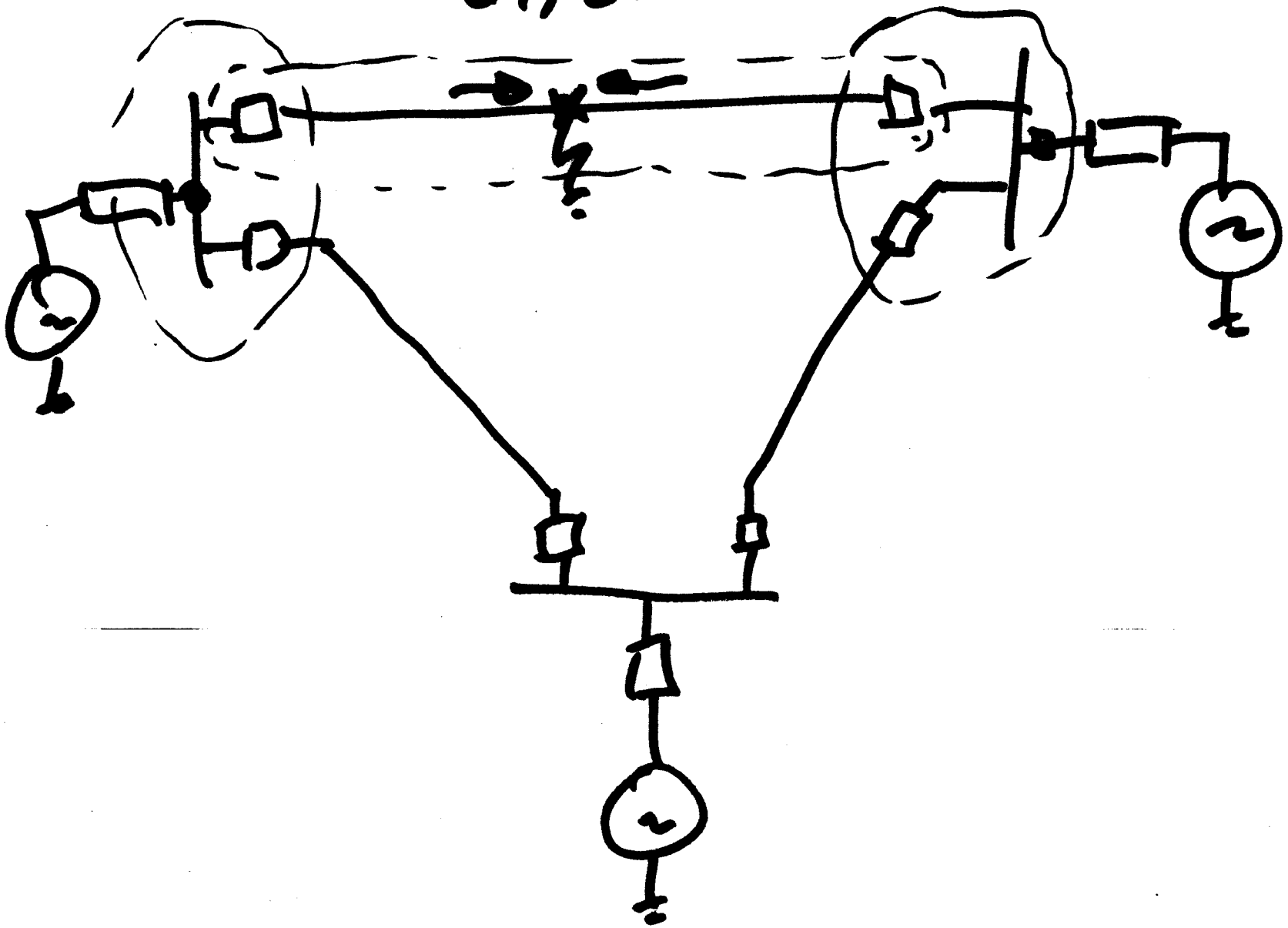
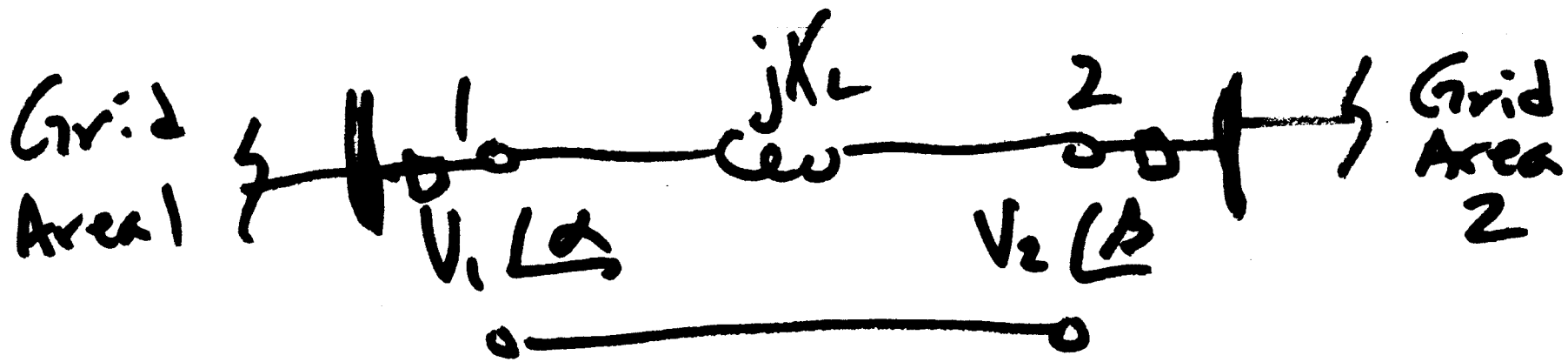
EE 5223 - Lecture 16 Mon Feb 13, 2023

