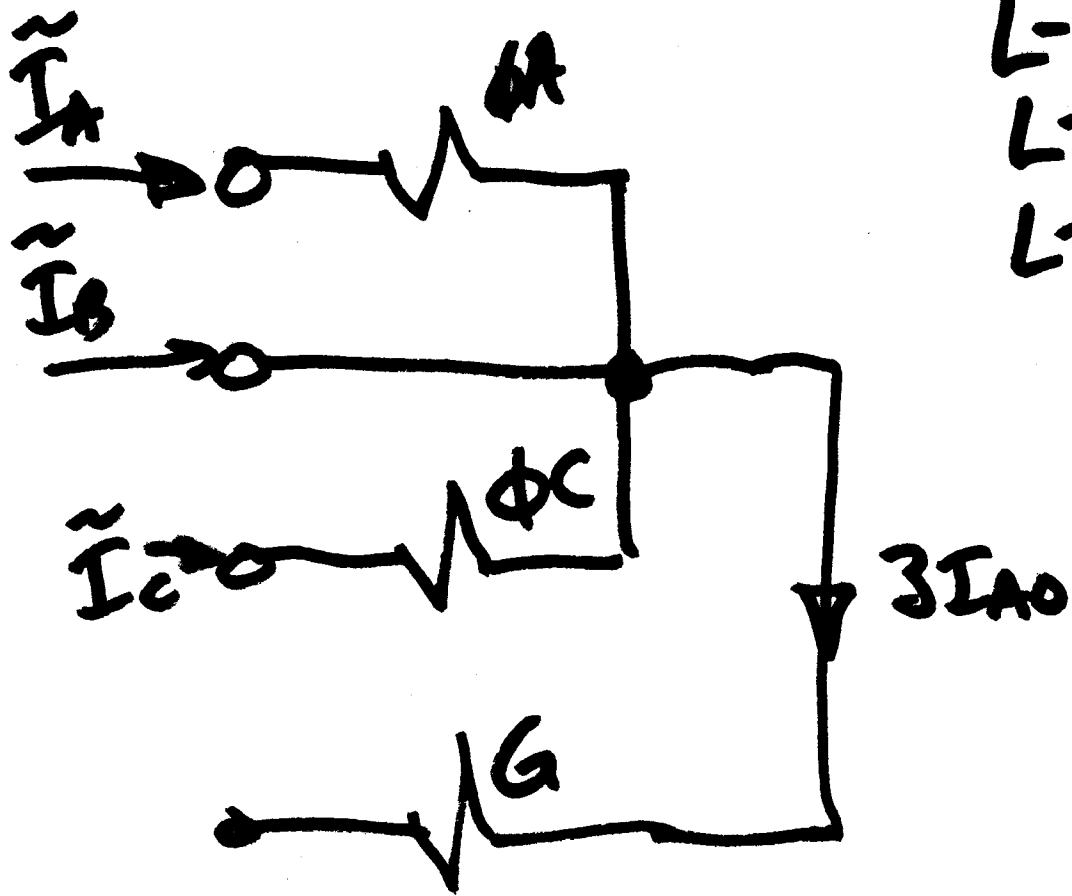


Ongoing List of Topics:

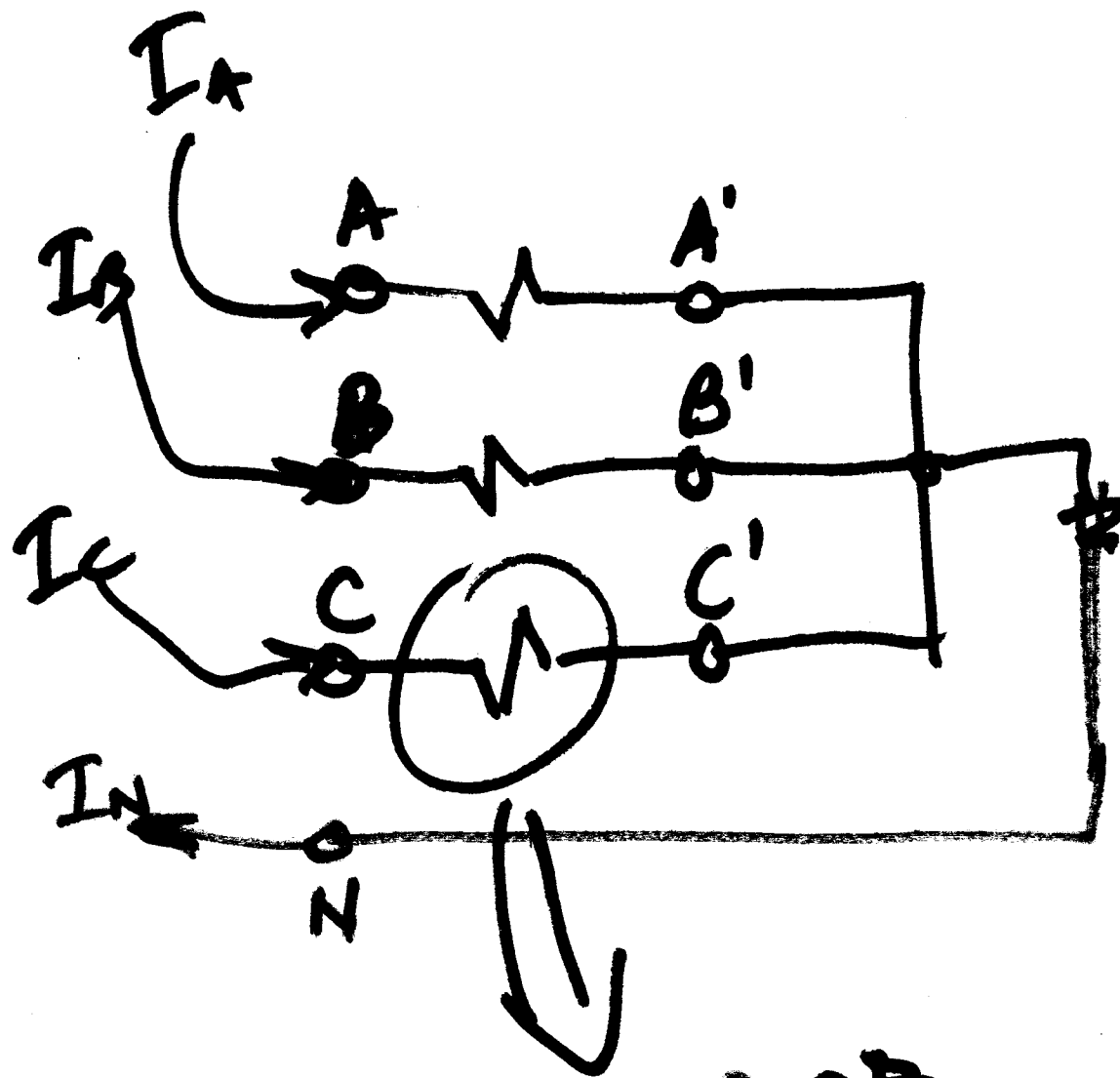
- URL: <https://pages.mtu.edu/~bamork/EE5223/index.htm>
- Labs - EE5224 Lab 2 - begins on Wed Feb 10th
- Term Project - Propose 3 possible topics after WC.
- Exercises posted

Today:

