monitor current?

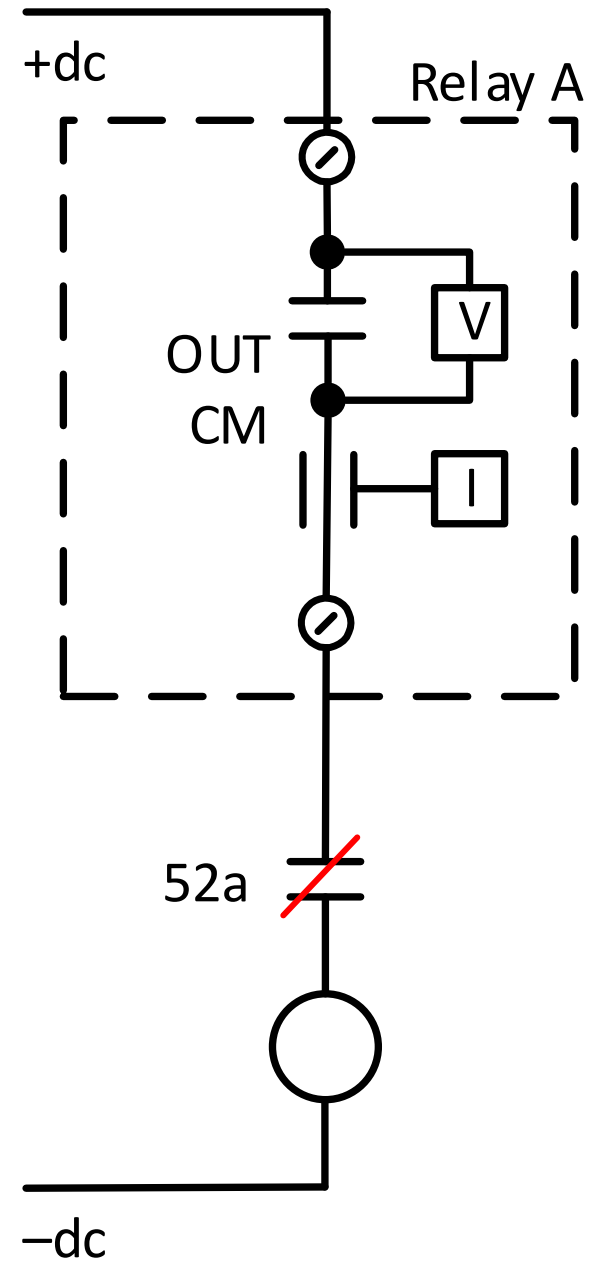# What does current tell us?

Consistent trip signature on same coil
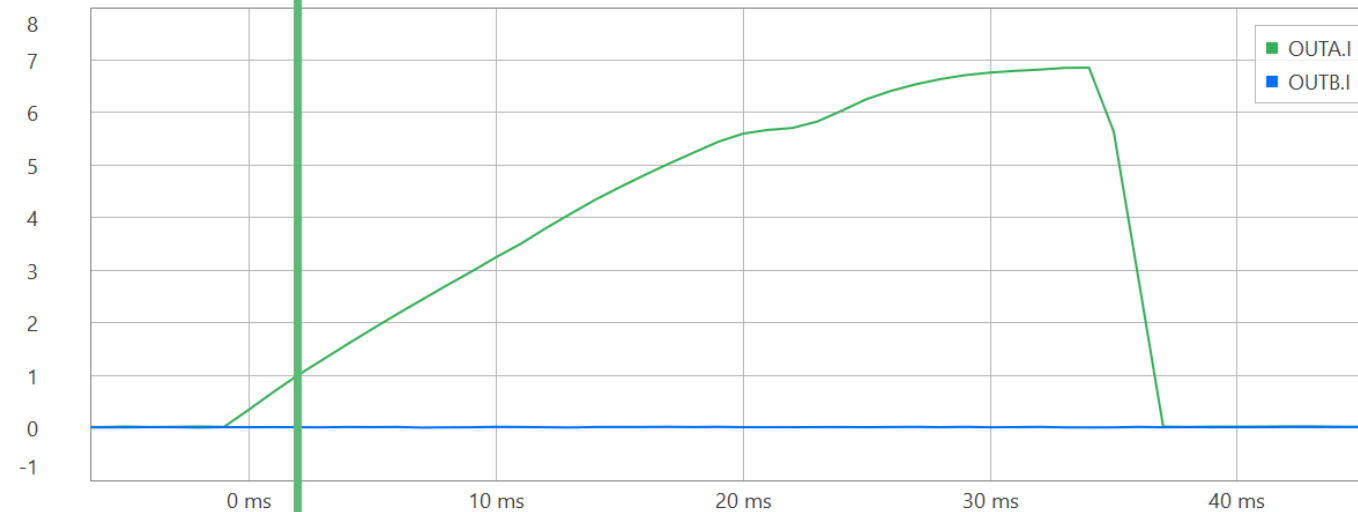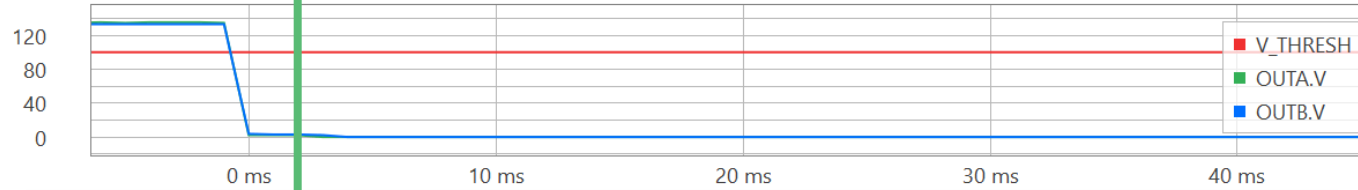
Different breaker types and ratings
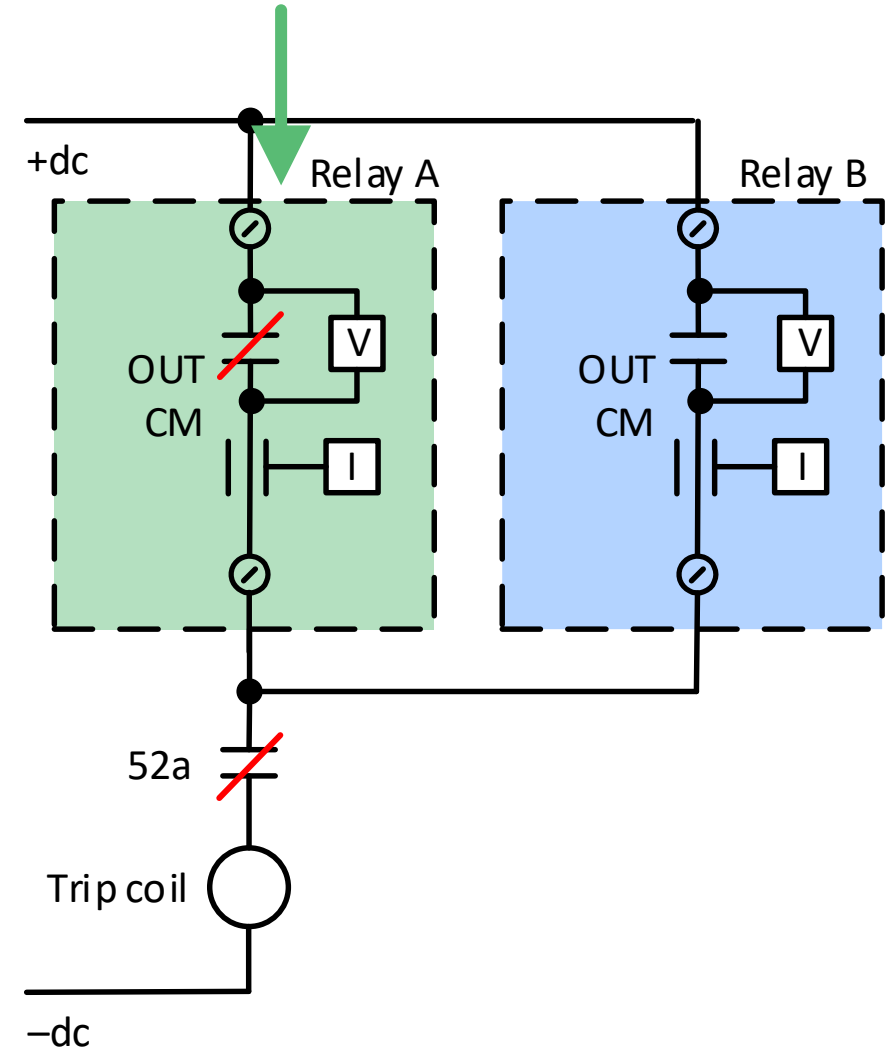
Simple algorithm for single contact