Ongoing List of Topics:

- URL: https://pages.mtu.edu/~bamork/EE5223/index.htm
- Labs - EE 5224 Labs ongoing. Key: do the prelab!
- Team formations - Homeworks 3A (done) and 3B (Feb 21st) !
- Fri Feb 17th - Proposed project topic for term project. Propose 2 project ideas (about 3 sentences each: topic, what/how you will do, and deliverables).
- Today:
- Show and tell - 67 relays
  - electromechanical IRD (from SB19)
  - electronic BE1-67N (from SB35)
  - uProc SEL-311 (From SB35)
- Proposed term project idea/topic (2-3 sentences) submit by end of week!
- Misc Topics: insulators, BIL, NESC clearances, corona
- Symmetrical Components overview
  - Basic pos/neg/zero networks
  - Fault current is only first step of calc. Need fault contributions at relays!
  - transformer connections in zero seq, and phase shifts in pos/neg.
- Homework #8 - group assignment by project teams.

67, 21



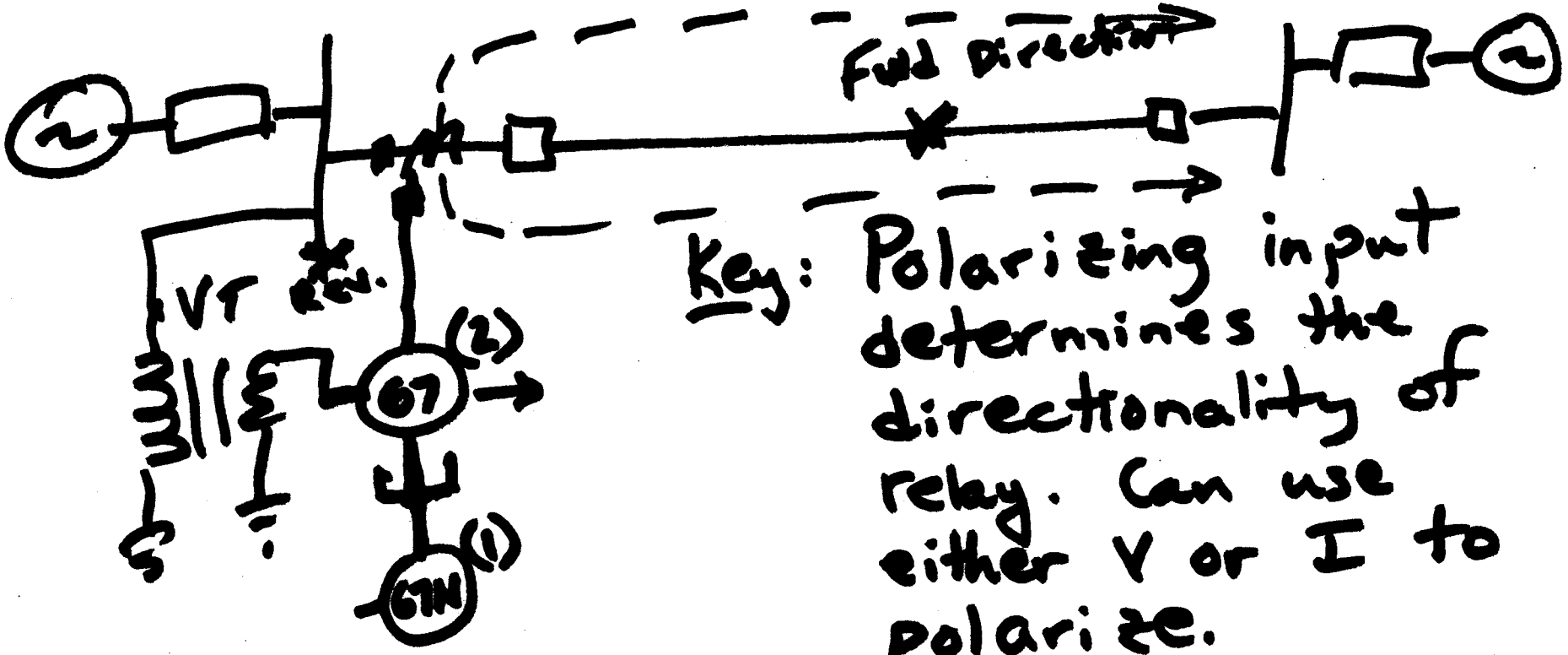


$$P_{12} \Longrightarrow \frac{V_1 V_2}{X} \sin(\alpha - \beta)$$

$\Longrightarrow (\alpha - \beta)$ increases as P_{12} increases

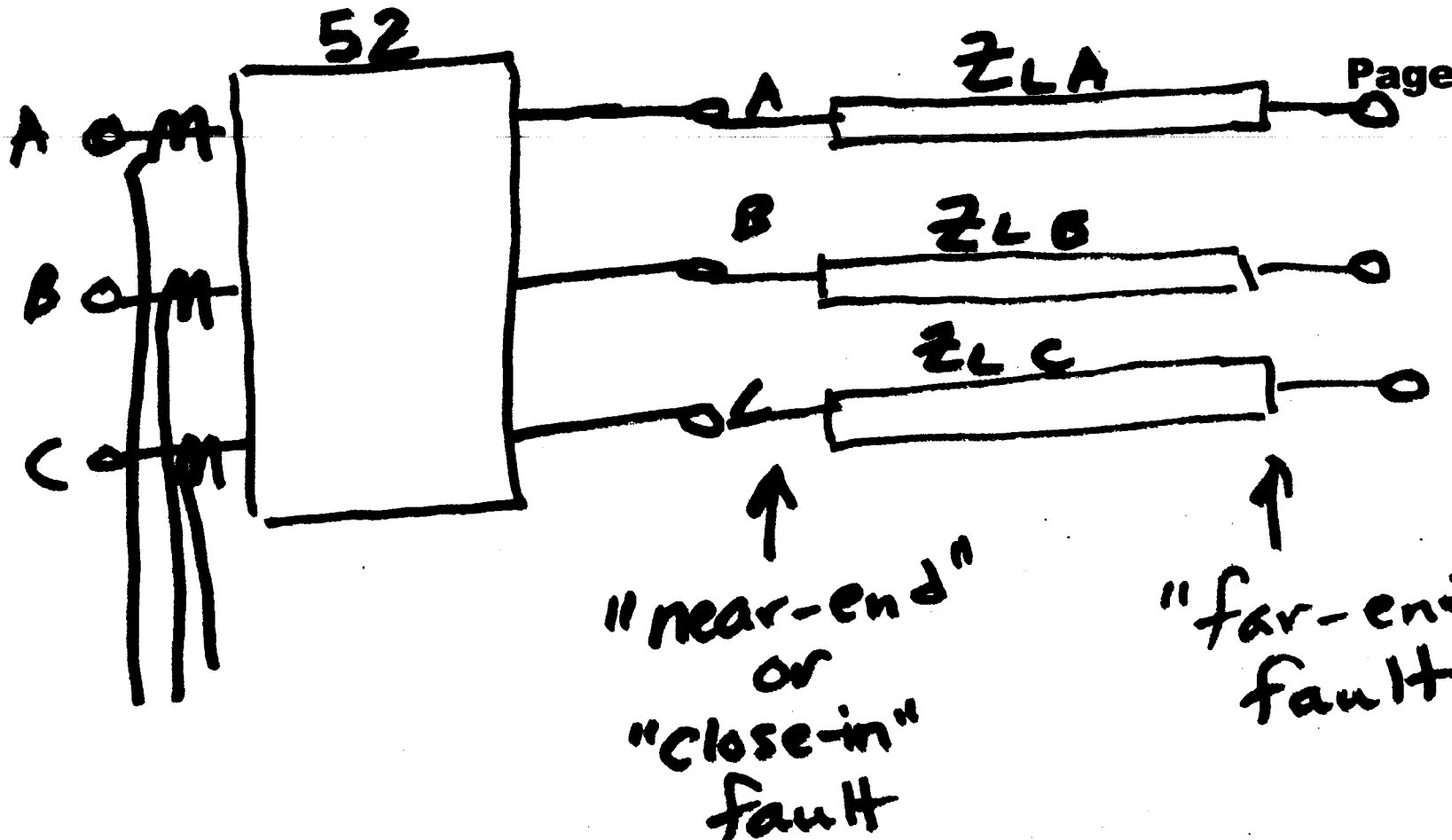
- Tripping line increases $\angle\alpha - \angle\beta$
- Reclosing may be problematic...
  (25) set at $\leq 40°$...??