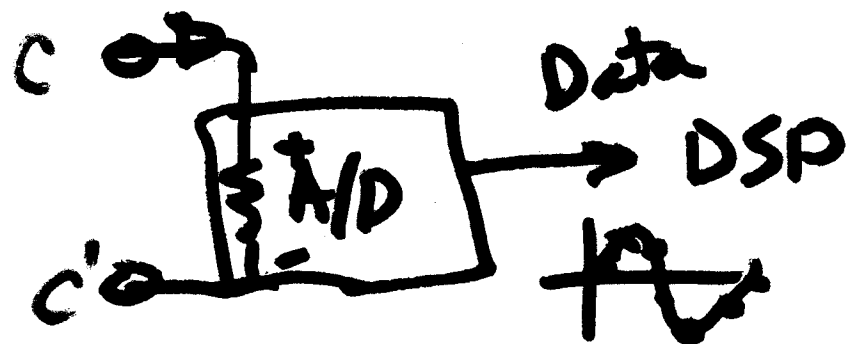
- Reclosing - radial vs. grid system
- Short circuit protection in grid systems
 - Directional overcurrent
 - Impedance
- Voltage & Current relationships during faults, §3.5-3.10
 - X/R ratio, dc offset, decay of dc offset
 - Relative angles and magnitudes of all Vs & Is during fault
- Basic connections of directional overcurrent (67) relays.
 - Phase relays - each line current is polarized with V_{LL} from other phases.
 - Ground relay - residual current ($3I_{ao}$) polarized with $V_{\text{broken delta}}$ ($3V_{ao}$)
- Excellent Illustrations: figures 3.7 thru 3.10



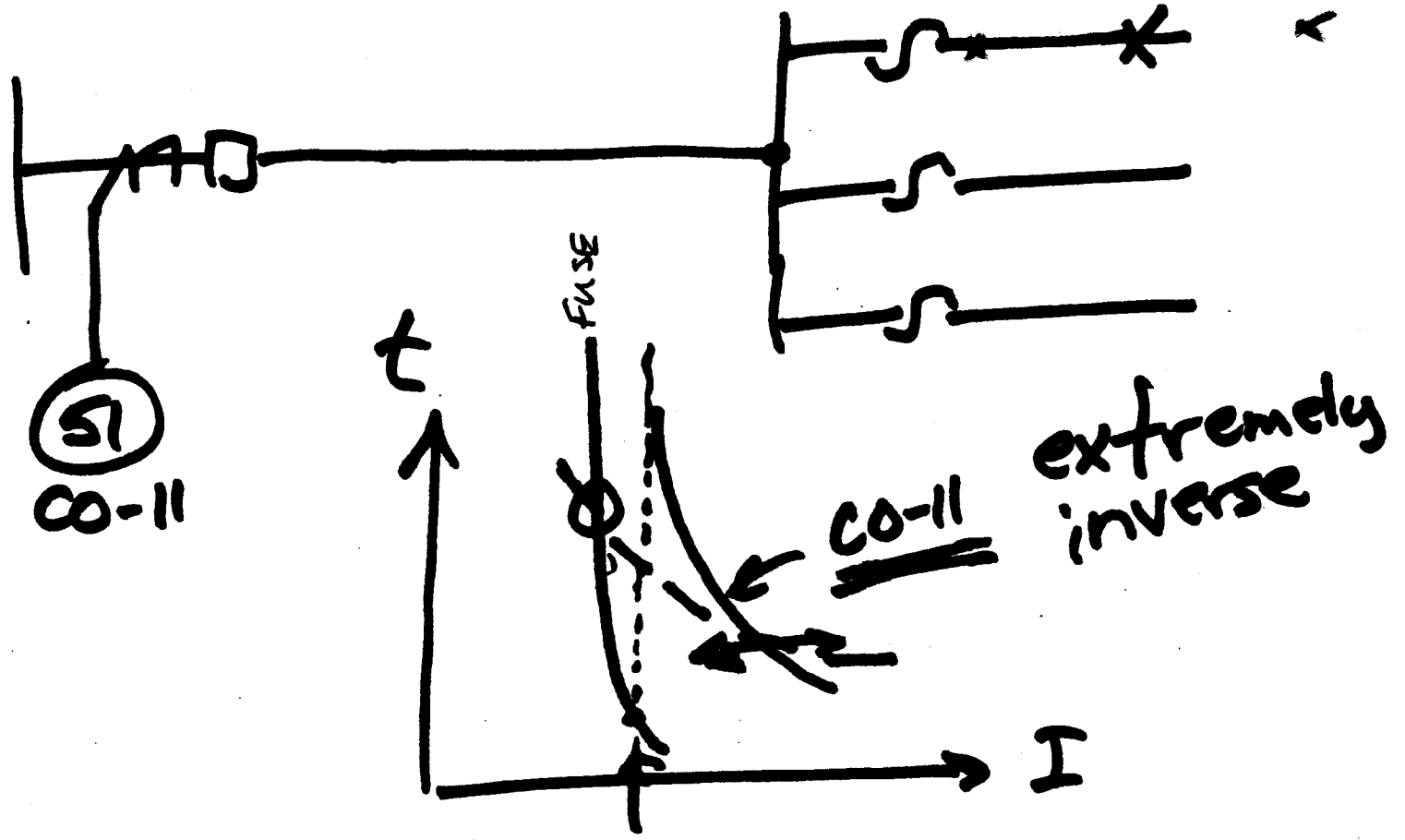
$3\phi \sim$
 $L-L \sim$
 $L-L-G$
 $L-G$