- Success when current is measured

- Fail when no current is measured

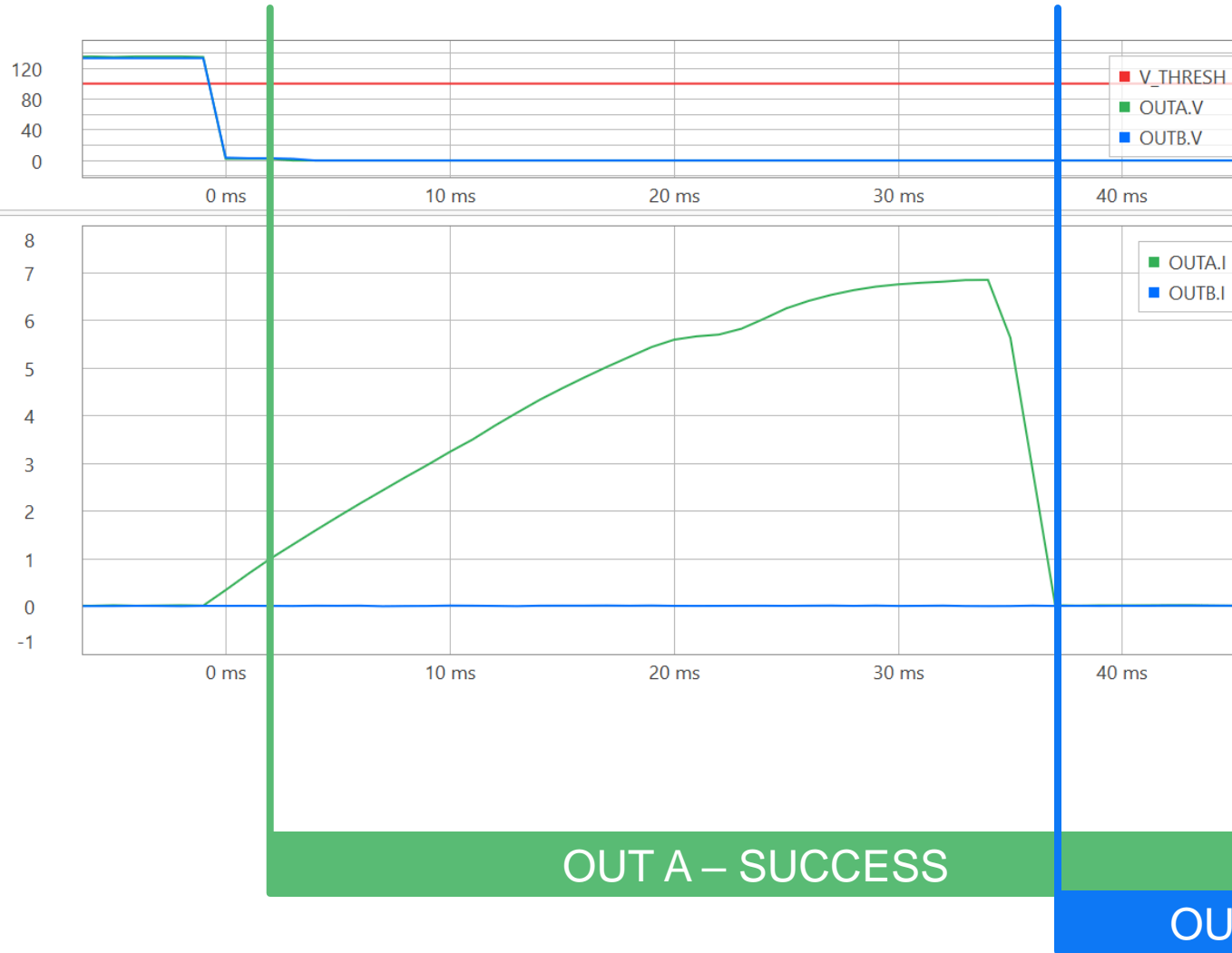# Success when current is measured
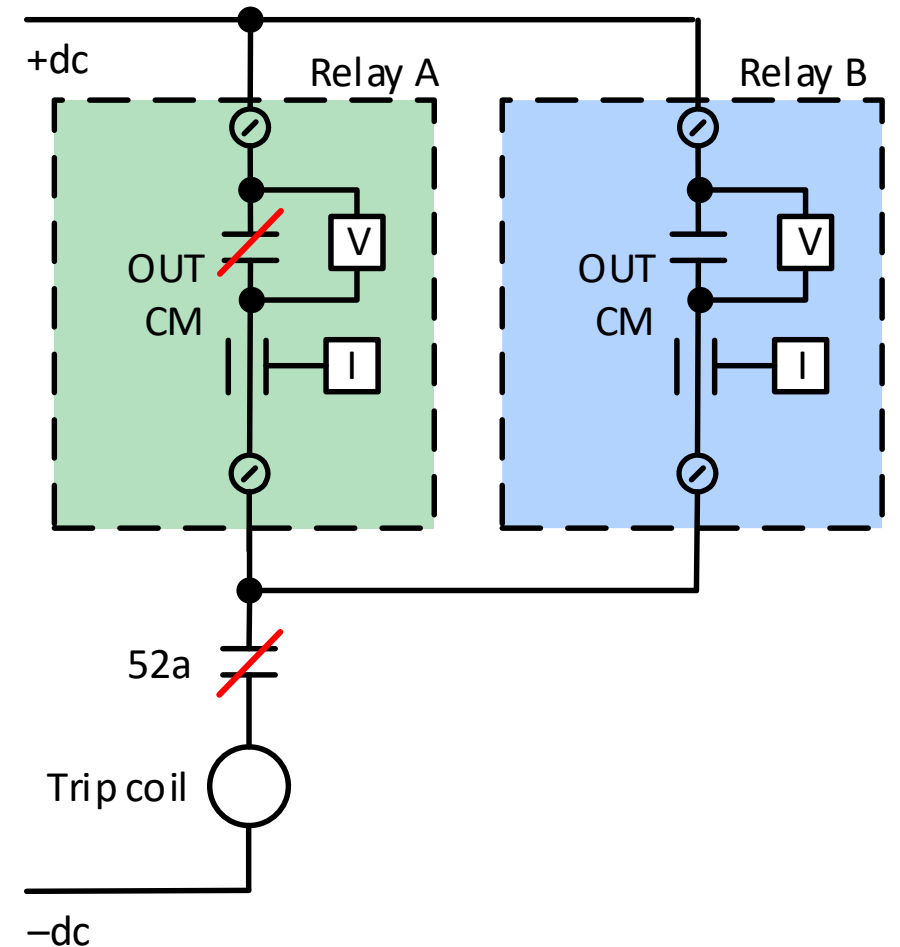