67- Directional O.C.
(Can also have inst. & time delay versions).



Key: Polarizing input determines the directionality of relay. Can use either V or I to polarize.

MichiganTech Instructor: Bruce Mork Phone (906) 487-2857 Email: bamork@mtu.edu



Types of Faults -- 3-Phase, 3-Phase-G
- L-L
- L-L-G

(-LG) } Z_F

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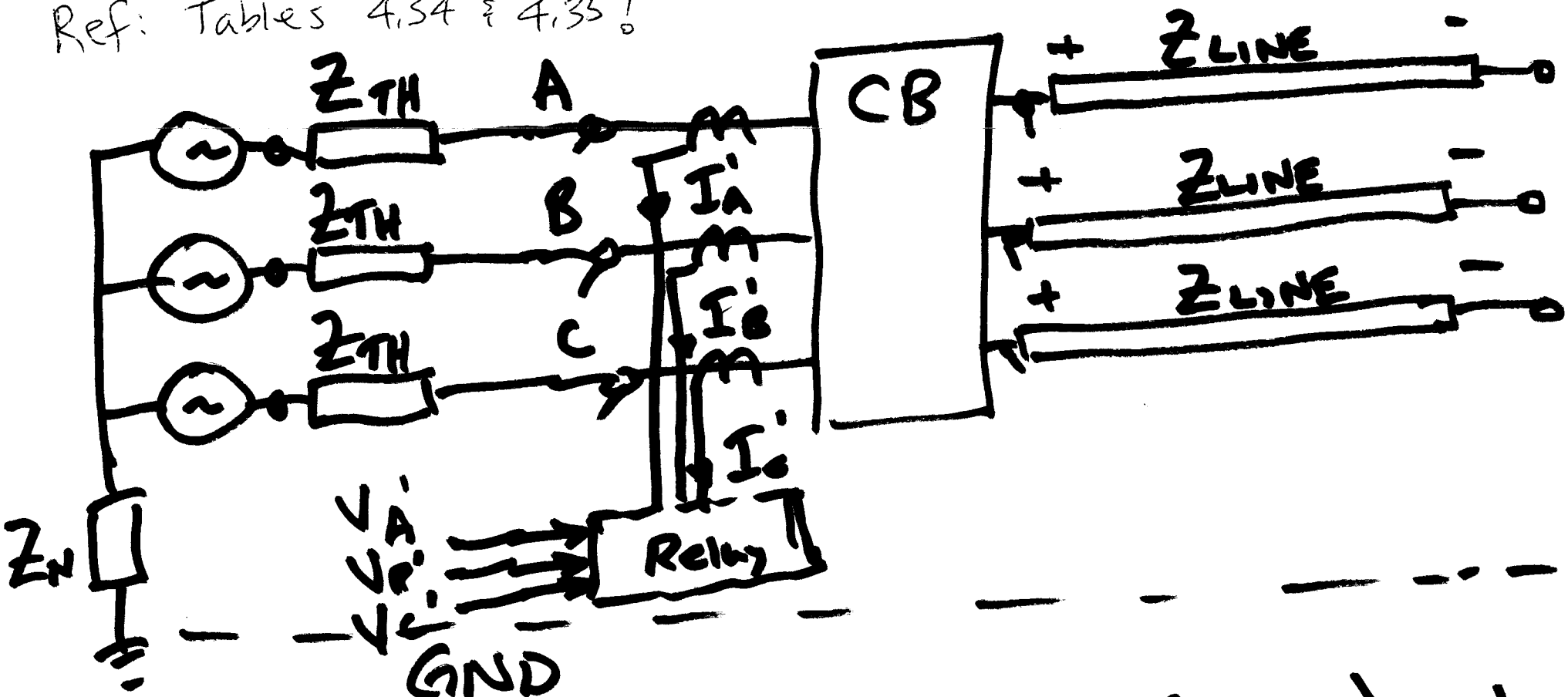
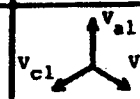
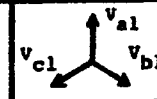
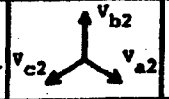
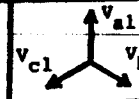
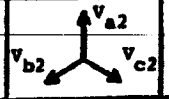
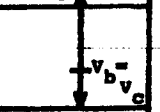
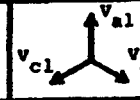
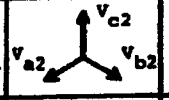
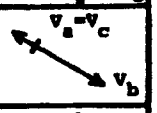
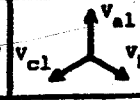
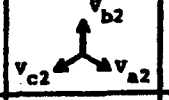
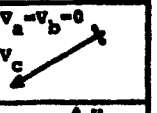
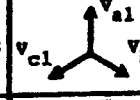
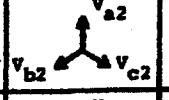
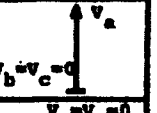
