



POWER SYSTEMS ENGINEERING

CIRCUIT BREAKER CONTROL SCHEME



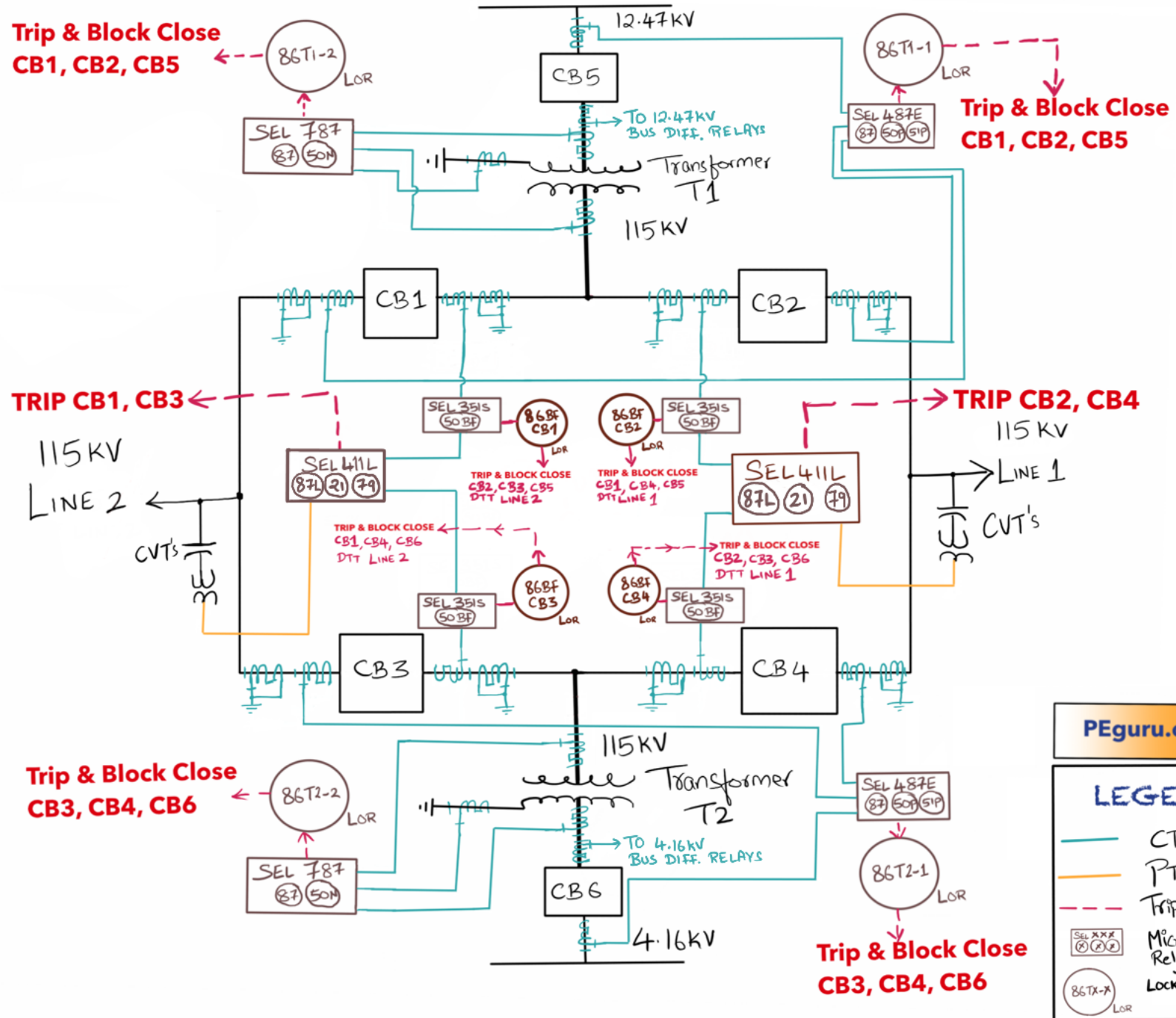
LEARN TO WIRE LOCKOUT RELAYS
AND MICROPROCESSOR RELAYS

ALEEN MOHAMMED

TABLE OF CONTENTS

- 1 THE RING SUBSTATION**
Substation relay oneline
- 2 METHODOLOGY**
Reasoning for the oneline
- 3 BREAKER CONTROL SCHEME**
Trip & close breaker scheme
- 4 THE STRAIGHT BUS SUBSTATION**
Substation relay oneline
- 5 EXERCISE**
Test your knowledge

