

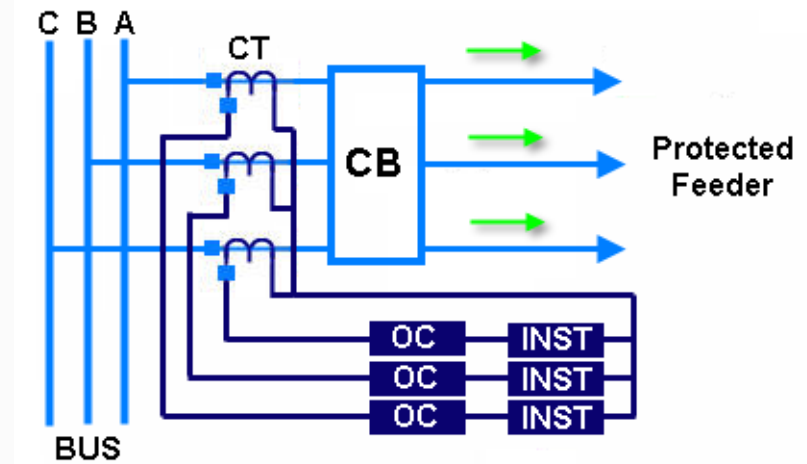
# **Why Testing Digital Relays Are Becoming So Difficult!**

## **Part 3**

### **Advanced Feeder Protection**

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*OMICRON electronics Corp USA*

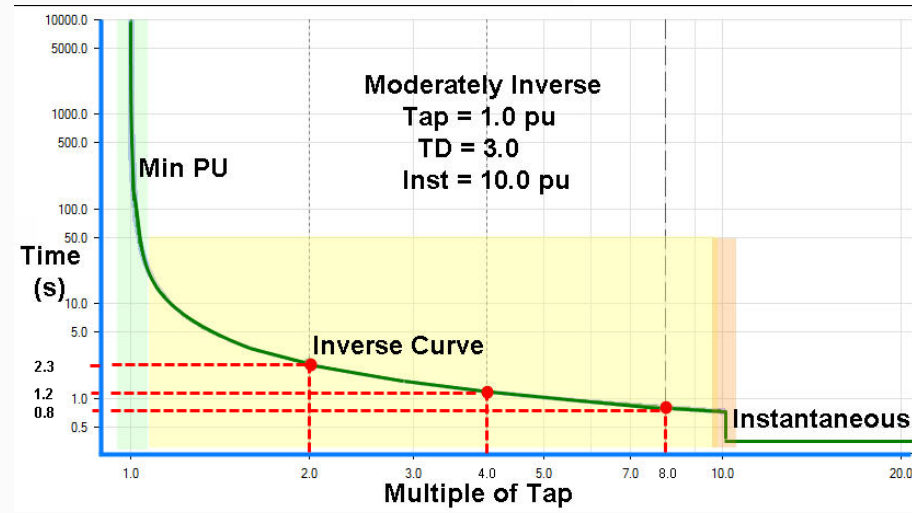
# Legacy Feeder Protection



- Discrete Overcurrent elements
  - Instantaneous, Inv Time, Per Phase
- Over/Under Voltage, Underfrequency
- Timers for base logic
  - Cold Load Pickup, Reclosing, etc.

# Legacy Test Techniques

- Visual Inspection
- Mechanical checks
- Single phase current injection
  - Step, Ramp
- Single phase voltage injection
  - Step, Ramp
- Verify timing and calibration