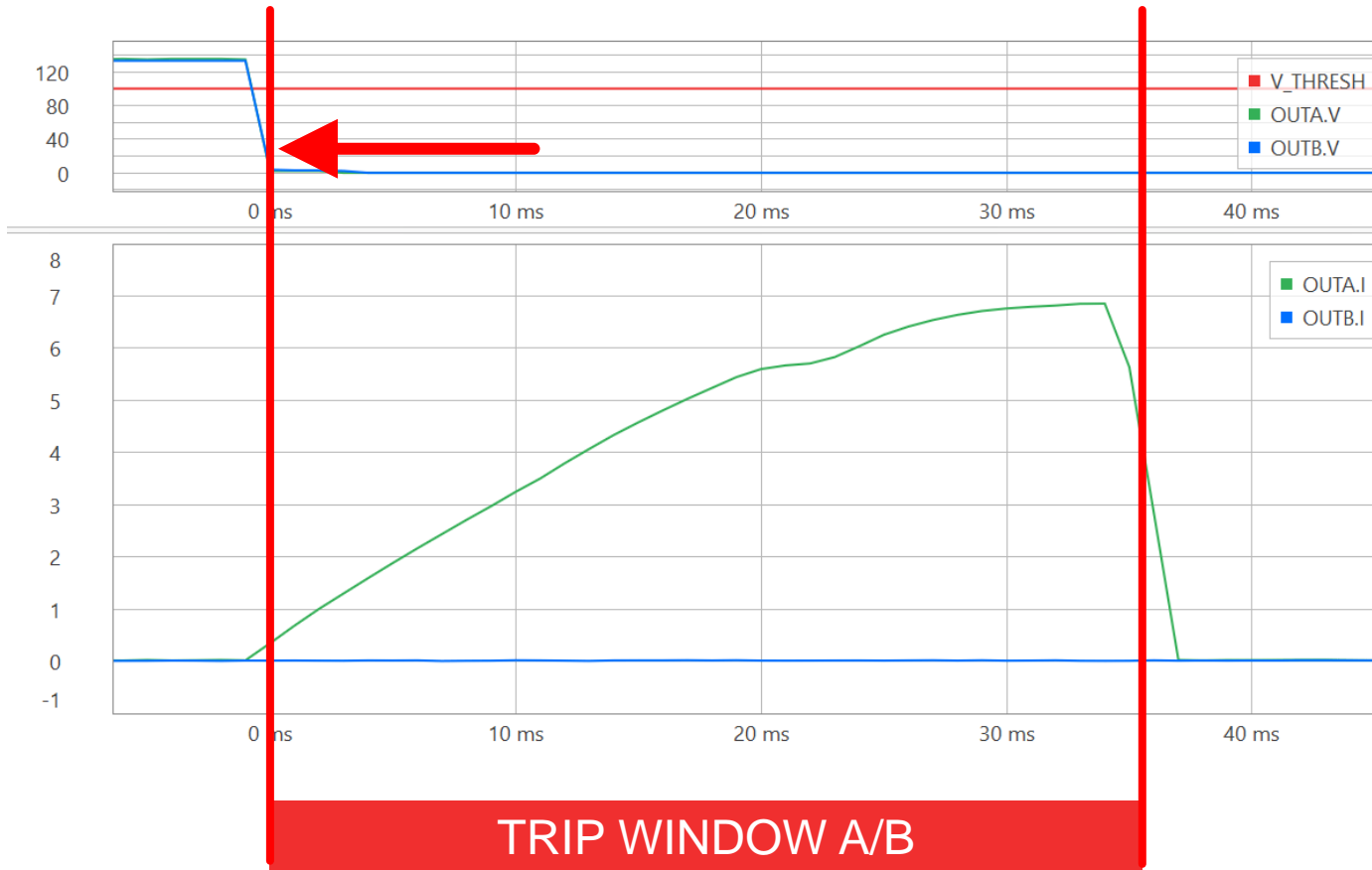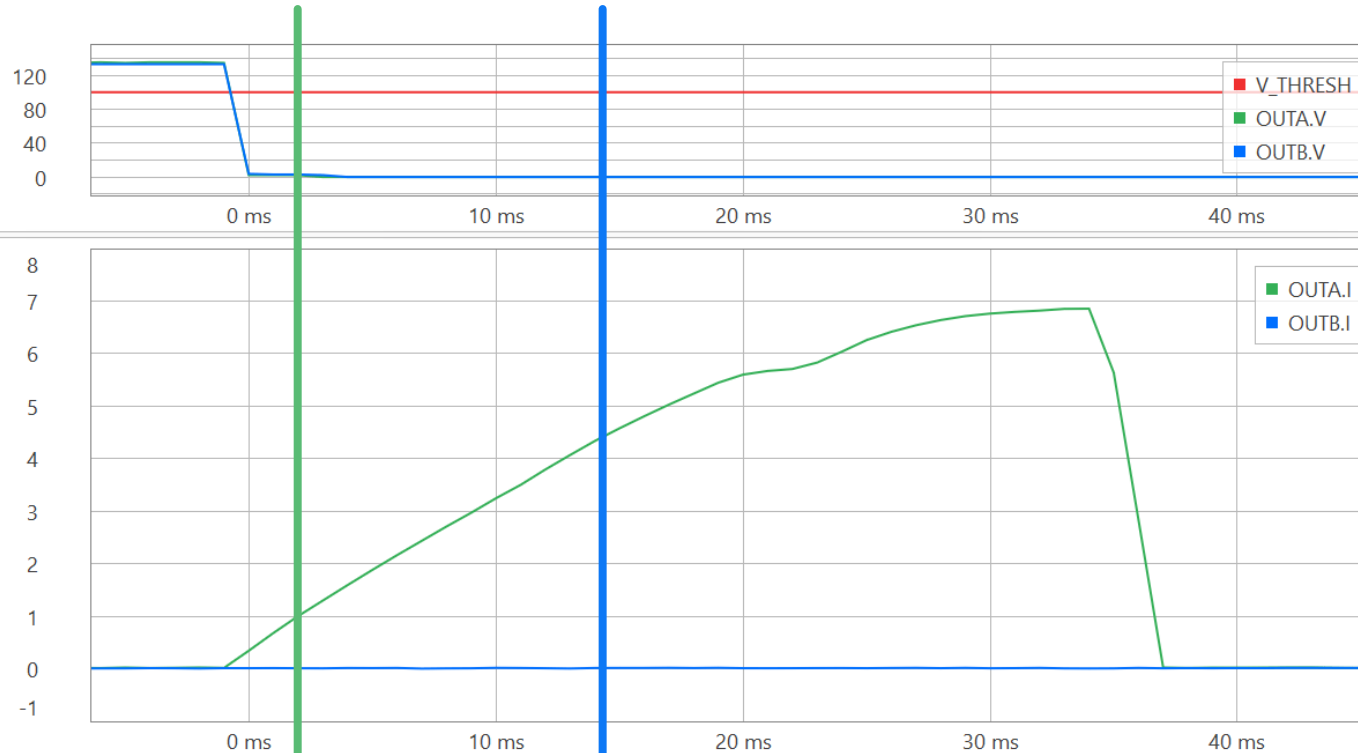
Declaring fail is not as simple
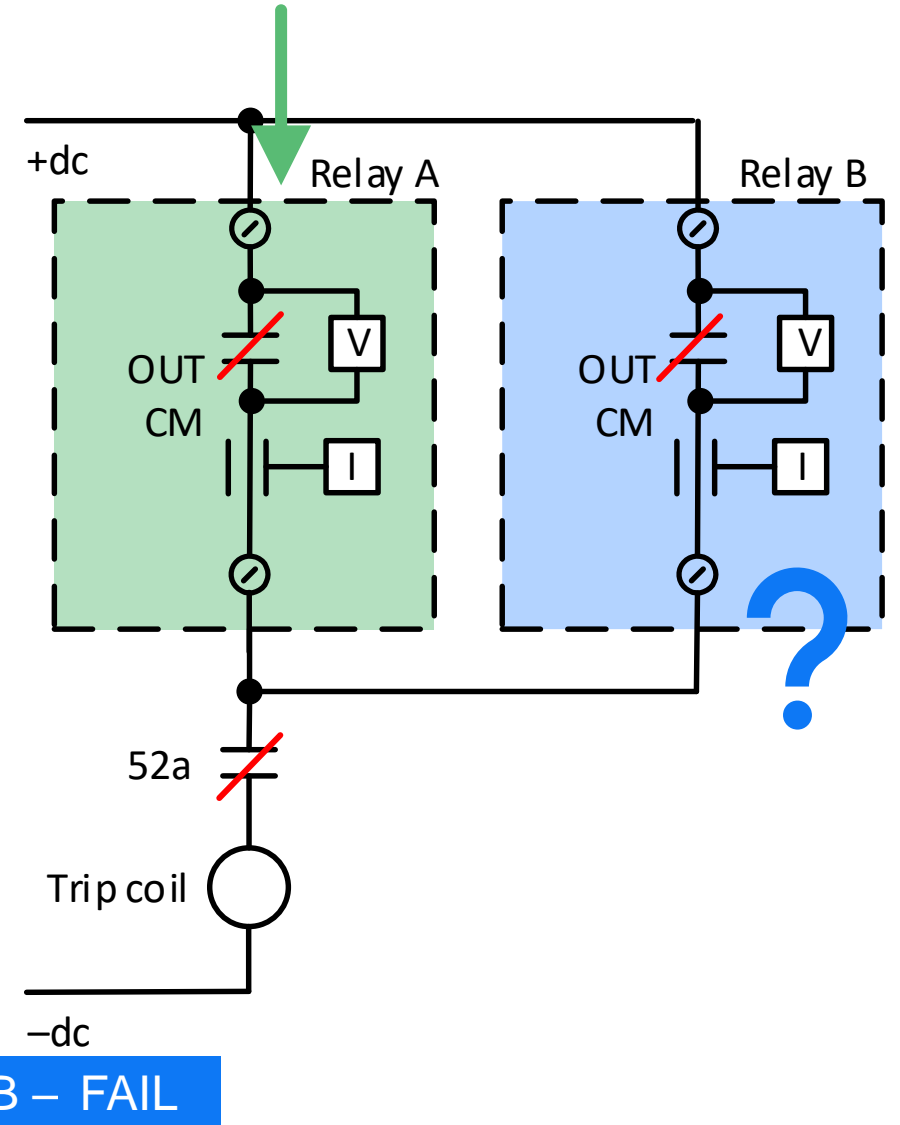
Relays know when closed output should measure current