01 THE RING SUBSTATION



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LEGEND

- CT Circuit
- PT Circuit
- - - Trip Signal
- SEL XXX (87)(21)(79) Microprocessor Relay
- 86TX-X LOR Lockout Relay

02 METHODOLOGY

OBJECTIVE:

- Develop breaker control scheme of 115kV circuit breaker CB1 from the Ring Substation. Schematic drawing will show how to connect trip contacts and close (or block close) contacts of relays.
- Test your knowledge using a different substation layout (included).

Making sense of the Ring substation online

Why ring layout?

- Ring layout is chosen for most new substations. Not too elaborate and very reliable (from operation standpoint).

What is the methodology for relay selection?

- Current differential is the best form of protection. Any relay with this functionality should be your first choice. There are exceptions, will be described below.
 - For **Transformer protection** –
 - Schweitzer SEL787 chosen. It implements current differential using current transformers (CT) on the power transformer bushings.
 - Schweitzer SEL487E also chosen. CT's from breaker bushing chosen in this case. Zone of protection is much larger and encapsulates the one from SEL787.
 - Both relays can implement overcurrent protection 50 and 51 on phase and neutral/ground as backup.
 - Not shown, the sudden pressure relay – internal to transformer, trips the 86T lockout relay directly.

02 METHODOLOGY

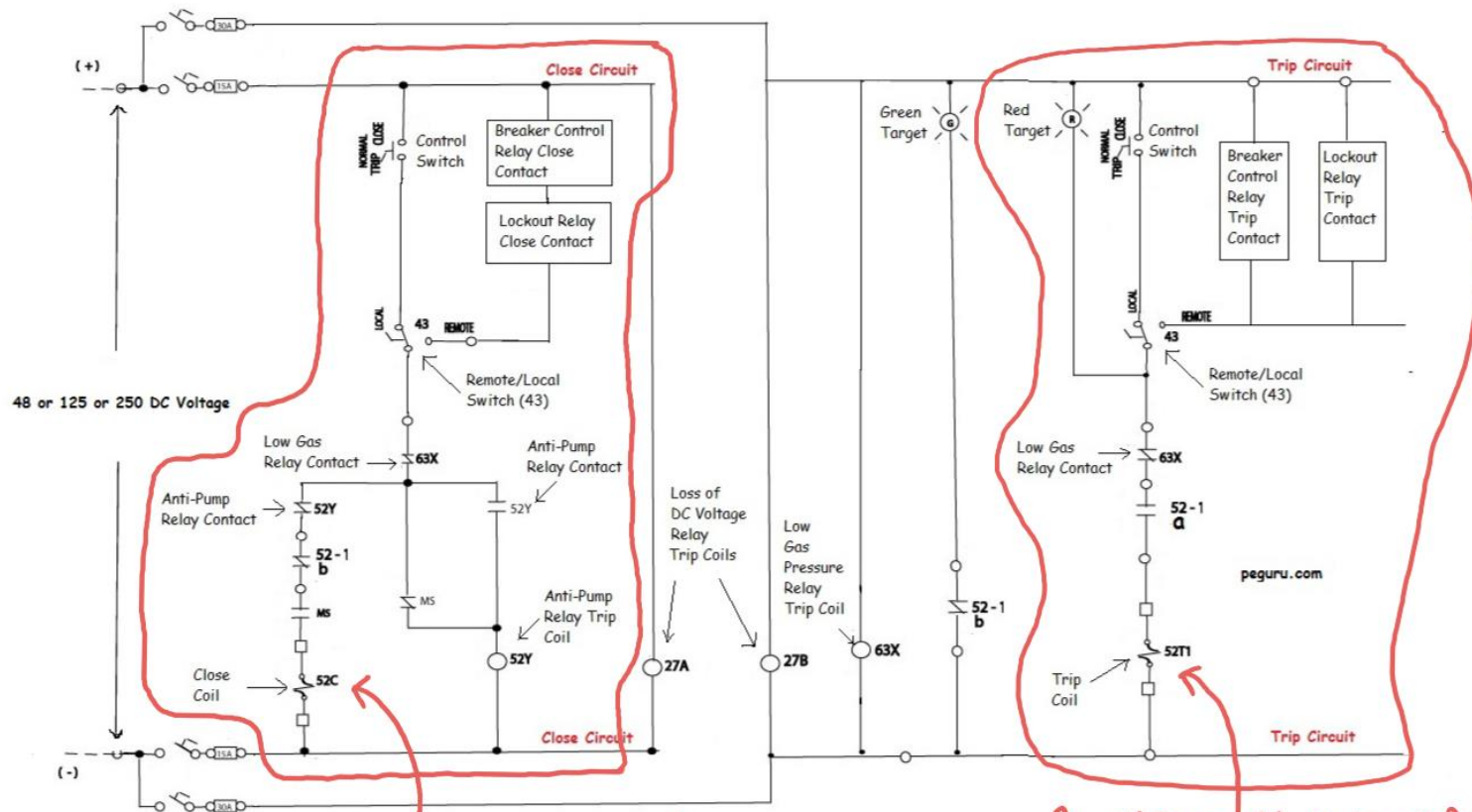
- For **Bus protection** –
 - Ring layouts do not need separate relays for bus protection. All pieces of bus fall inside either transformer or transmission line zone of protection.
 - For any other bus layout (straight, breaker-and-a-half, etc), bus differential relay is required. A short-circuit on a bus generates incredibly high fault currents. If CT saturation is possible then use high impedance bus differential relay like SEL587Z. Otherwise a low impedance relay like SEL487B works just fine.