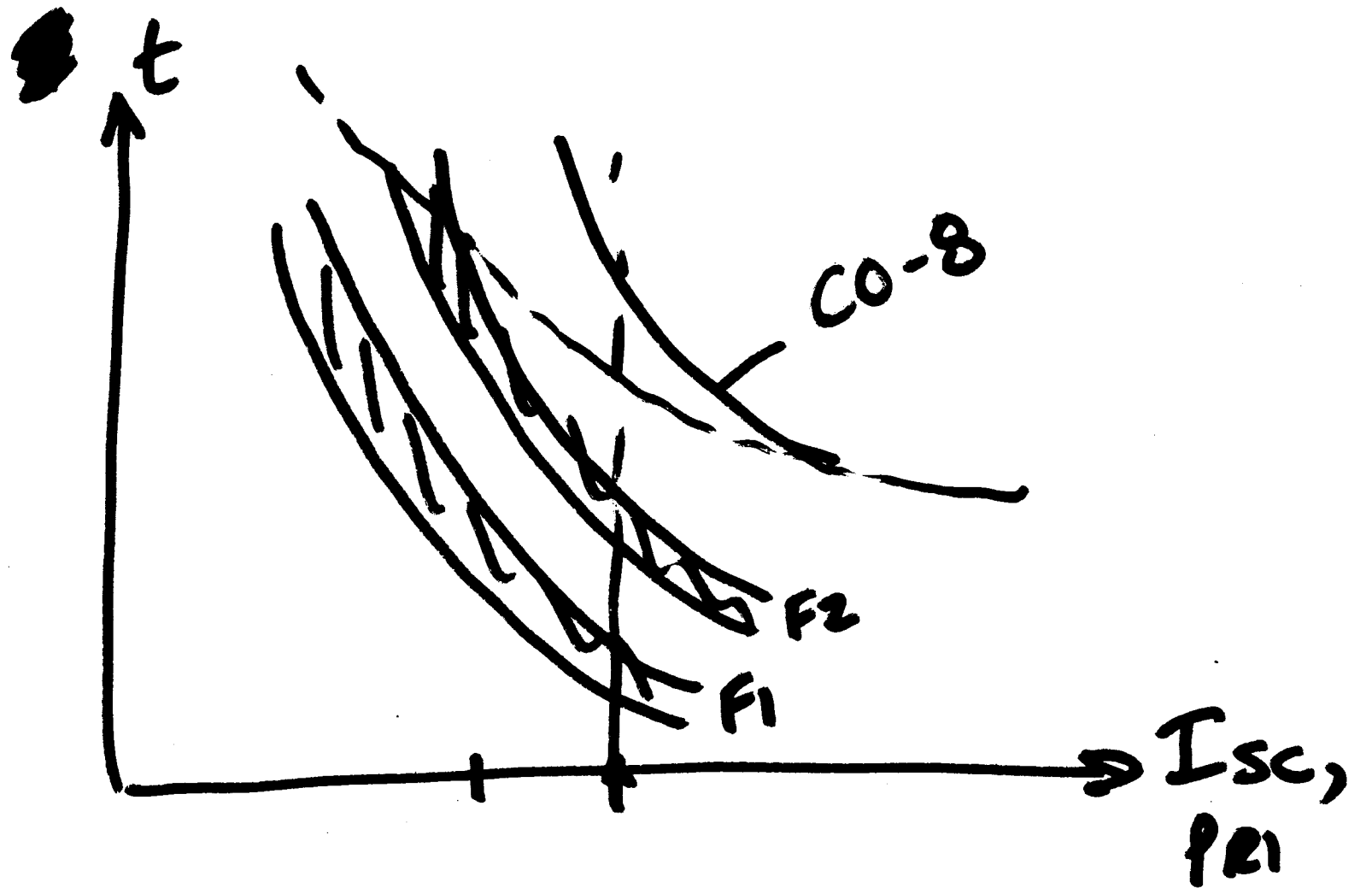


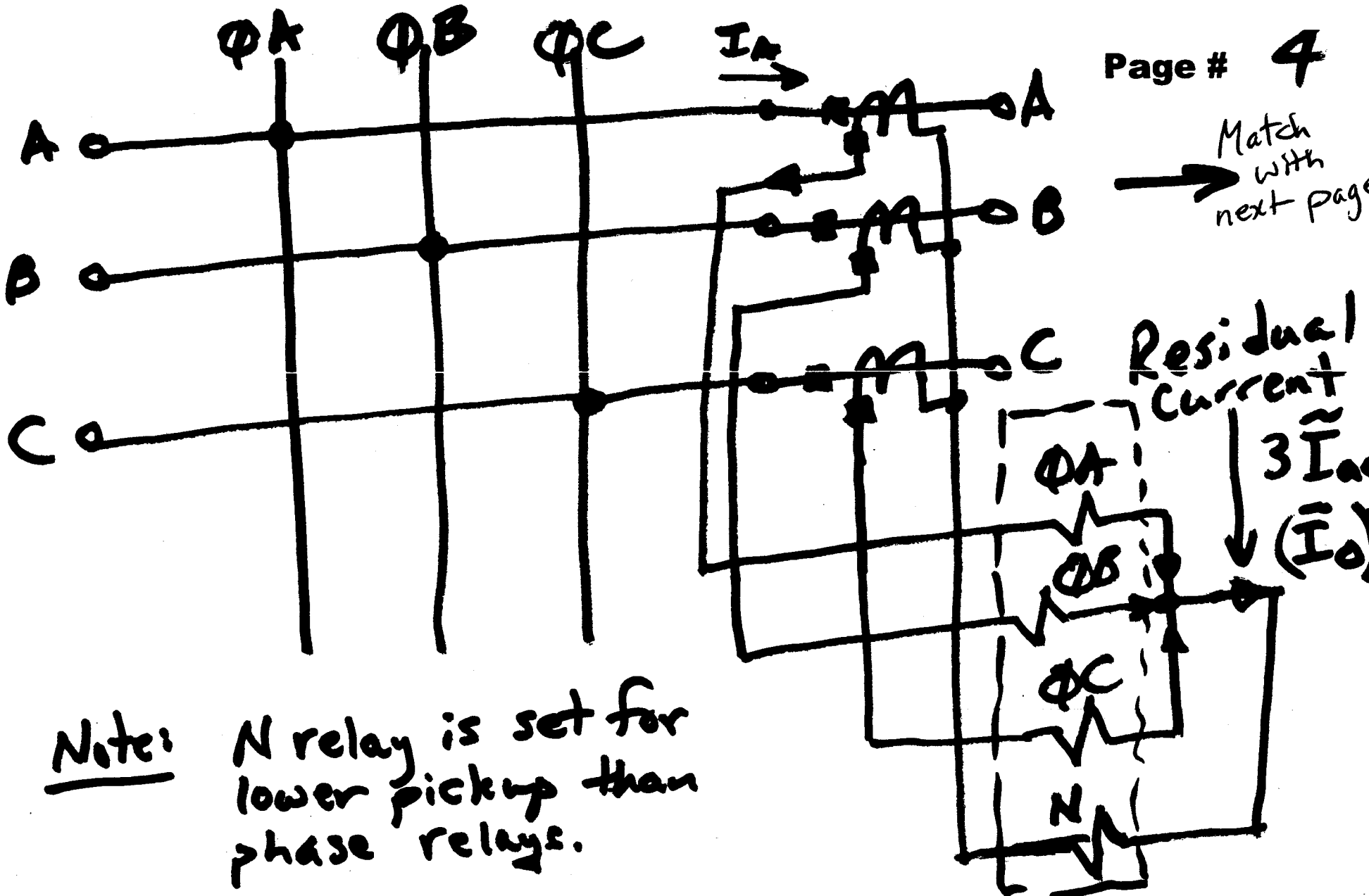
$$\underline{\underline{3\tilde{I}_{A0}}} = \tilde{I}_A + \tilde{I}_B + \tilde{I}_C$$