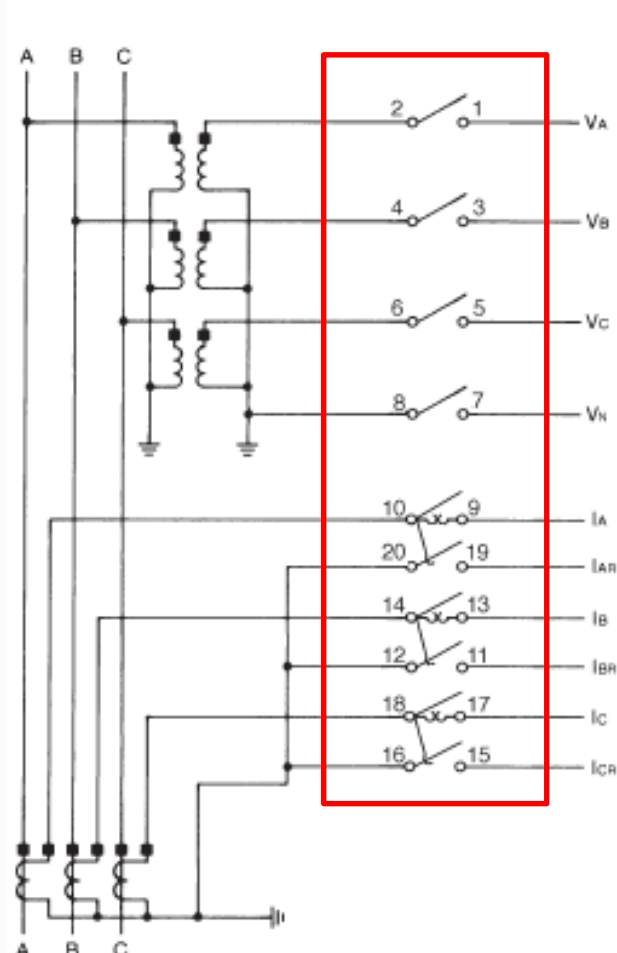
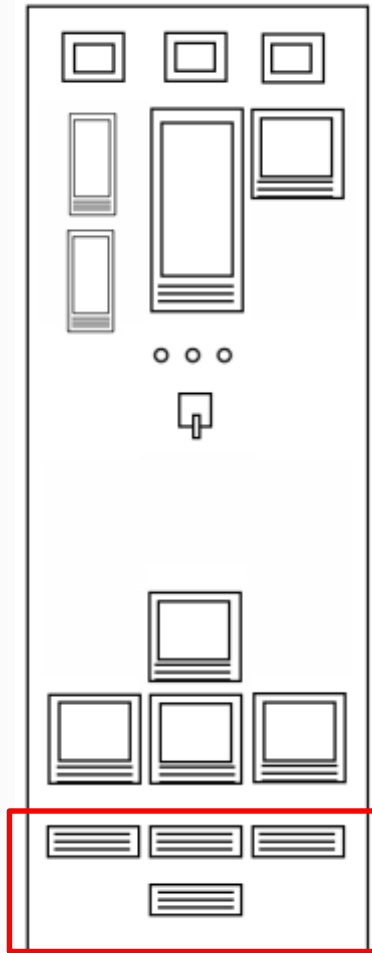
# Results for PU, Inv Time, Inst.

State	Type	Angle	Trip Value	Resolution	I Pick-up				I Drop-off
					nom	min	max	act	act
✓	A-N	n/a	2.0 In	50.0 ms	1.0 In	0.99 In	1.01 In	1.003 In	0.997 In