Fail is only declared in trip window
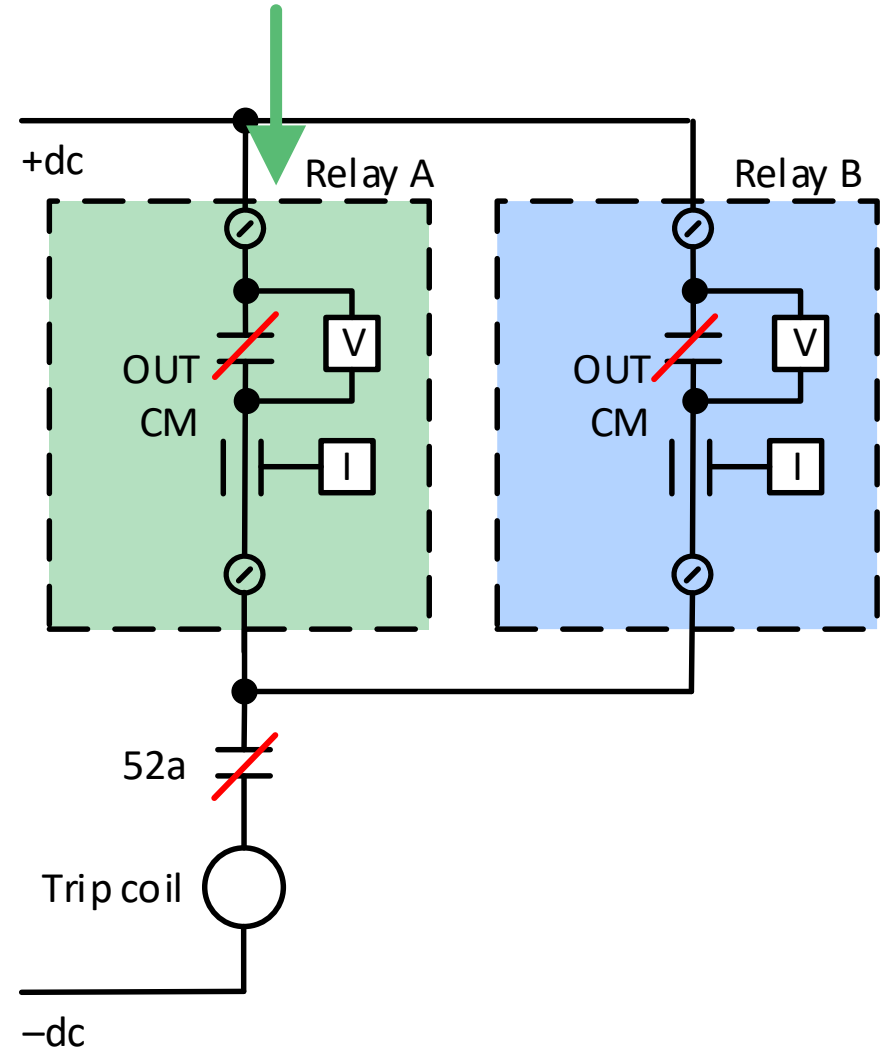
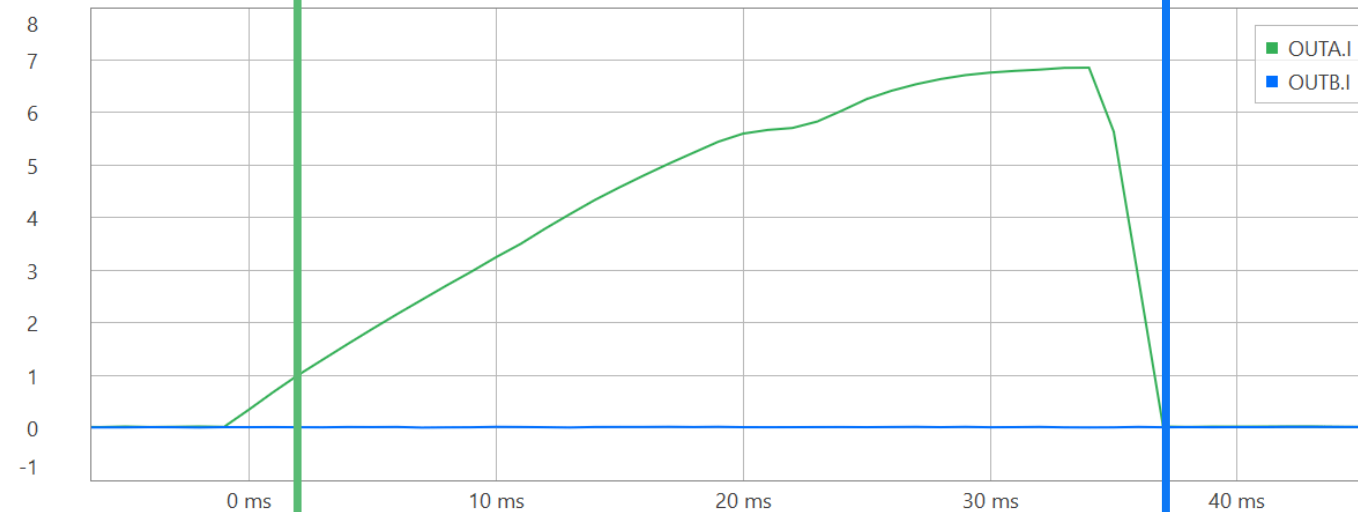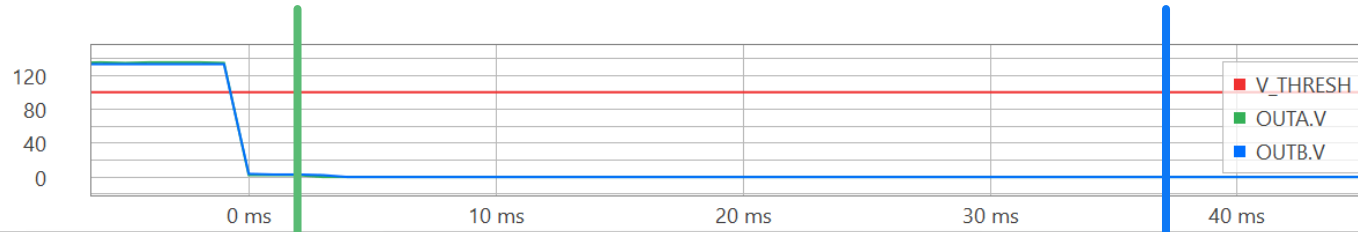