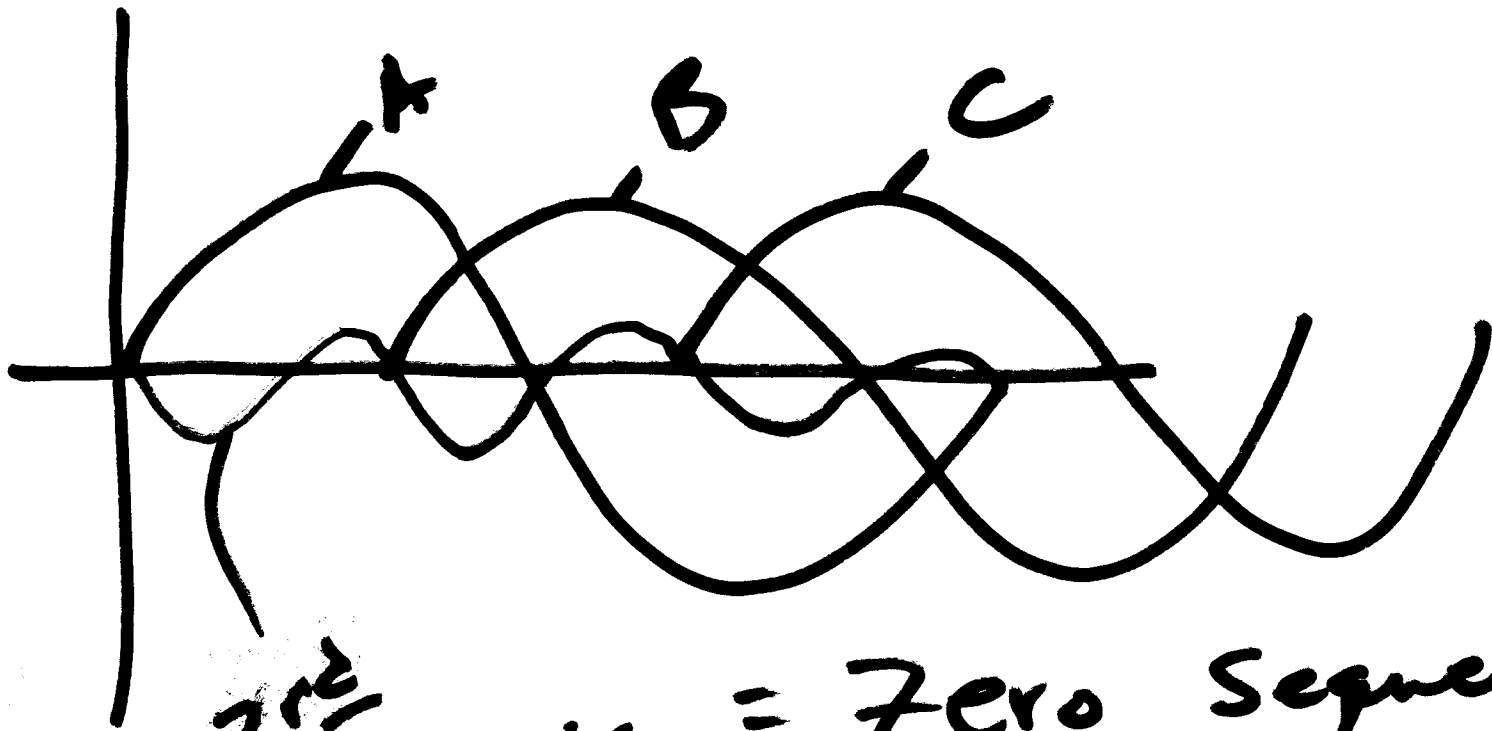
Coordination of Fuses w/relays





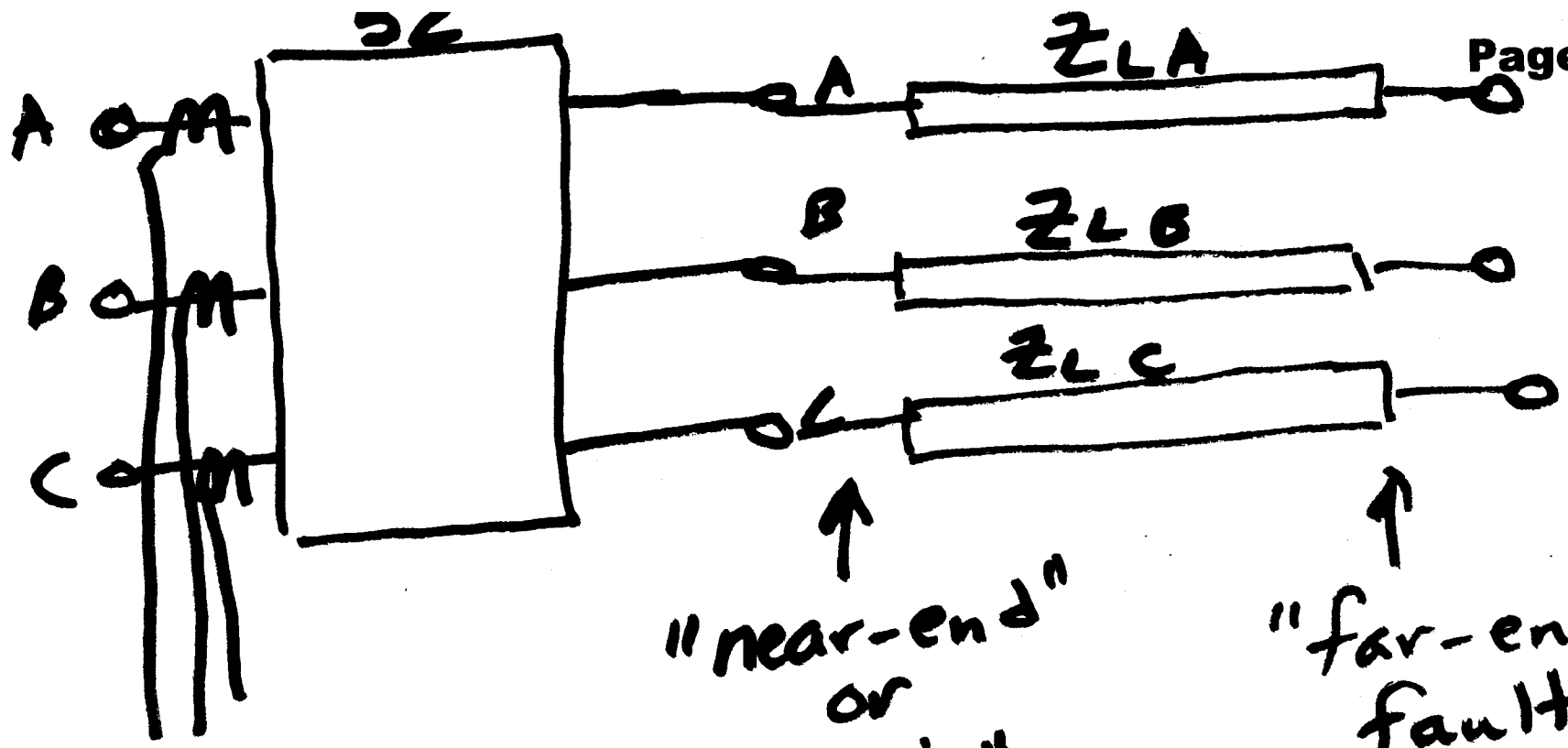


Note: N relay is set for lower pickup than phase relays.



3rd Harmonic = Zero Sequence

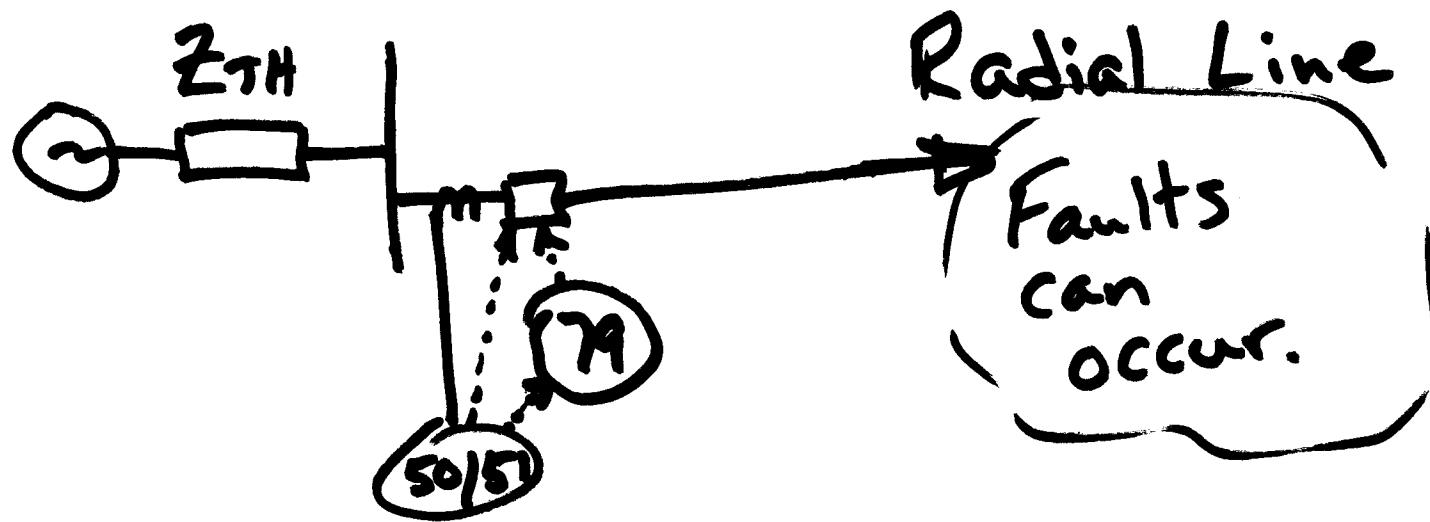
Harm	POS	NEG	ZERO
3 rd , 6 th , 9 th ...			x ← "Tri-plen"
2 nd , 5 th , 7 th		x	
1 st , 4 th , 8 th	x		



"near-end"
or
"close-in"
fault

"far-end"
fault

Types of Faults - - 3-Phase, 3-Phase-G
 - L-L }
 - L-L-G } (LG)
 } (ZF)



Reclosing:

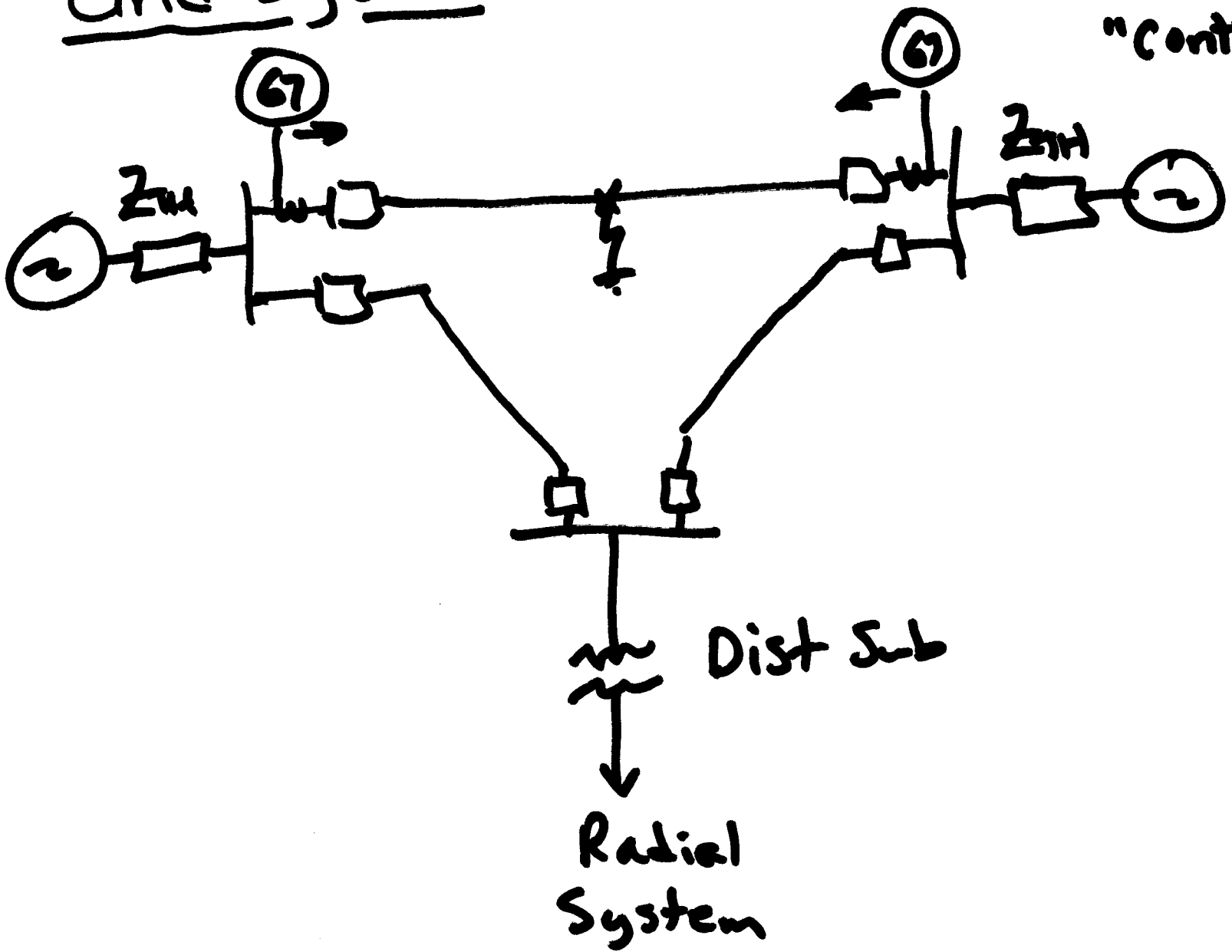
- Trip for fault
- Wait
- Reclose (79)

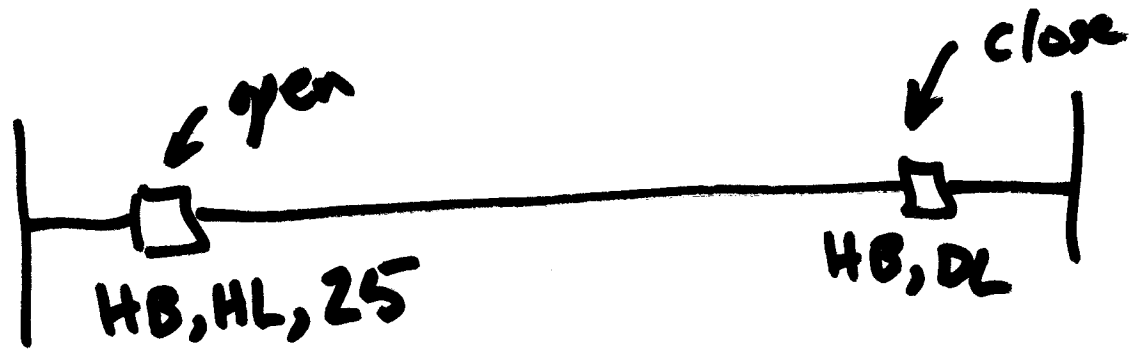
Conditions to check for:

~ NONE

Grid System:

"N-1"
"Contingency"