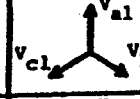
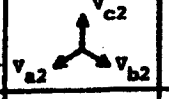
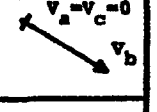
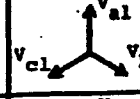
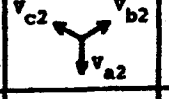
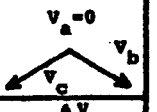
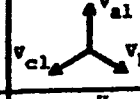
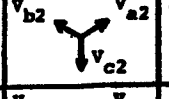
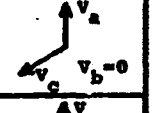
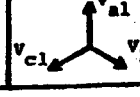
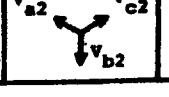
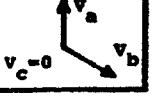
Ref: Tables 4.34 & 4.35!



Key: Relay located at sending (near) end of line.

- Voltage at relay greatly reduced during fault, but will only be zero for close-in fault.

FIGURE 4.34 Sequence voltages and the voltage at the fault point for the various fault types. Solid faults with $Z_1 = Z_2 = Z_0$ for simplicity. Magnitudes are not to scale. AT RELAY

Fault Type	Positive Sequence	Negative Sequence	Zero Sequence	Fault Voltages
a,b,c				Zero at Fault
a,b				
b,c				
c,a				
a,b,G				
b,c,G				
c,a,G				
a,G				
b,G				
c,G				