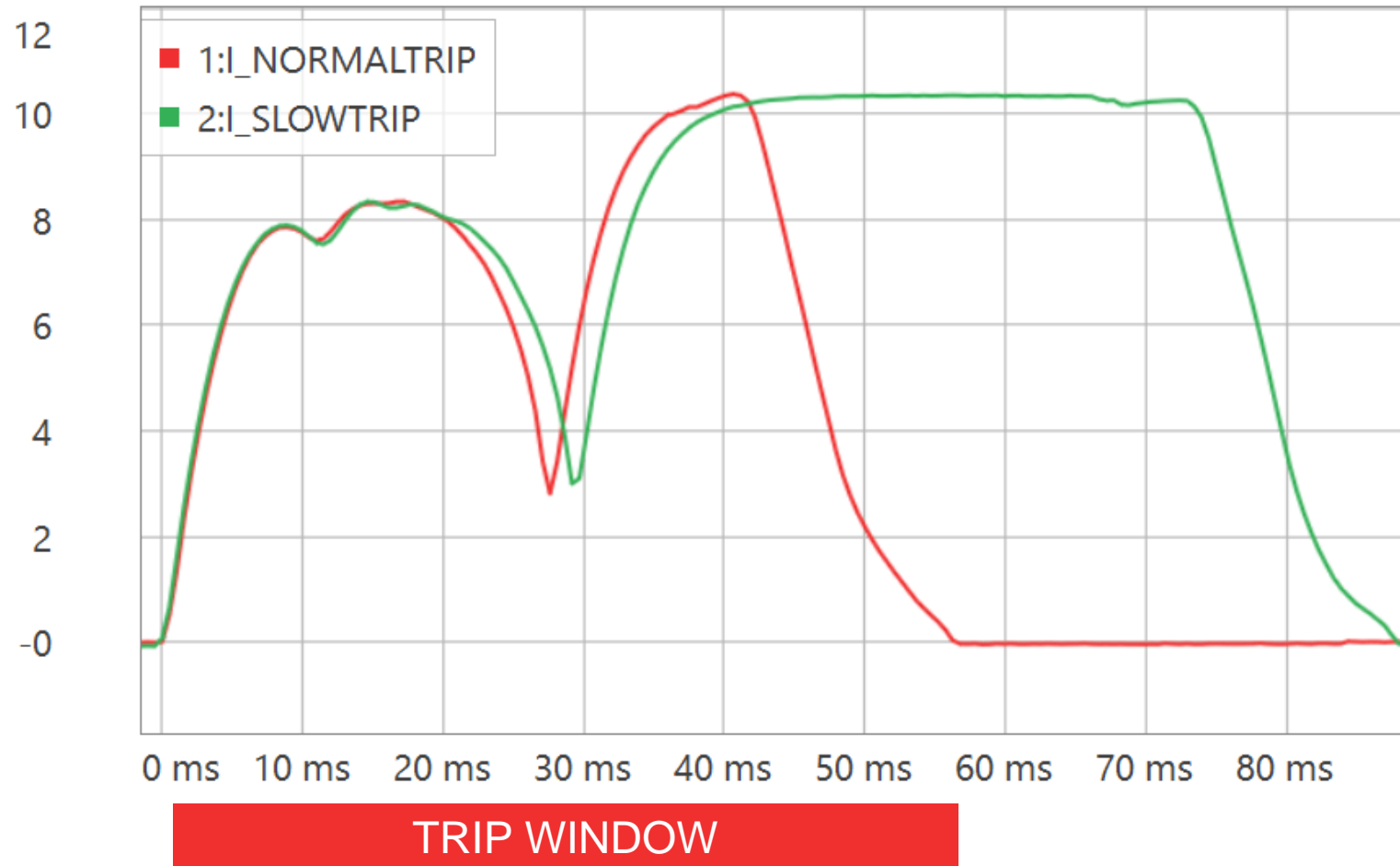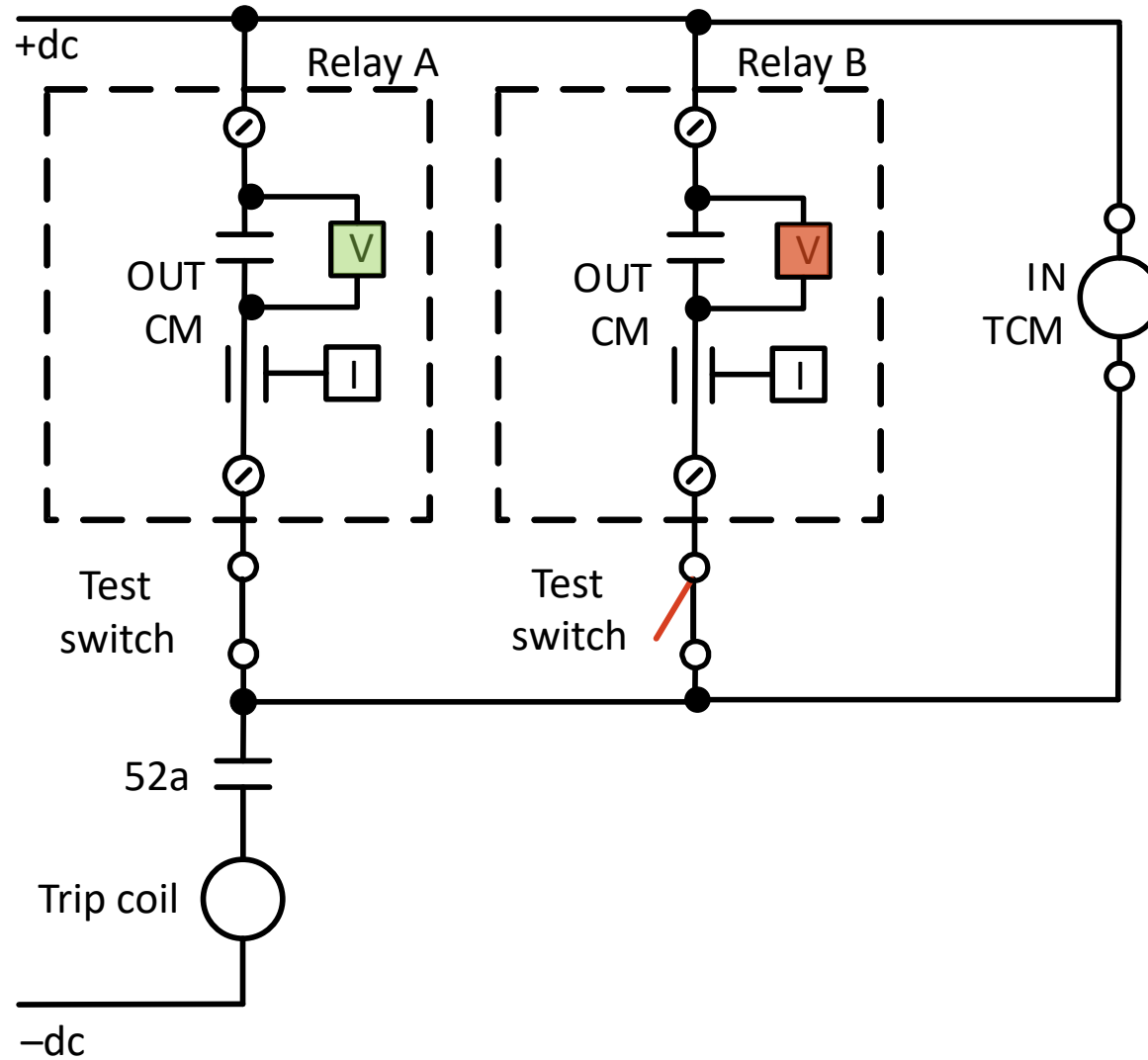# Output closes outside of trip window
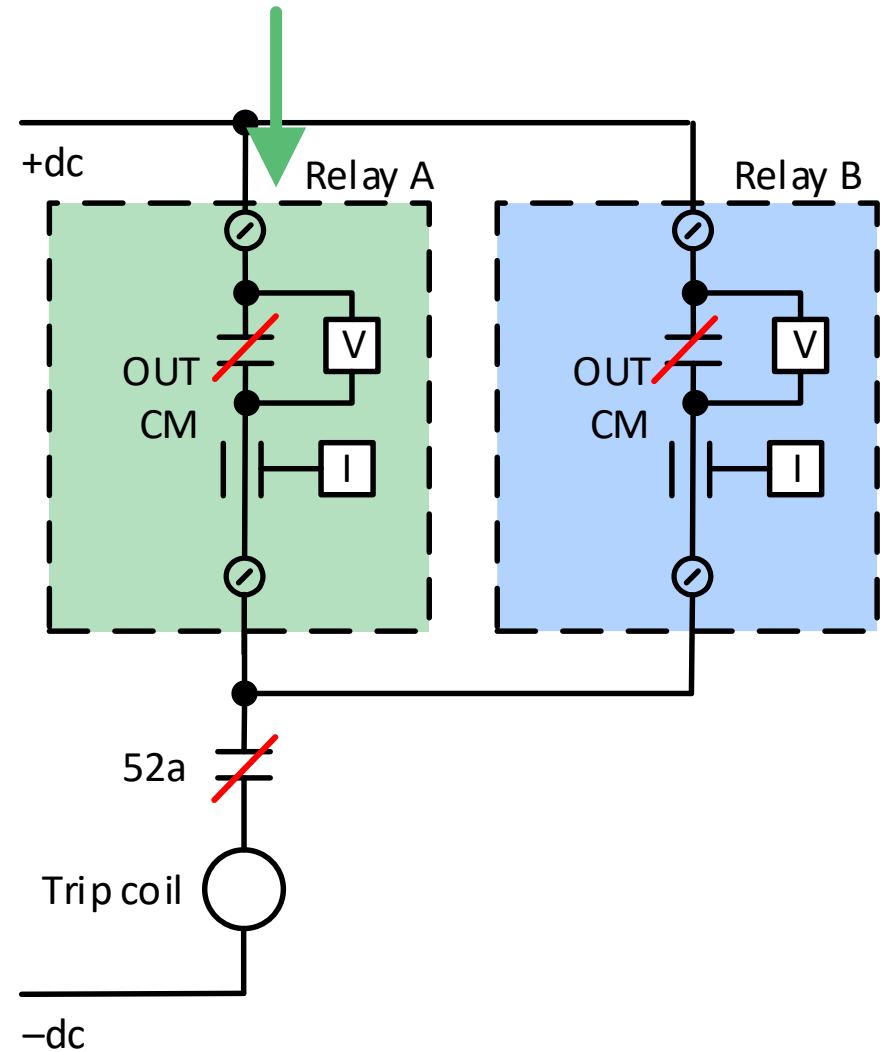