- For **Line protection** –
 - Relay choice for line protection cannot automatically be a line differential relay. It is driven by following reasoning

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03 BREAKER CONTROL SCHEME

Generic breaker control scheme. Details of this schematic drawing are [provided here](#).

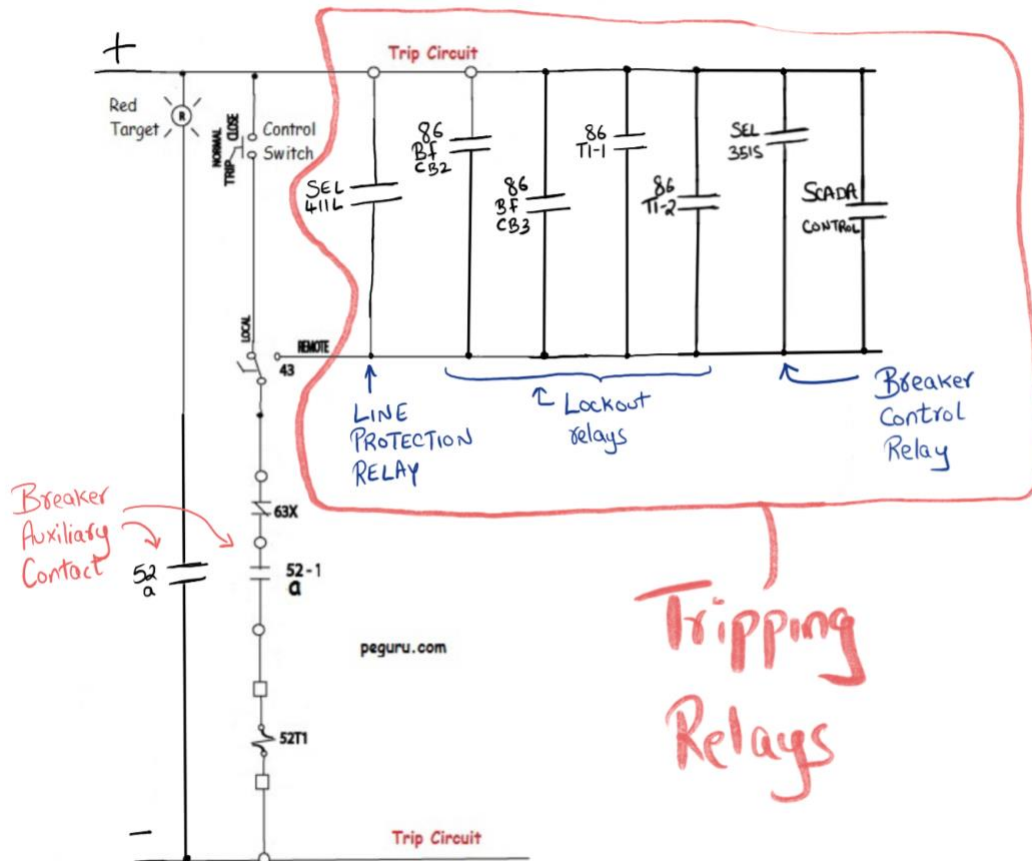