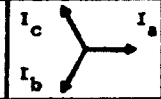
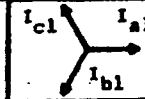
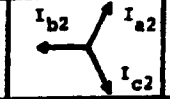
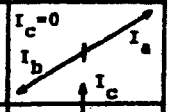
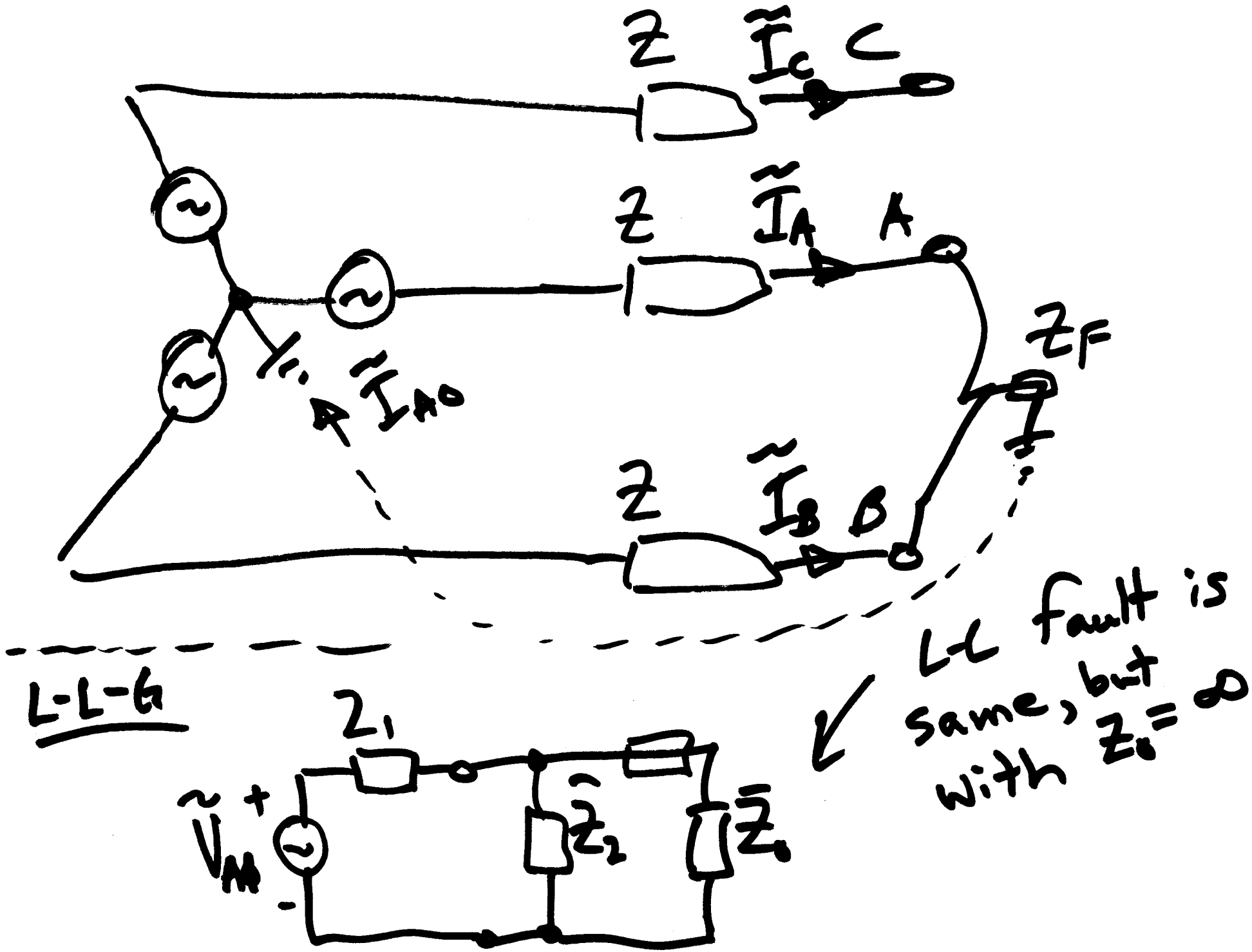
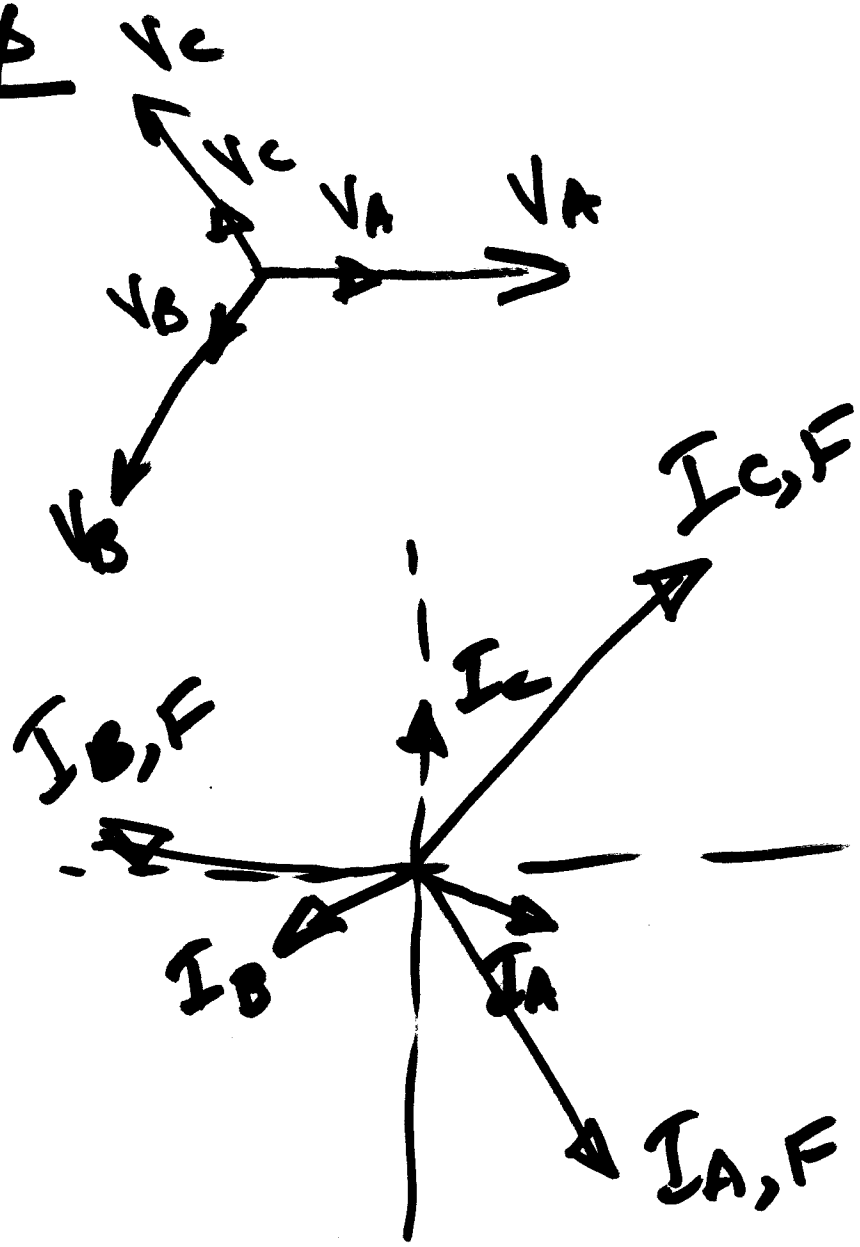