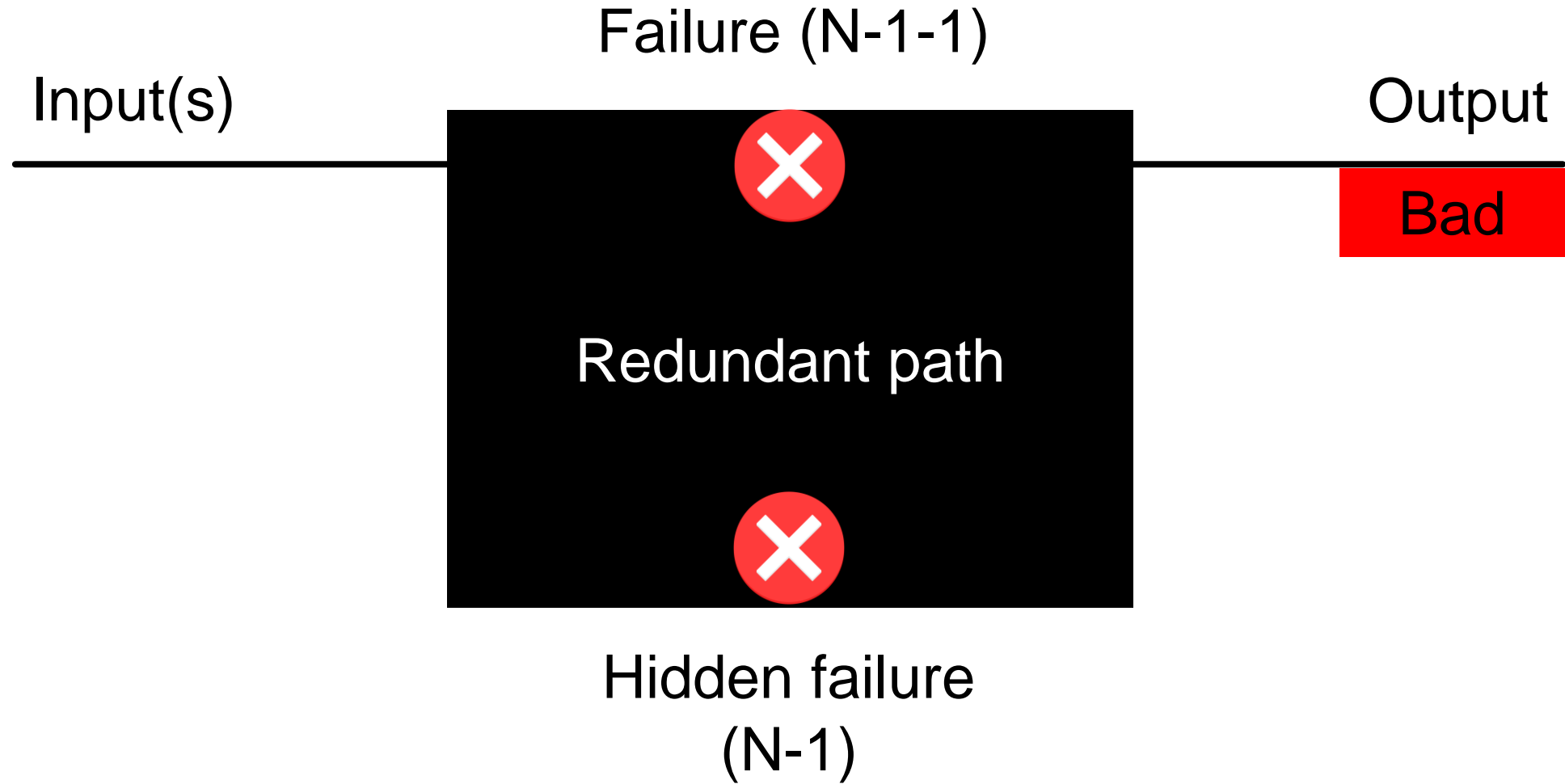
Both outputs declare success
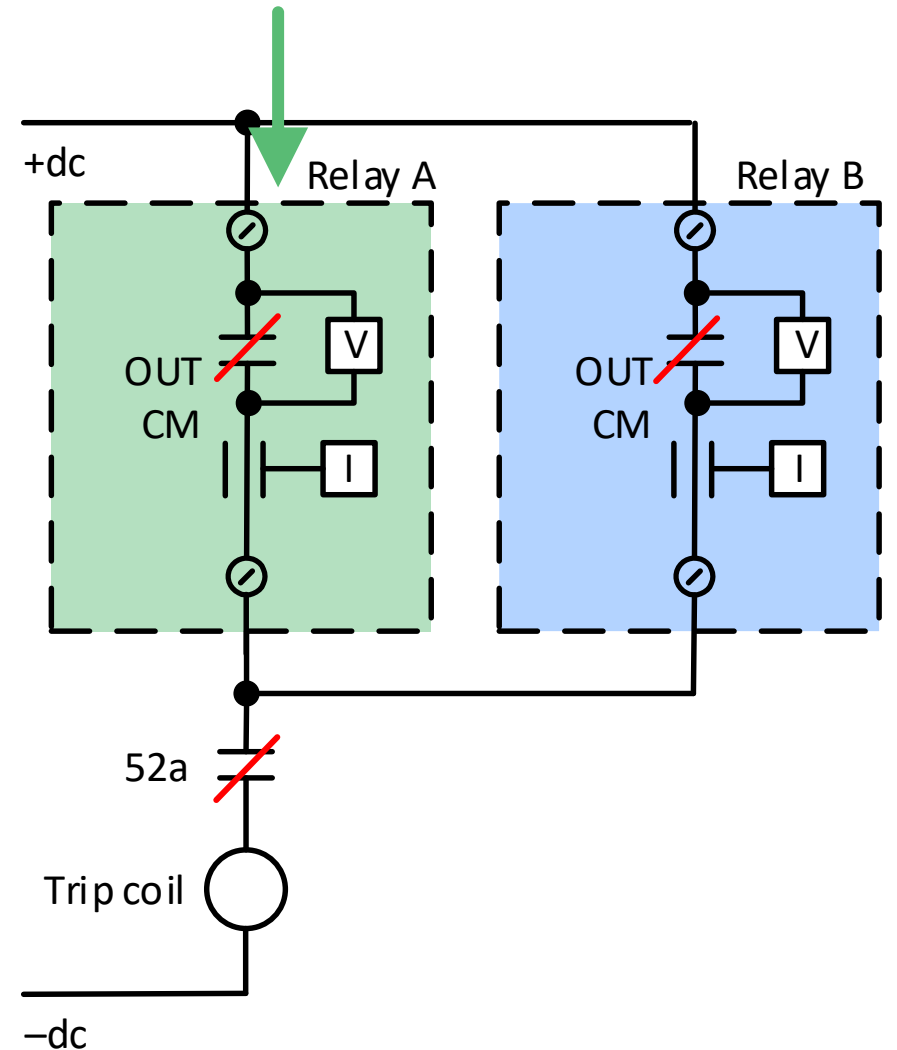
Slow breaker can indicate maintenance need