Anything tied to close coil is part of Close circuit

Anything tied to trip coil is part of trip circuit

03 BREAKER CONTROL SCHEME

Tripping scheme for 115kV circuit breaker CB1

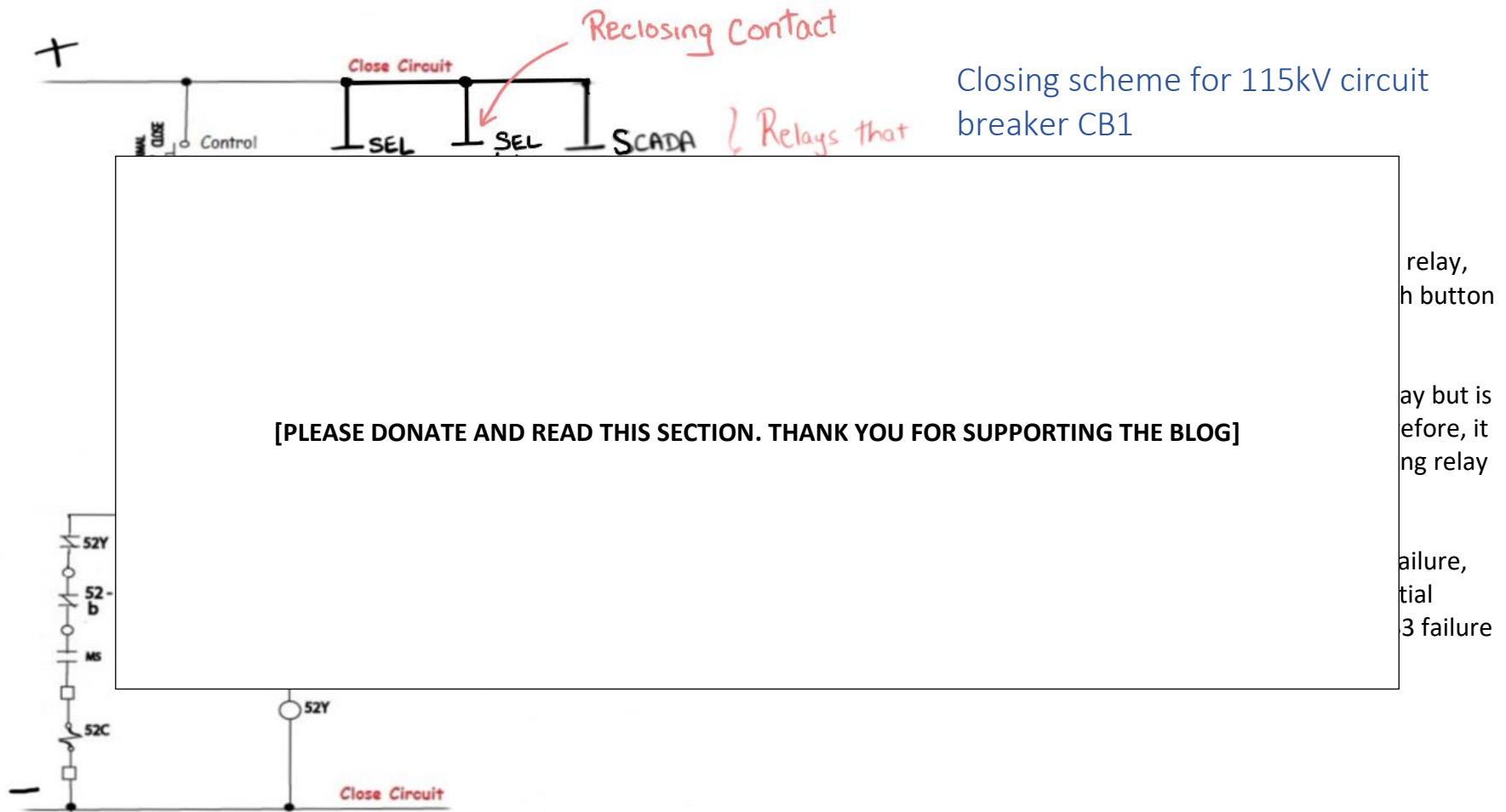


Note this breaker is in the 115kV Line 2 zone of protection and transformer TR1 zone of protection.