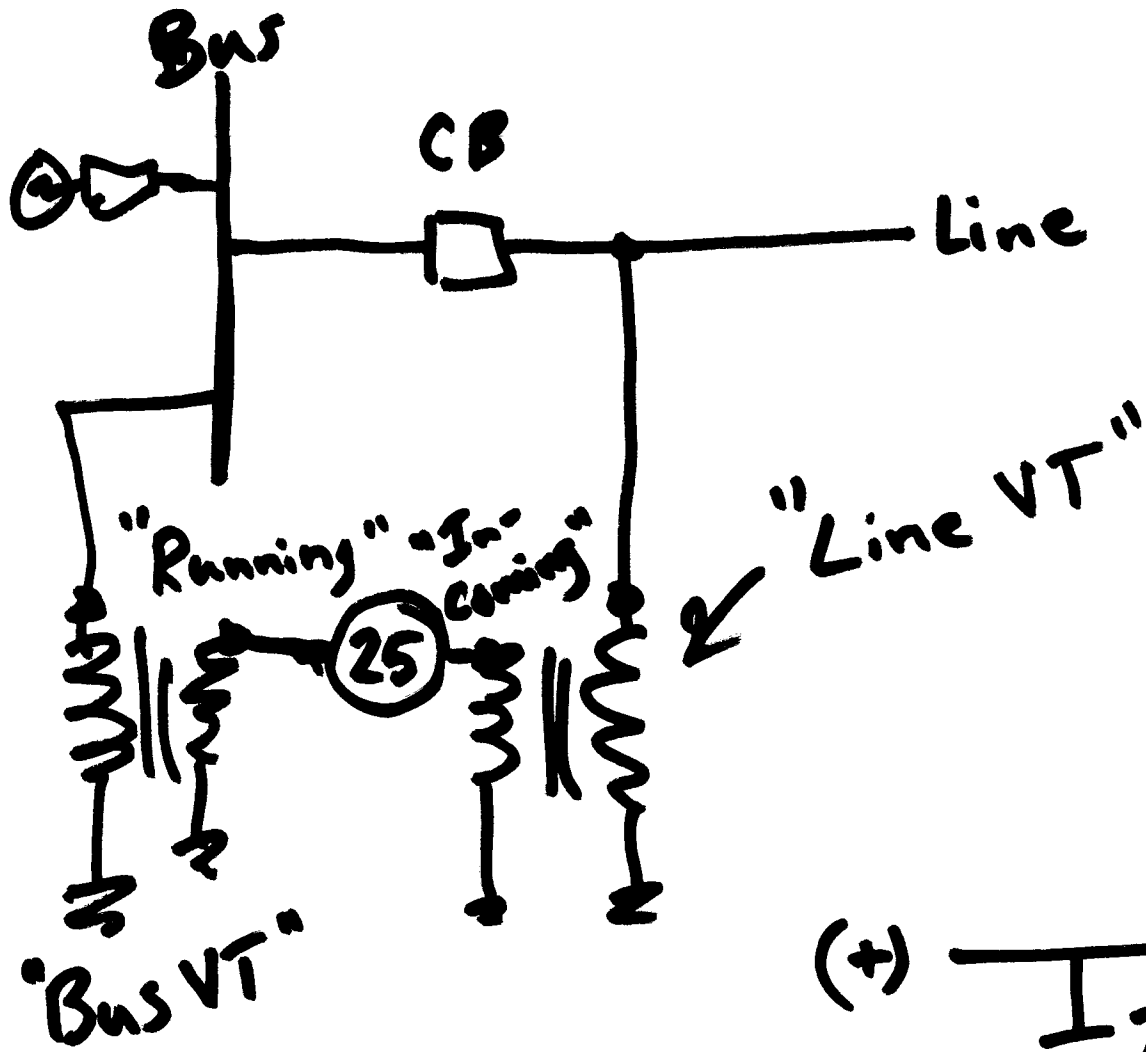




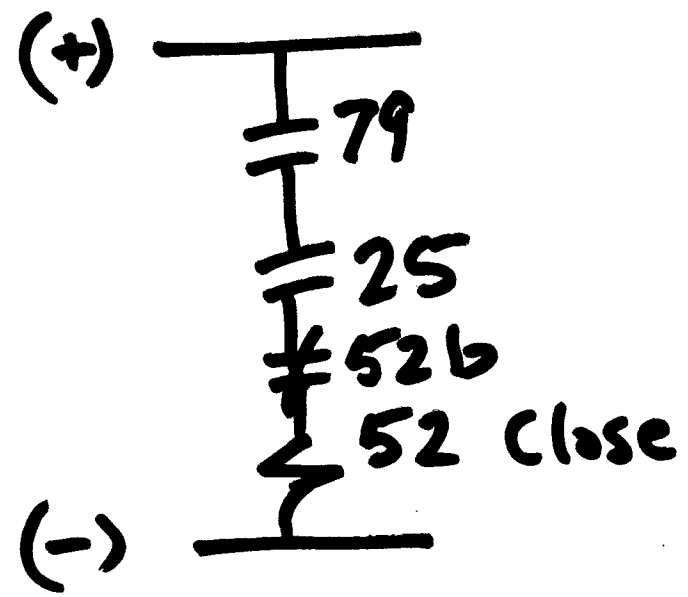
- Standing voltage angle between 2 ends

Reclose strategy:

- 1) Reclose CB at one end. Line is reenergized. Leave other CB open for the moment.
- 2) Check voltages across 2nd CB. Close if within acceptable range. This depends on line & util, usually $< 40^\circ$ or $< 45^\circ$.



- HOT BUS
- Dead Bus
- Hot Line
- Dead Line





SEL-351S Protection and Breaker Control Relay

Optimize Distribution Protection, Automation, and Breaker Control



Apply the SEL-351S Relay to enhance your service quality through integrated protection, monitoring, and control.

Features and Benefits

■ Overcurrent Protection

Protect lines and equipment using a sensitive and secure mix of phase, negative-sequence, and ground overcurrent elements. Use directional control elements in looped systems. Provide high-speed operation, even with severe CT saturation, using SEL Adaptive Overcurrent Element. Apply "recloser" time-overcurrent curves for coordination with and sequencing of downstream reclosers.

■ Operator Controls and Reclosing

Use direct-action operator controls to eliminate the need for expensive, panel-mounted control switches and associated wiring. Integrate automation elements, including remote, local, and latch switches, plus display points, for remote and local control. Selectively reclose with synchronism and voltage checks.

■ Relay and Logic Settings Software

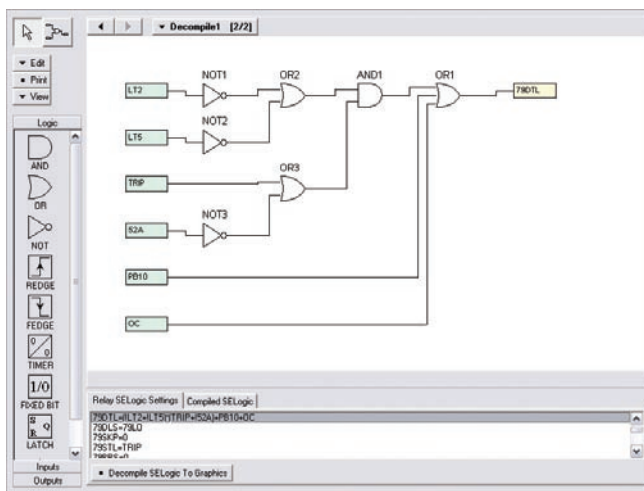
Use acSELERATOR® QuickSet™ SEL-5030 Software to reduce engineering costs for relay settings and logic programming. Use graphical tools included with acSELERATOR to develop SELoGic® control equations.

■ Accurate Metering and Monitoring

Use built-in, high-accuracy metering functions to eliminate expensive, separately mounted metering devices. Improve maintenance scheduling using circuit breaker contact wear and substation battery voltage monitors.

■ Sequential Events Report

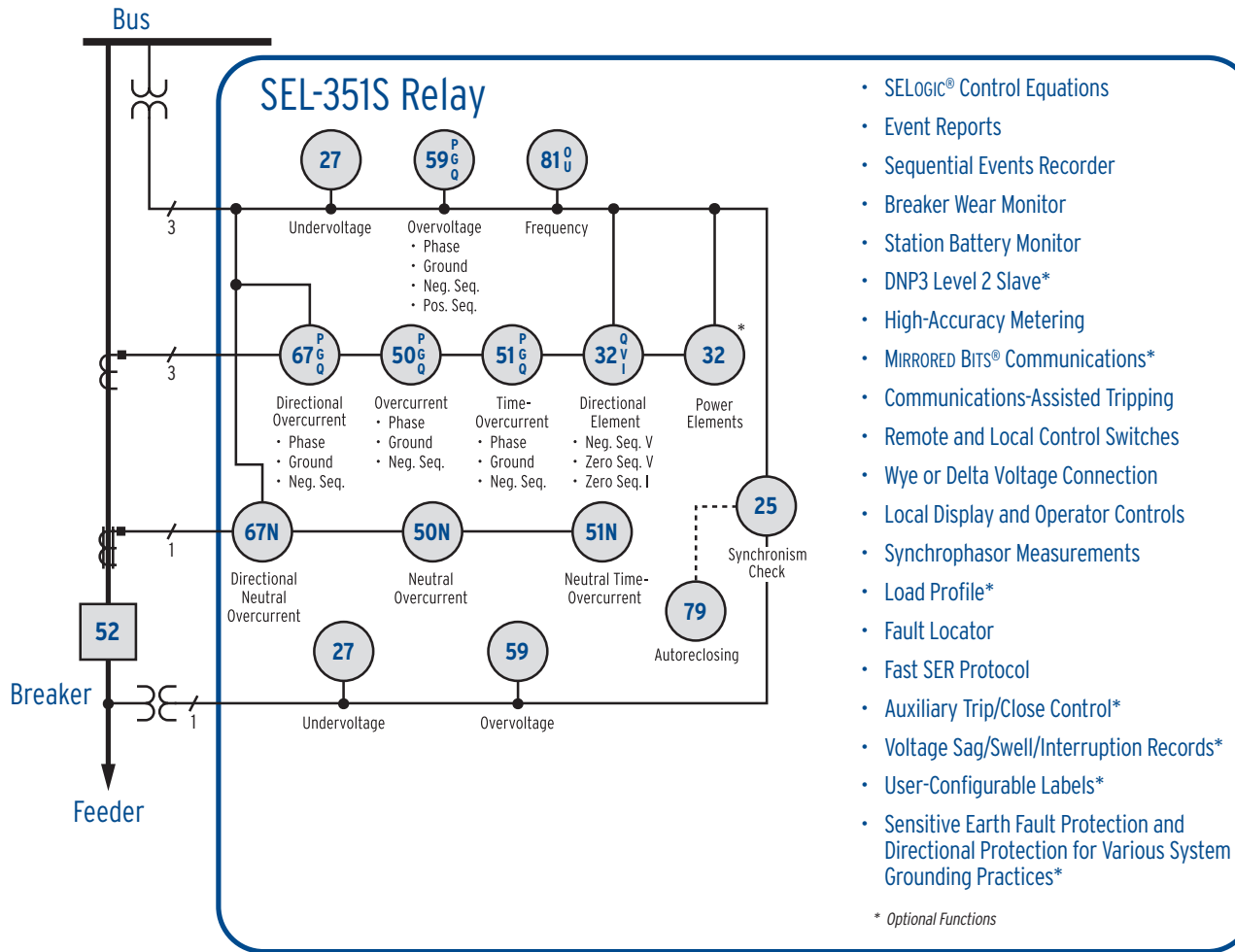
Analyze Sequential Events Recorder (SER) and oscillographic event reports for rapid commissioning, testing, and post-fault diagnostics.