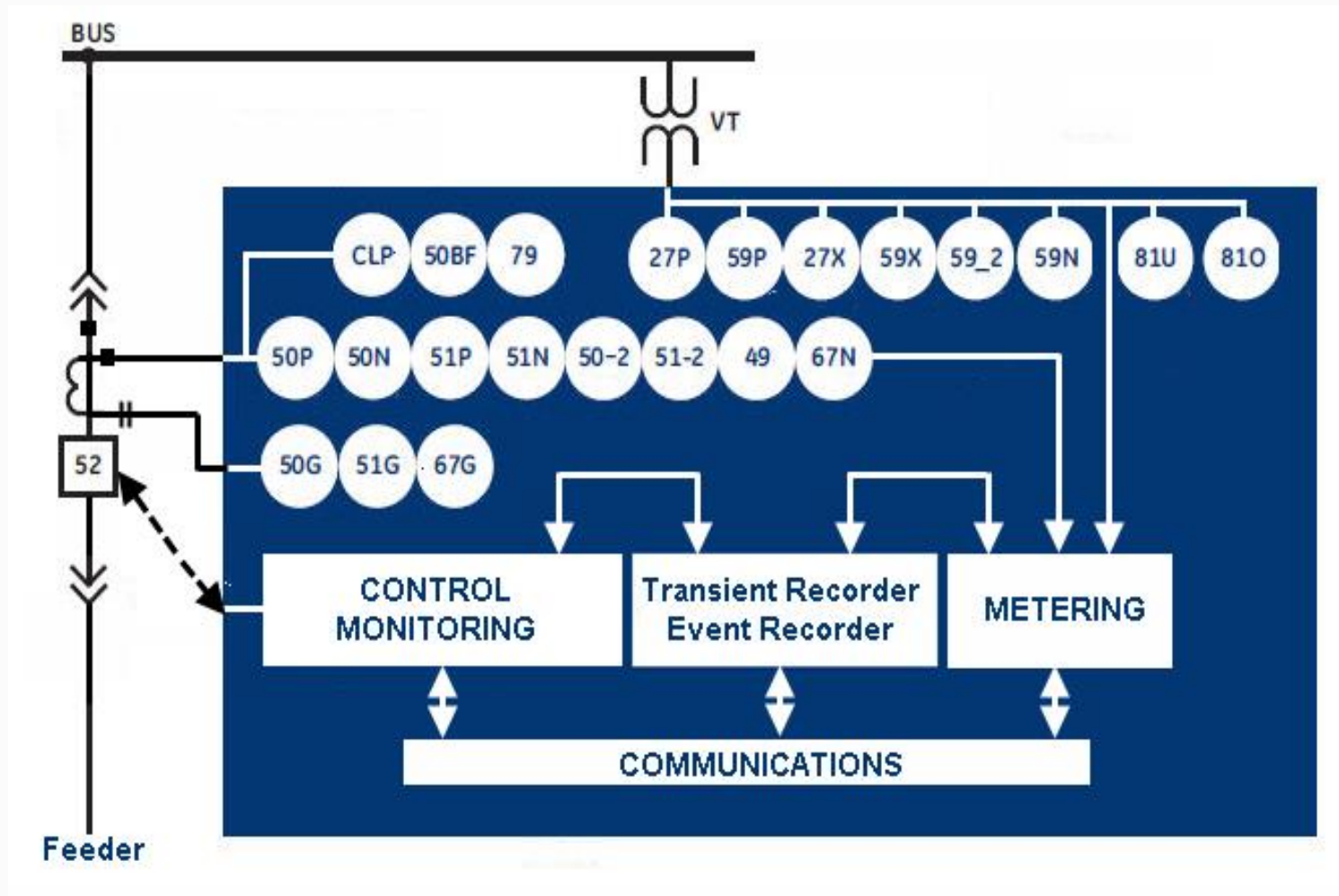
State	Type	Relative To	Factor	Magnitude	Angle	tnom	tmin	tmax	tact
✓	A-N	I #1 Phase	2.000	2.000 In	n/a	2.303 s	2.231 s	2.376 s	2.283 s
✓	A-N	I #1 Phase	4.000	4.000 In	n/a	1.178 s	1.130 s	1.226 s	1.198 s
✓	A-N	I #1 Phase	8.000	8.000 In	n/a	802.5 ms	758.9 ms	846.2 ms	782.5 ms

State	Type	Relative To	Factor	Magnitude	Angle	tnom	tmin	tmax	tact
✓	A-N	I #1 Phase	10.10	10.100 In	n/a	100.0 ms	60.00 ms	769.8 ms	120.0 ms