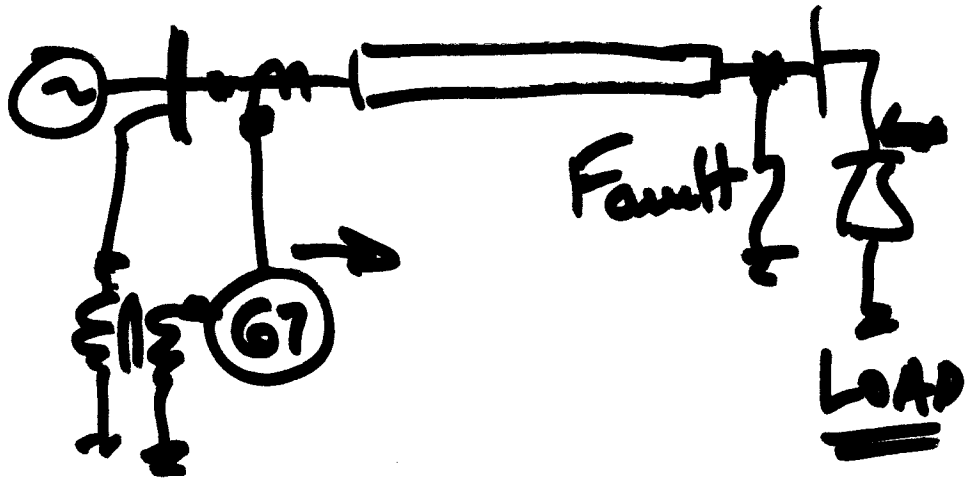
Fault Type	Positive Sequence	Negative Sequence	Zero Sequence	Fault Currents
a,b,c				
a,b				
b,c				
c,a				
a,b,G				
b,c,G				
c,a,G				
a,G				
b,G				
c,G				