Trip circuit monitor is built in

What is a hidden failure?

Failure (N-1-1)

Input(s)

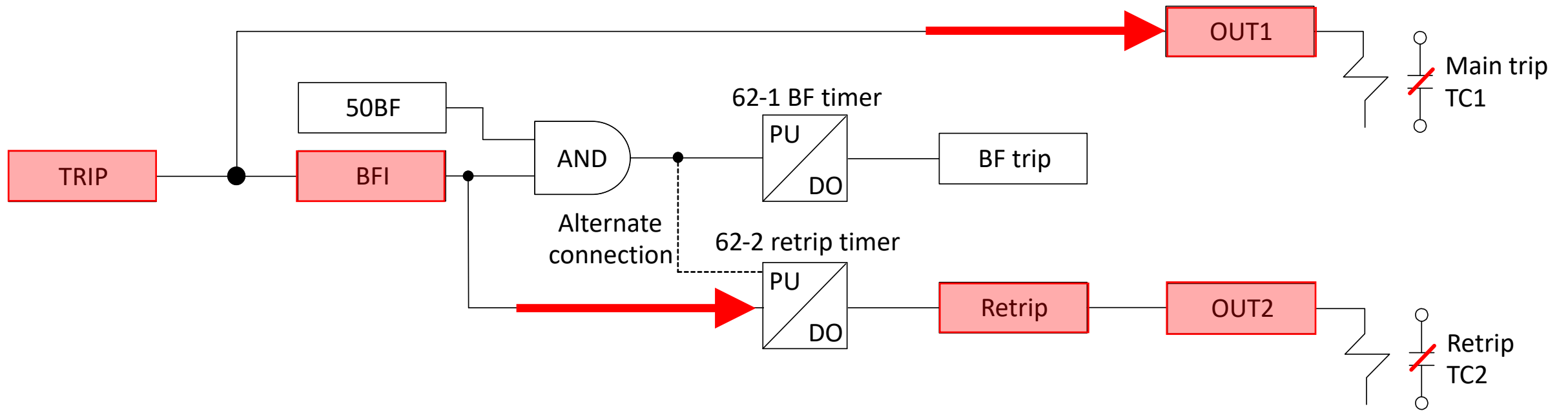Output

Bad

Redundant path

Hidden failure
(N-1)