# Feeder Protection Evolution

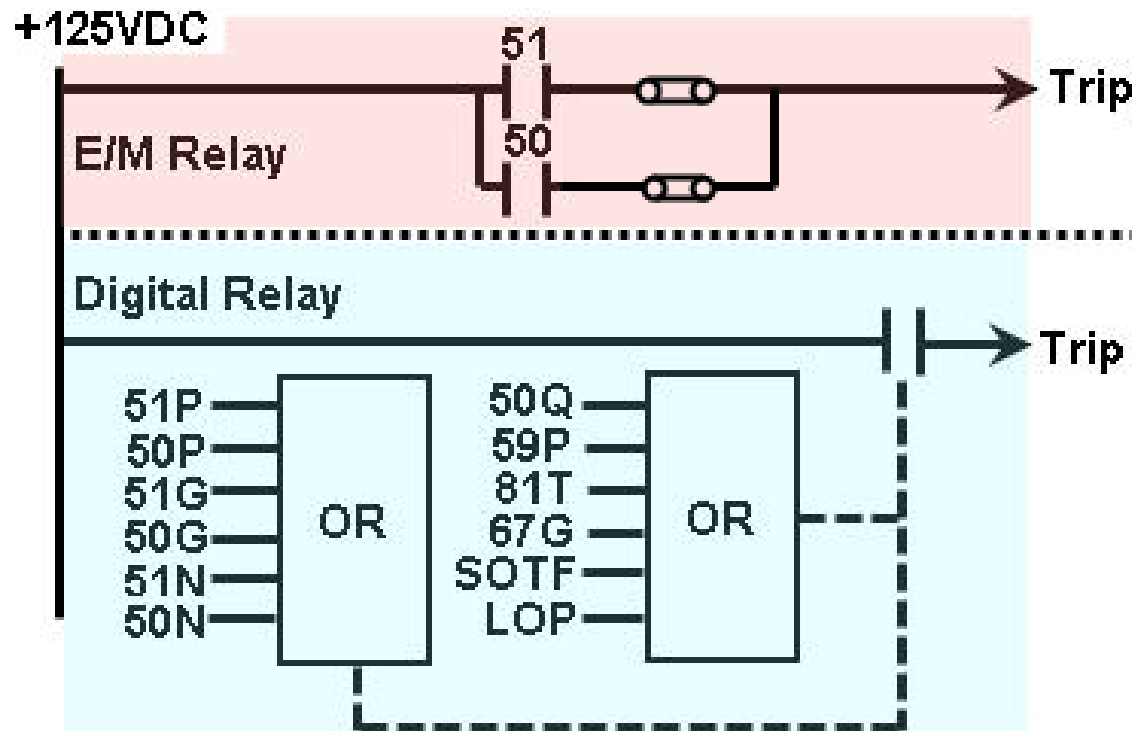


# Modern Feeder Protection



# Device Complexity = Test Complexity

## Tripping Element Comparison



# Using Proper Test Methods

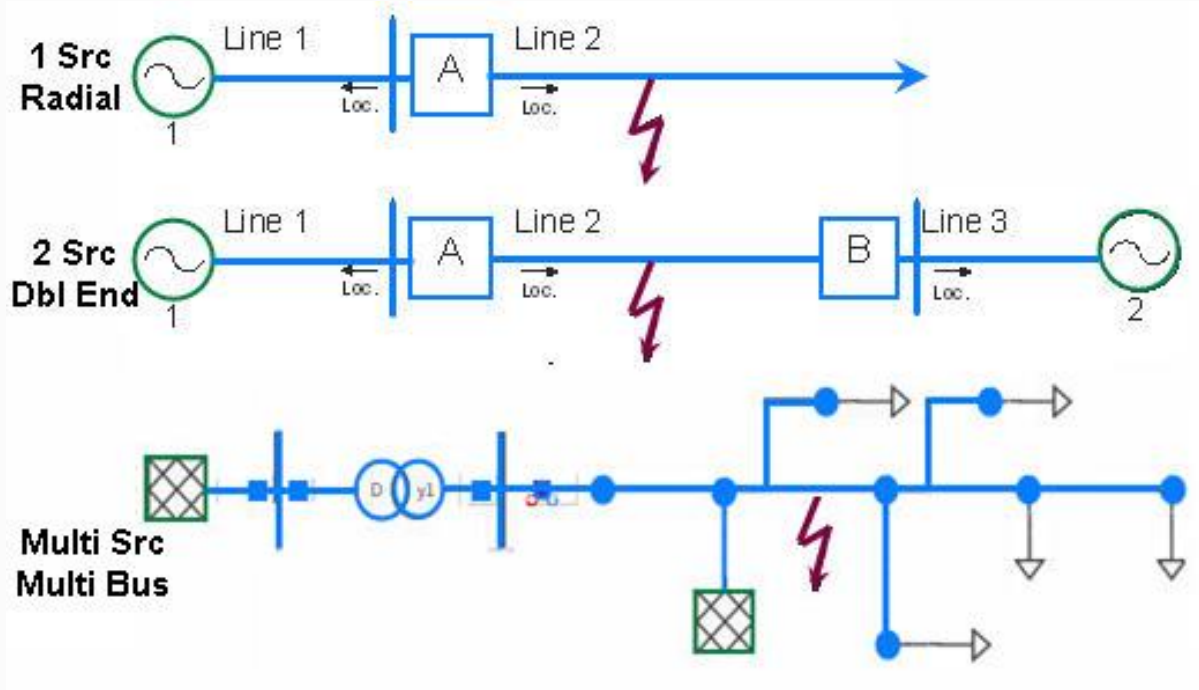
Avoid invasive tests that require rewiring or reprogramming; instead:

- Access wiring via test switches & safety isolation points;
- Verify voltage & current is accurately metered based on system configuration, settings, and application
- Utilize the Mfg's communication software / HMI for monitoring I/O and active element operation
- Modern test kits used as a power system simulator perform "system tests", based on the application
- Correct test cases verify all settings, logic schemes, & interlocking, with no reprogramming
- Verify Settings to source, verify logs & reports, & alarms