FIGURE 4.35 Sequence currents and the fault current for the various fault types. Solid faults with $Z_1 = Z_2 = Z_0$ for simplicity. Magnitudes are not to scale.


Z
$\tilde{I}_C$
C
Z
$\tilde{I}_A$
A
Z_F
$\tilde{I}_{AO}$
Z
$\tilde{I}_B$
B
L-L fault is same, but with $Z_0 = \infty$
L-L-G
Z_1
$\tilde{V}_{AA}$
+
-
Z_2
Z_0

3φ

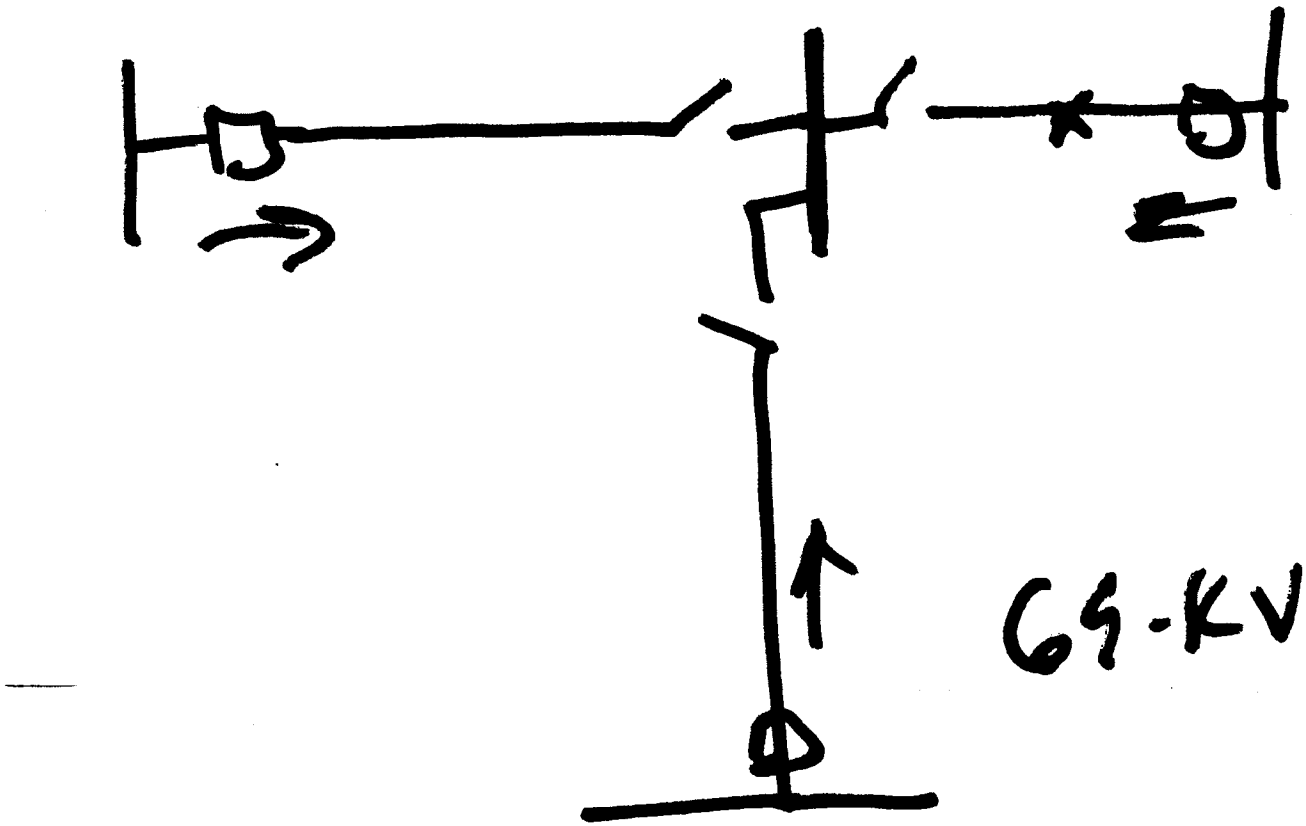




IF $Z_{TH}+Z_{LINE} \ll Z_{LOAD}$

$\Rightarrow$ Z_{LOAD} determines S.S φ-angle of I.

$\Rightarrow$ $Z_{TH}+Z_{LINE}$ determines S.S. φ-angle of I during fault!


69-KV