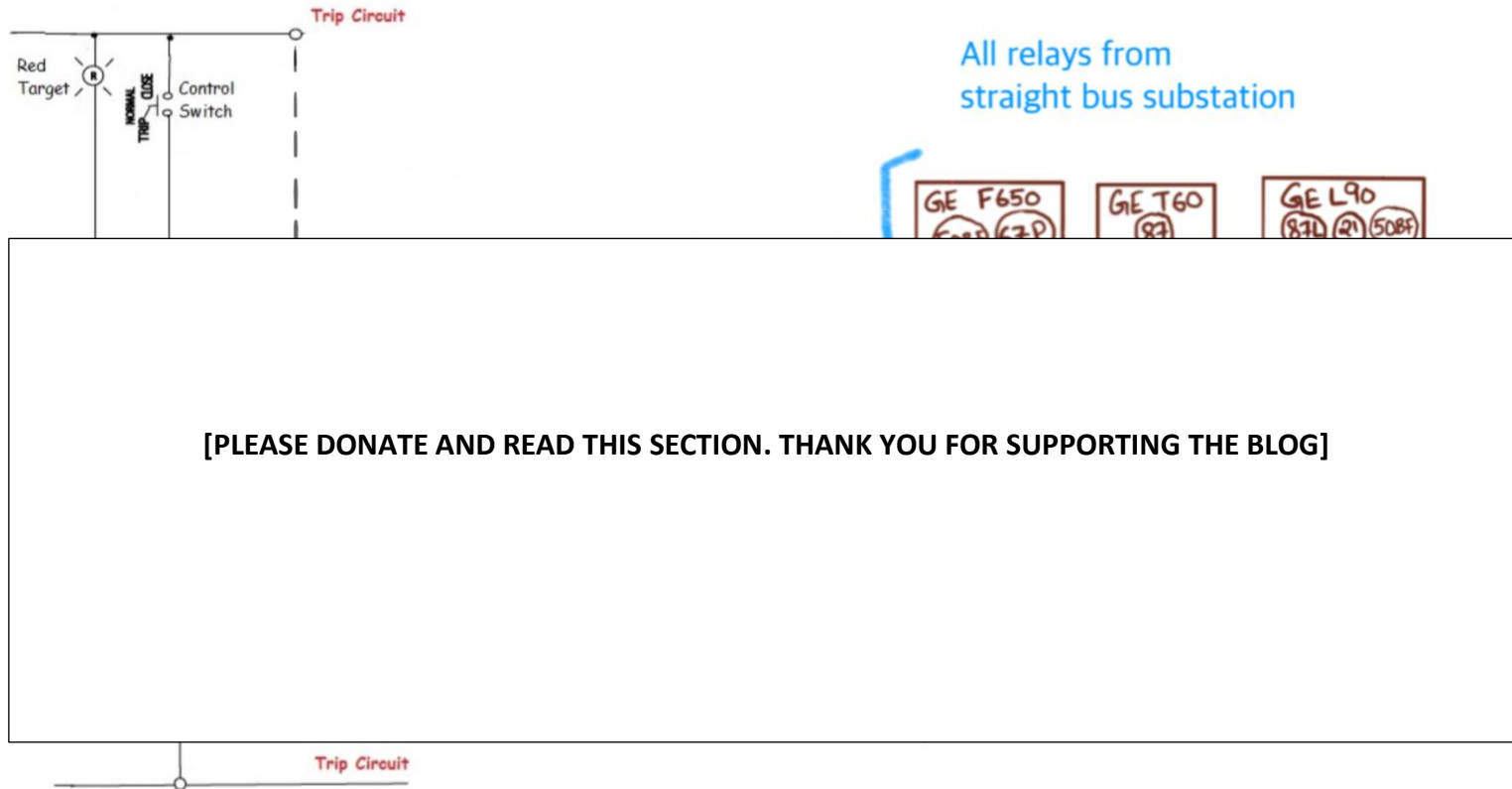
Reason for selecting relays (shown left) to trip the breaker:

- SEL411L: Needs to trip this breaker to protect transmission line 2.
- SEL351S: Needs to trip this breaker to protect it. Implements breaker failure logic.
- Lockout 86 relays: Need to trip this breaker to isolate the equipment it is protecting. For instance, 86T1-1 and 86T1-2 isolates transformer TR1, 86BF-CB2 isolates CB2 and 86BF-CB3 isolates CB3.