Develop SELoGic control equations using acSELERATOR Software.

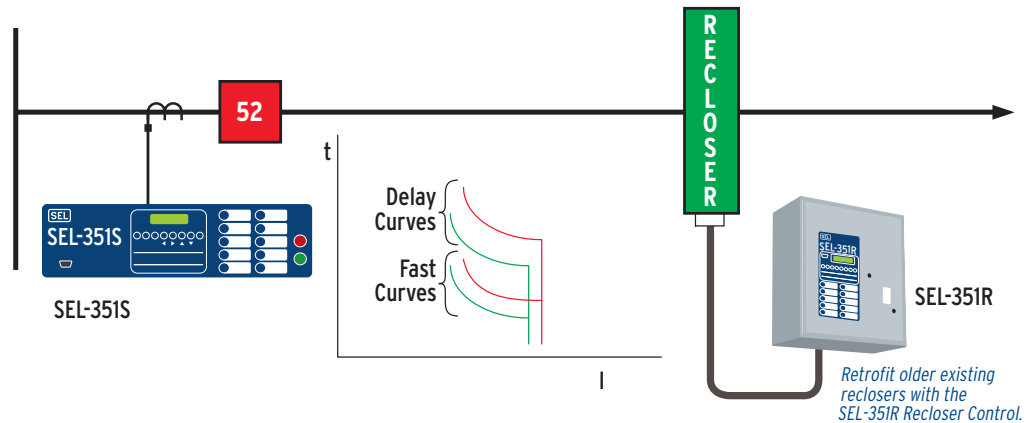
Making Electric Power Safer, More Reliable, and More Economical®

Functional Overview

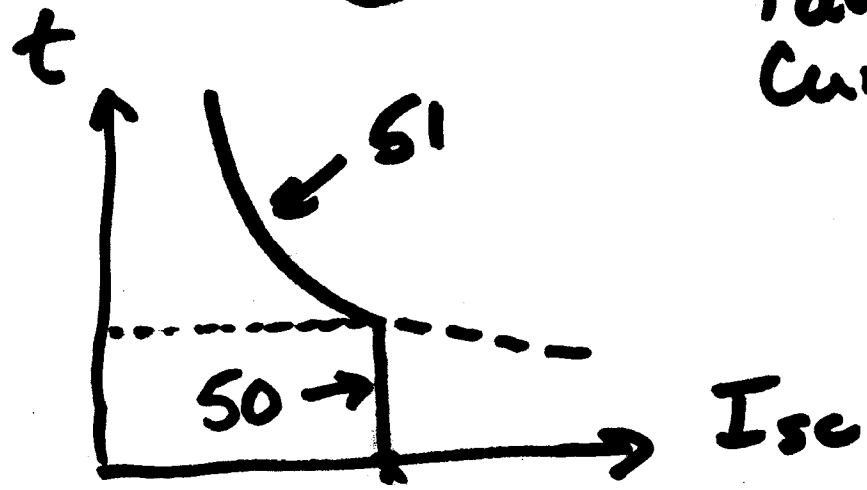
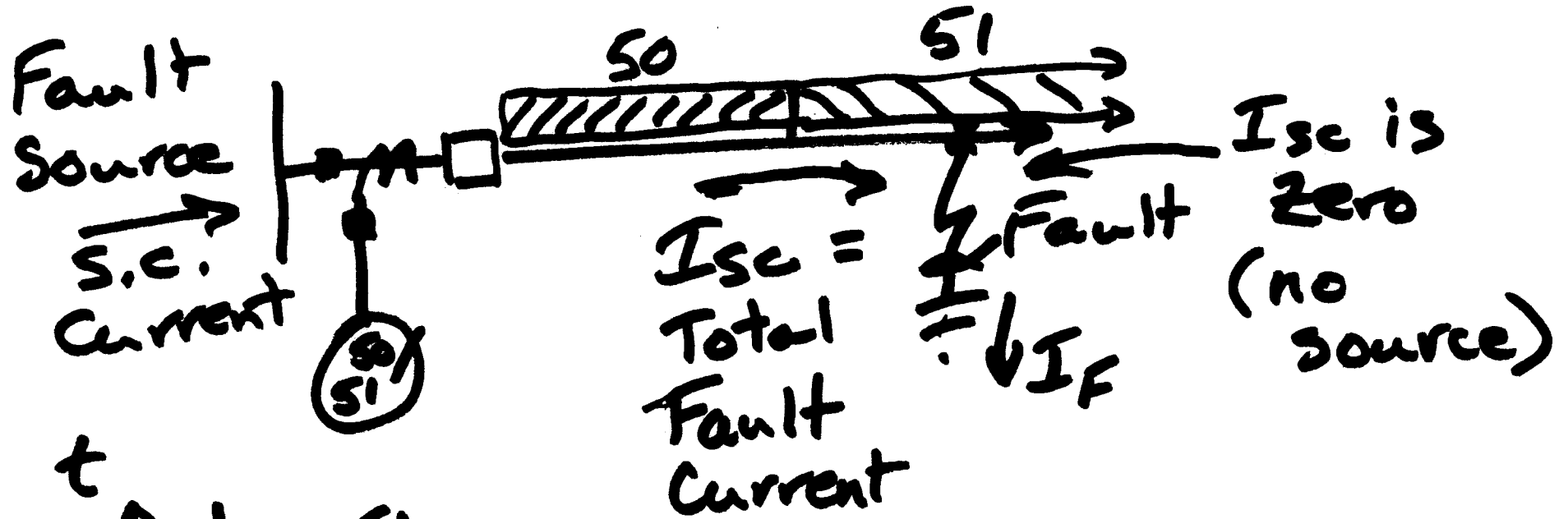


Coordinate Overcurrent Protective Devices

Use any of the 38 traditional recloser curves in the SEL-351S Relay to time-coordinate with downstream circuit reclosers. Sequence coordination keeps the SEL-351S in step with downstream reclosers and prevents tripping by overreaching overcurrent elements for faults beyond reclosers. Five standard US and IEC time-overcurrent curves provide coordination with other time-overcurrent relays.