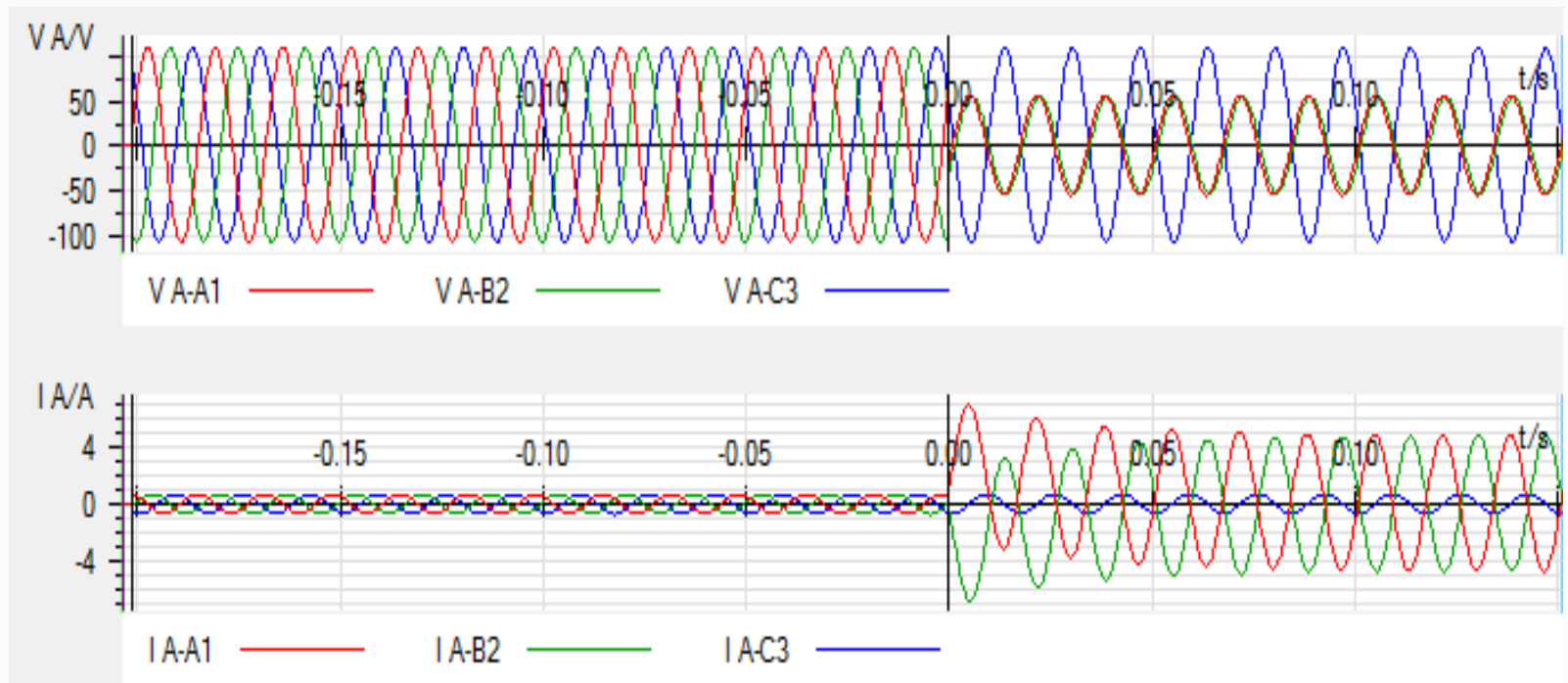


# Using Proper Test Methods

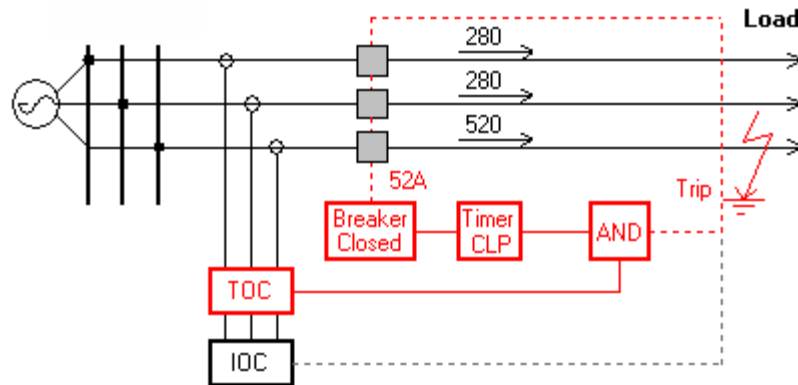
## System Models in Test Software



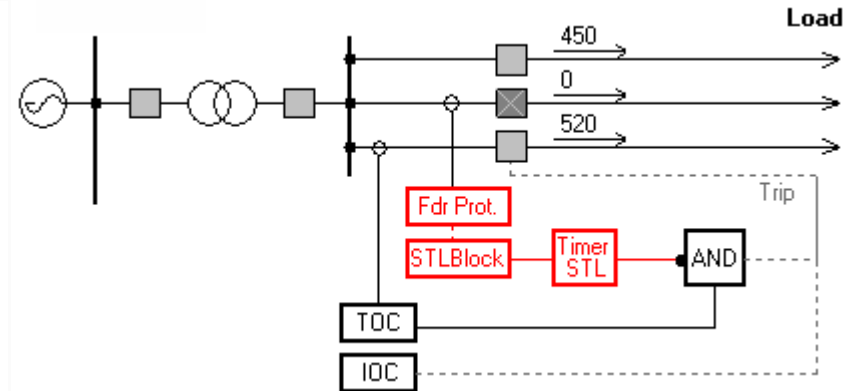
# Proper Test Methods Simplify Tests



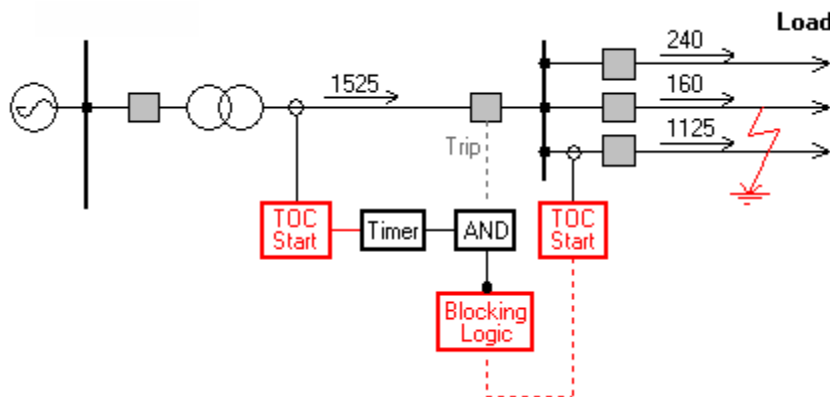
# Proper Test Methods Simplify Tests



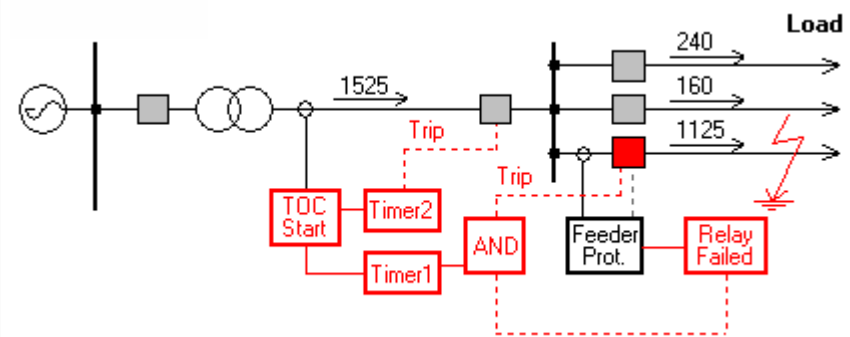
Cold Load Pickup



Sympathetic Trip logic



Bus Protection (Incomer)



Backup Selective Trip

# Benefits of System Test Approach

A system test approach reveals the true coordination of today's feeder protection schemes; benefits are:

- Proper simulation requires all scheme logic AND protection elements to work together correctly.
- Number of overall tests can be reduced significantly
- Reduce overall testing time
- Lower risk of human error leading to a misoperation
- Greater probability of finding logic scheme errors
- Establishes a performance baseline

The same efficiencies realized in HV Line Protection End to End testing can be realized for today's modern feeder protection, Distribution Automation, and Distributed Generation applications.

# Conclusions

- As digital relays continue to evolve and become more complex, our methods for testing them must also evolve.
- Legacy test methods will never properly quantify the health, status, availability, operational performance or compliance.
- Education, training, proper testing tools, and power system knowledge are required in order to verify today's modern feeder protection devices.

# QUESTIONS?