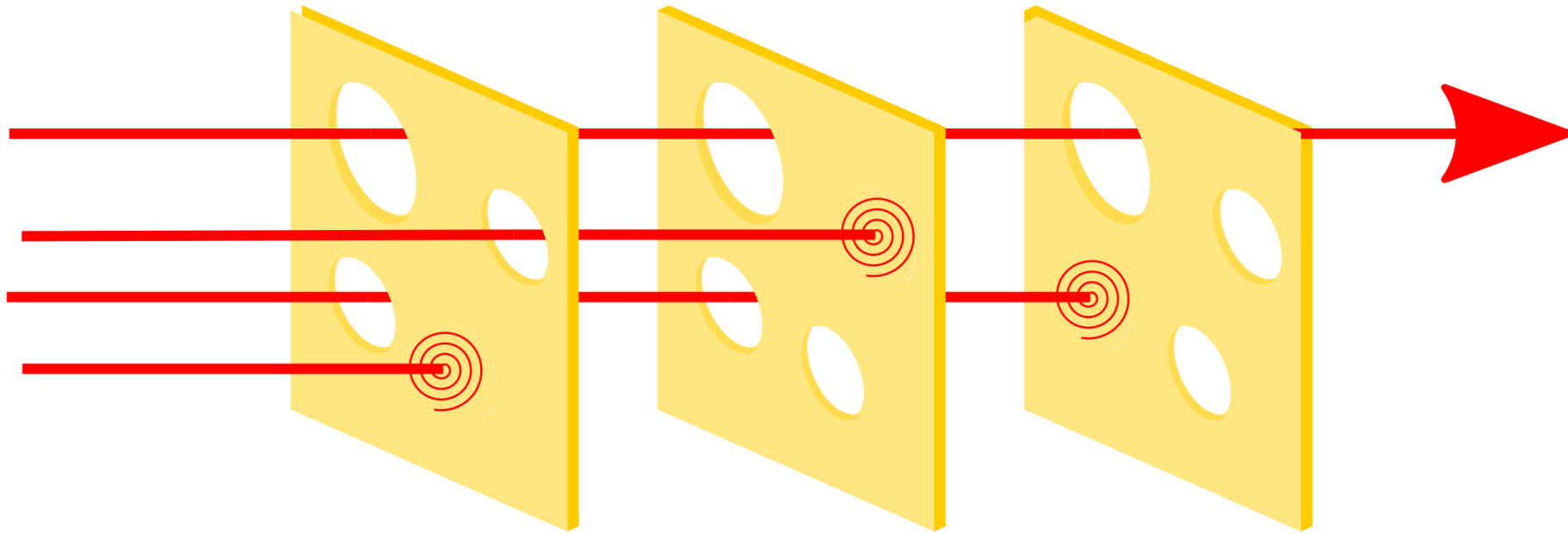# Hidden failures in cross-tripping scheme
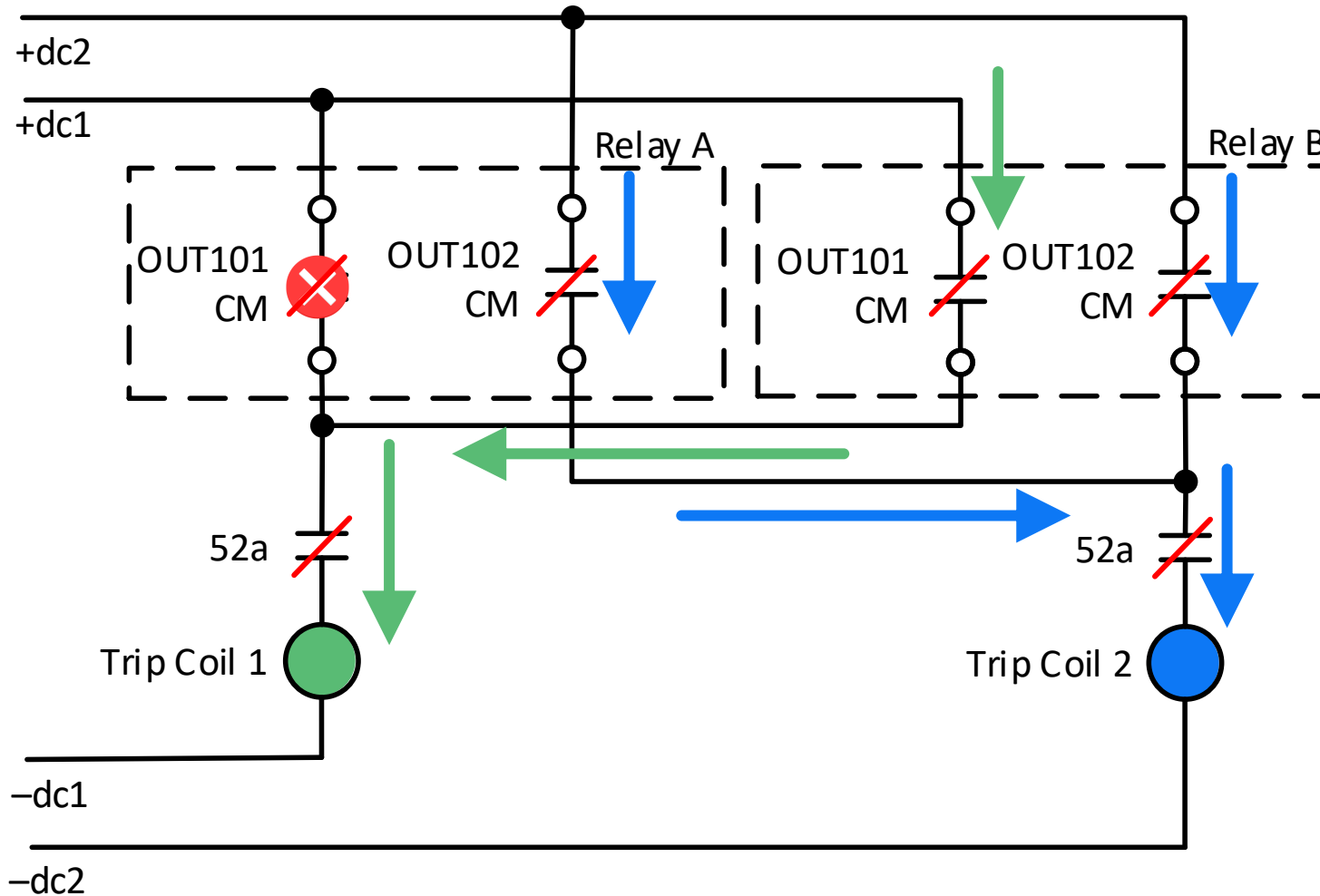
Which output trips the breaker?

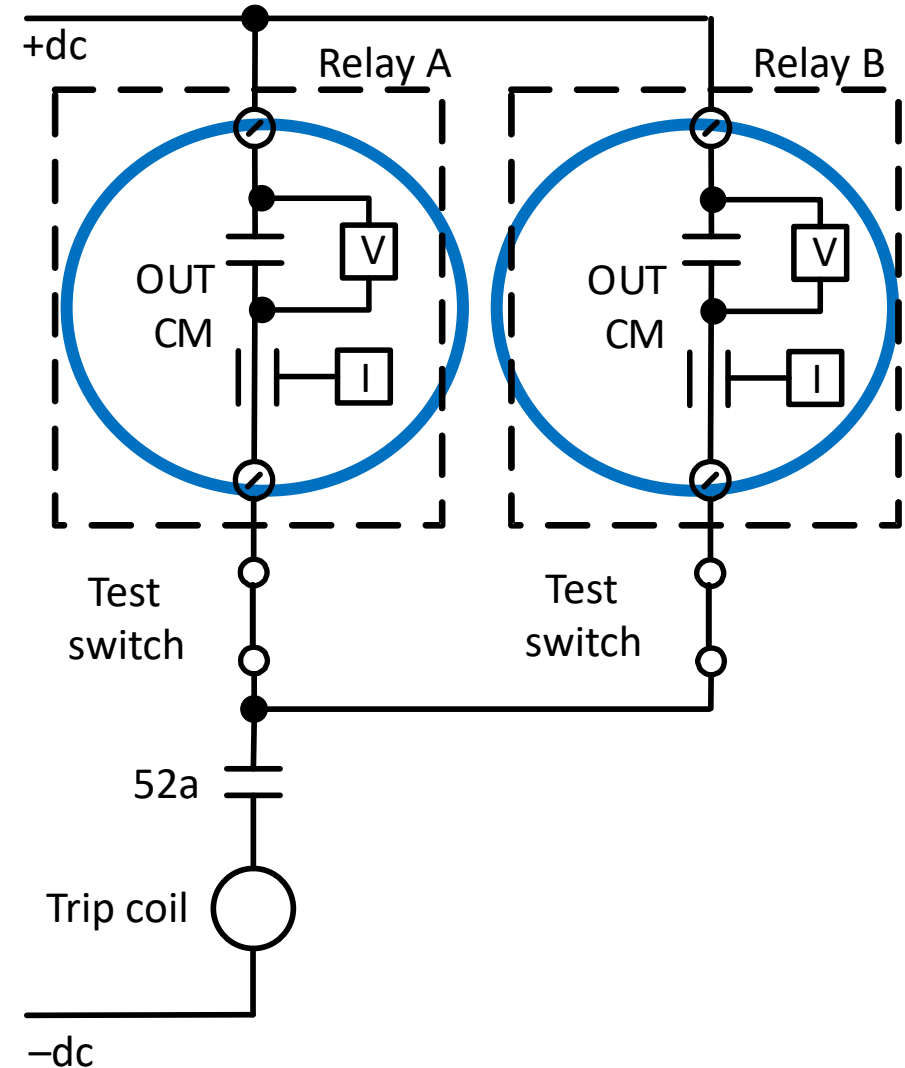# Hidden failures eventually line up

Conclusion

- Detects previously hidden failures
- Complements traditional TCM
- Provides missing data for critical trip circuits

Questions?