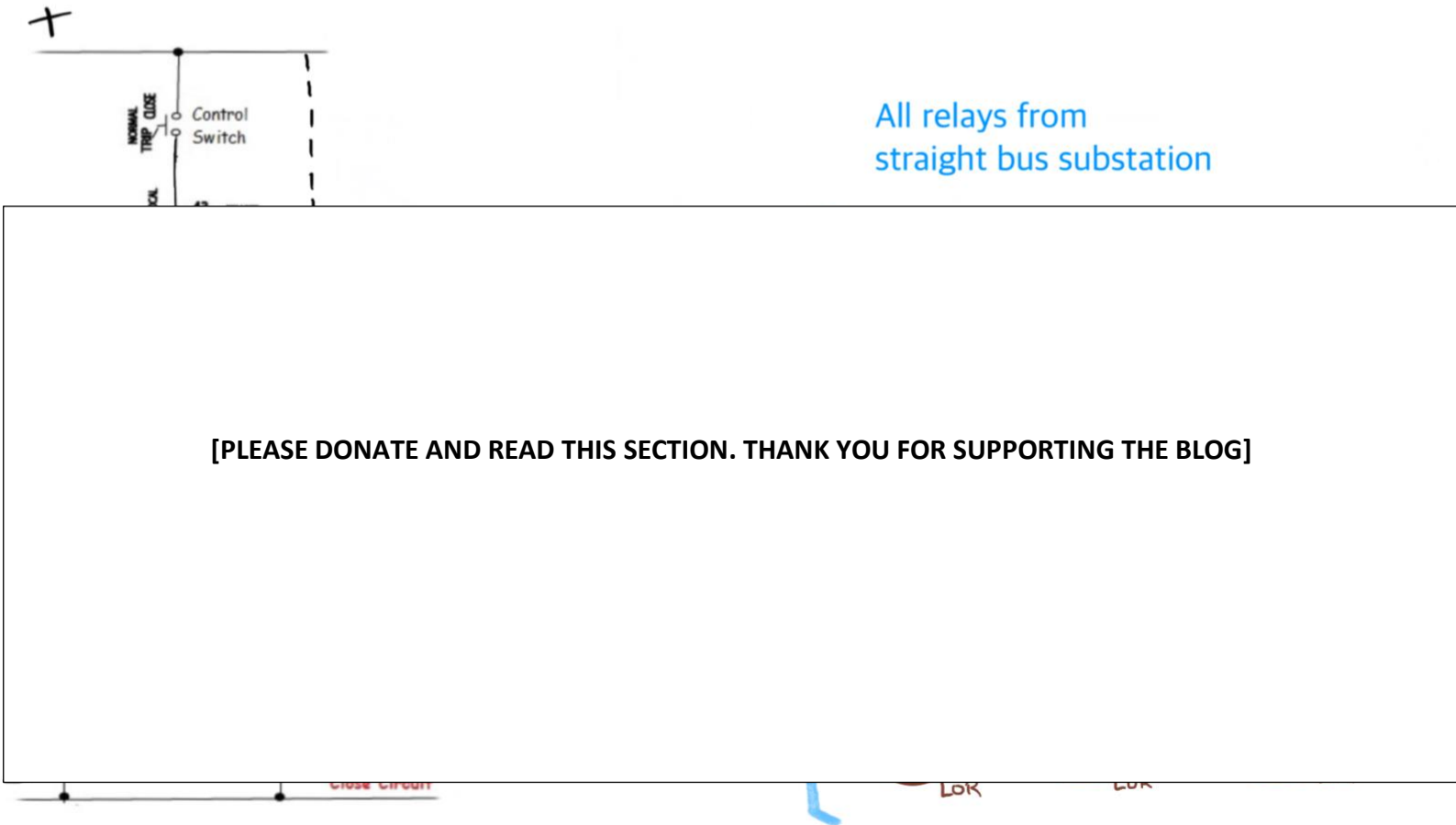
03 BREAKER CONTROL SCHEME



Practice problem - CB2 Trip Circuit



Practice problem - CB2 close circuit



SOLUTION

Practice problem - CB2 Trip Circuit

SOLUTION



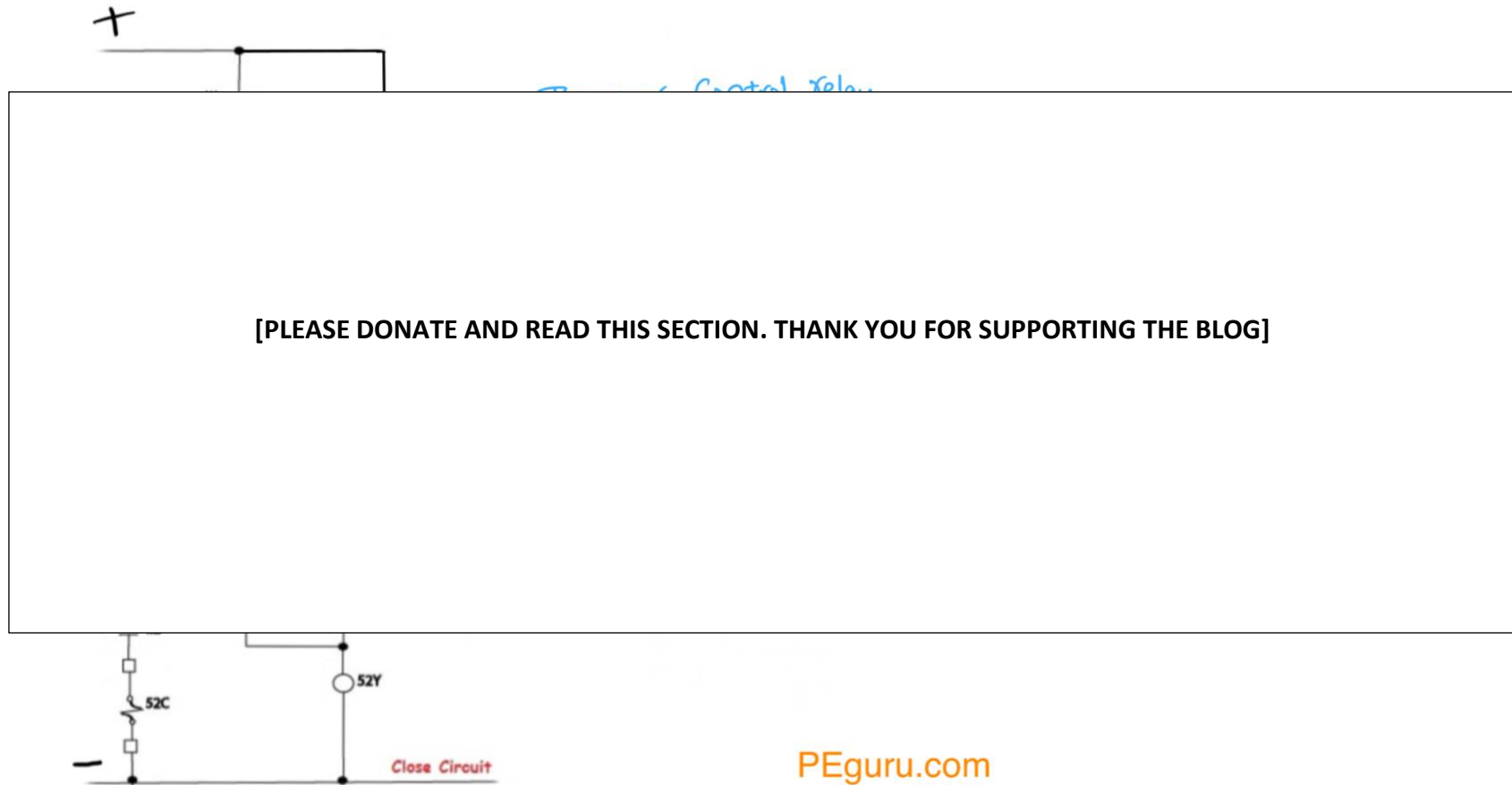
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Practice problem - CB2 close circuit

SOLUTION



BONUS INFORMATION

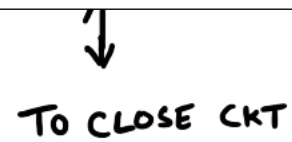
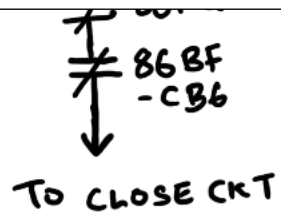
CB6 CONTROLS



CB8 CONTROLS



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