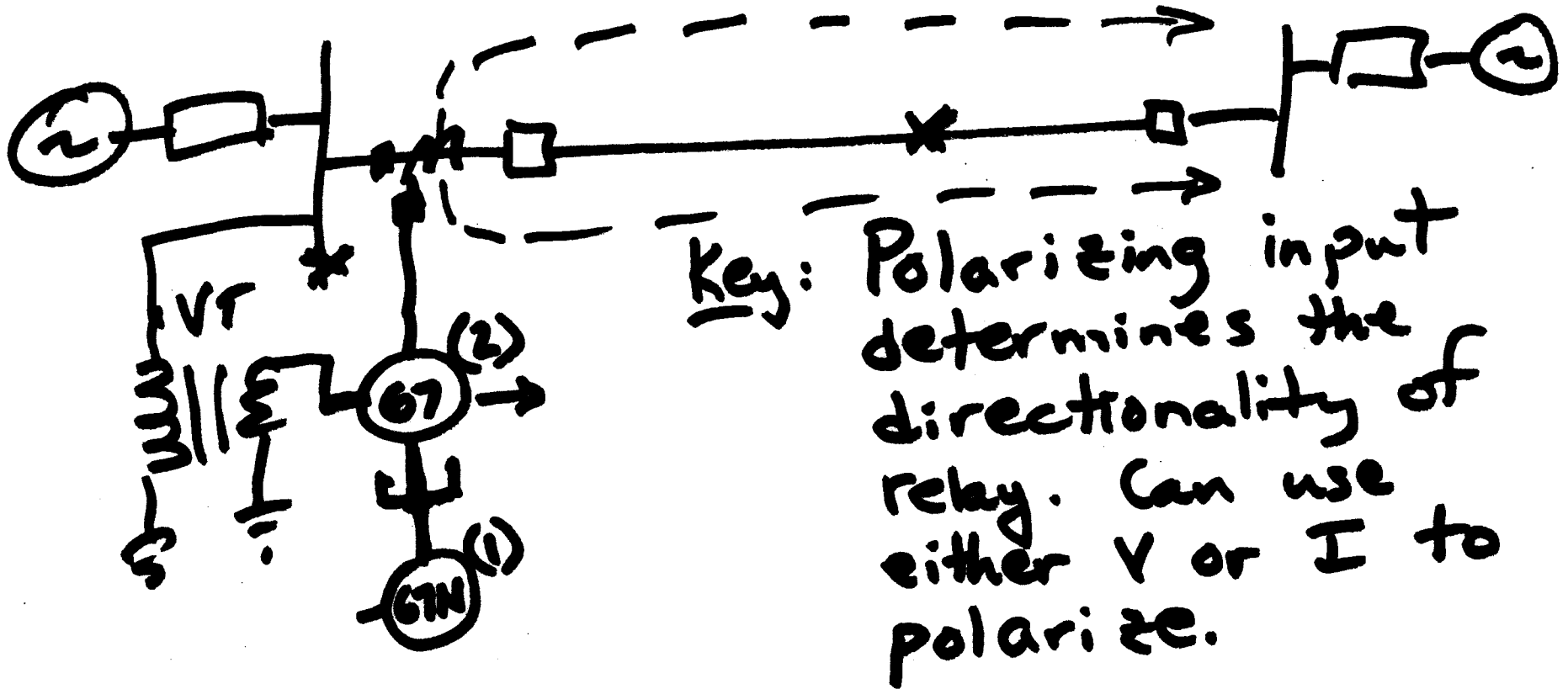
Overcurrent Protection -

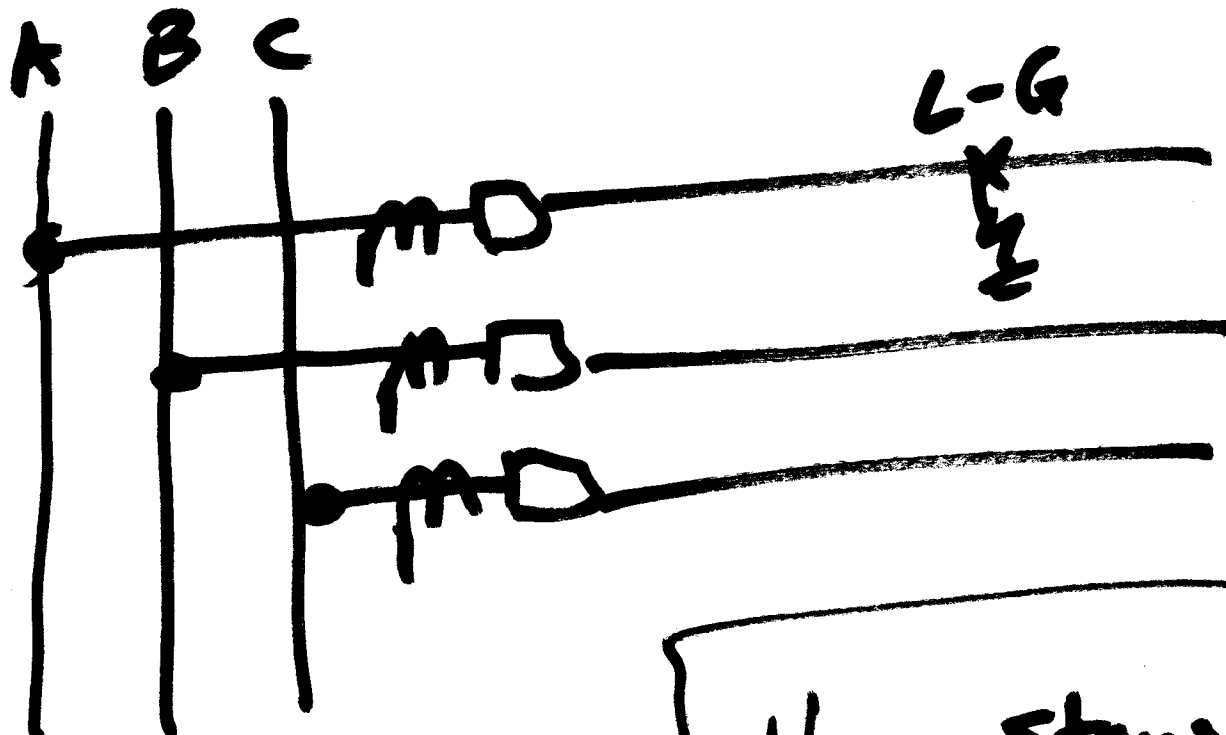


- Possible strategy:
- Set 50 to pick up for close-in or low-impedance faults.
 - set 51 to take care of high-impedance faults or faults farther out.

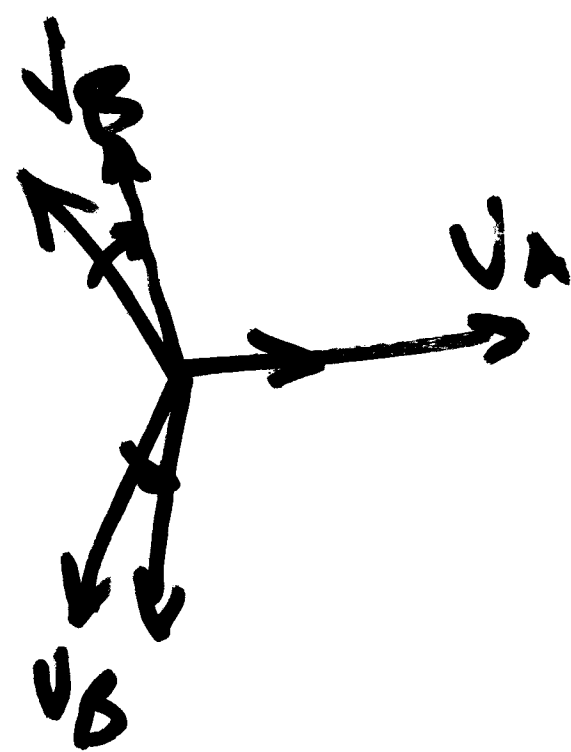
67- Directional O.C.

(Can also have inst. & time delay versions).





Pre-Fault:



V_{bc} stays at $+90^\circ$