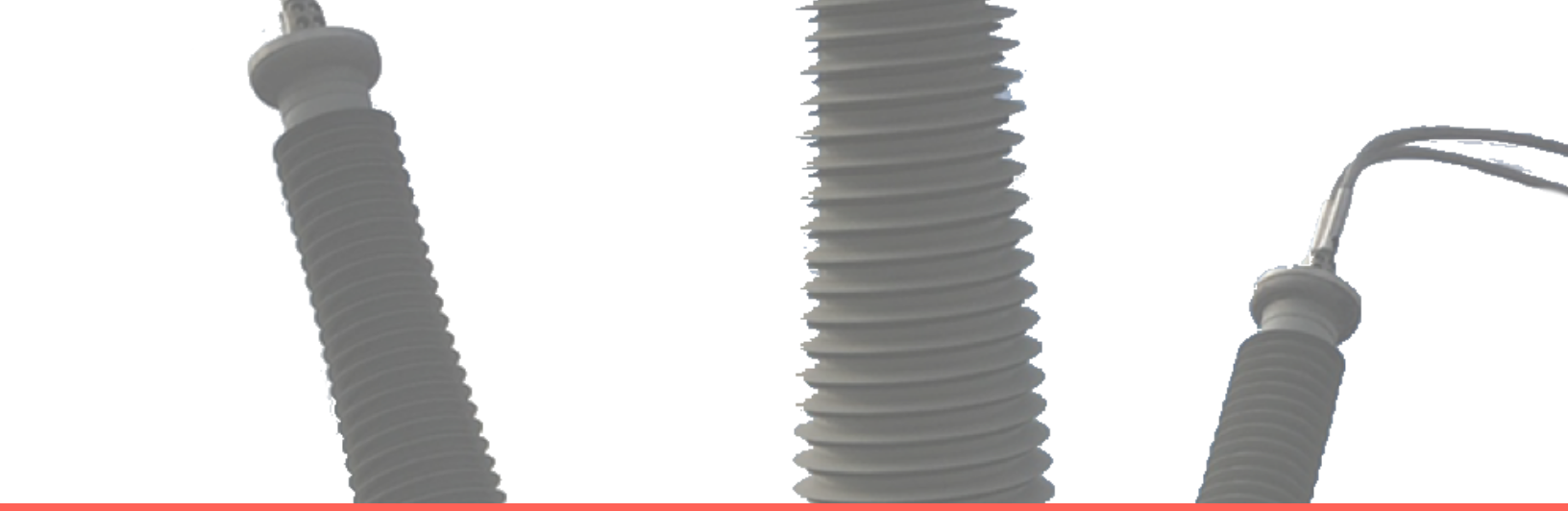
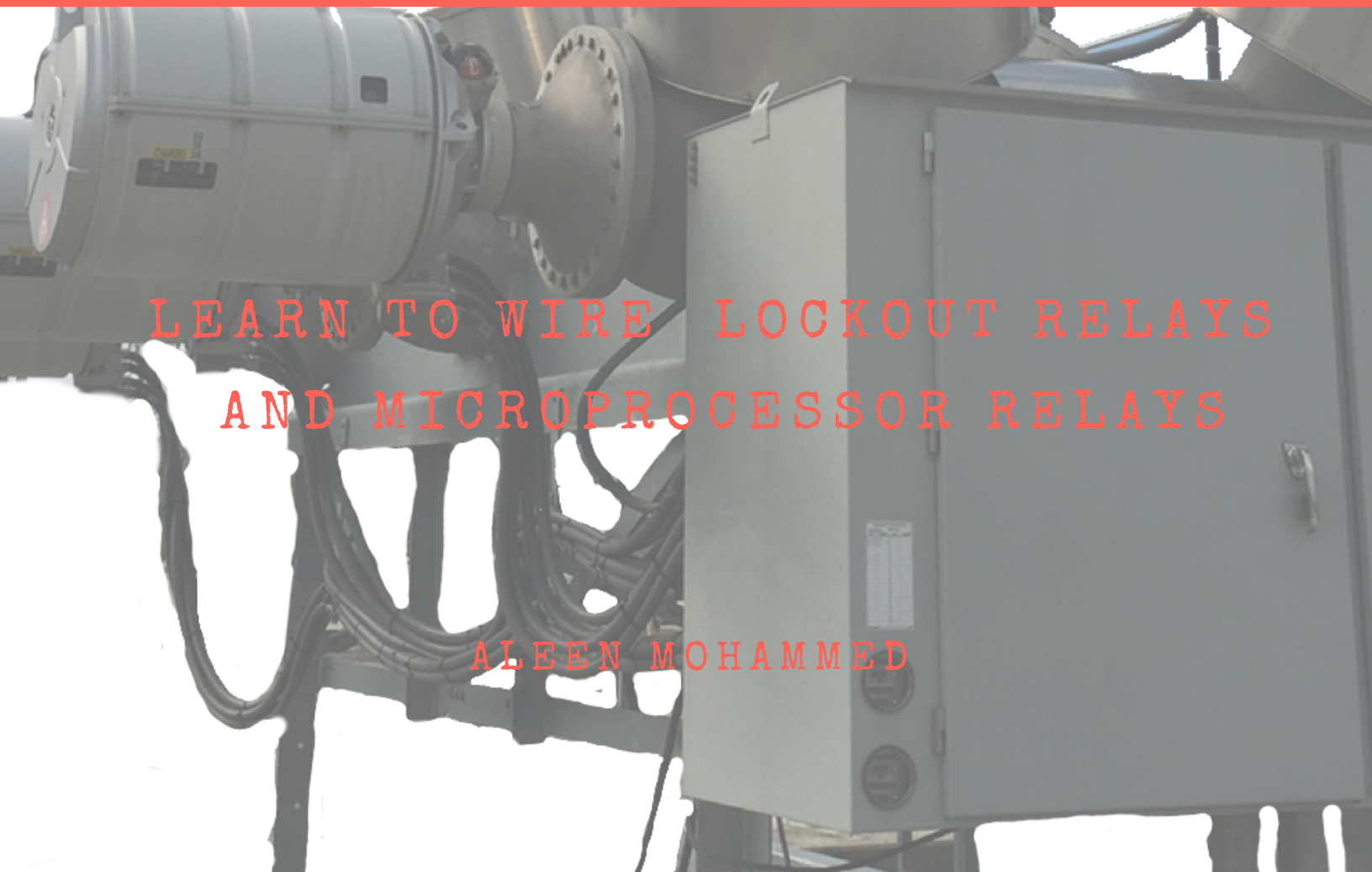


POWER SYSTEMS ENGINEERING

CIRCUIT BREAKER CONTROL SCHEME



LEARN TO WIRE LOCKOUT RELAYS AND MICROPROCESSOR RELAYS

ALEEN MOHAMMED

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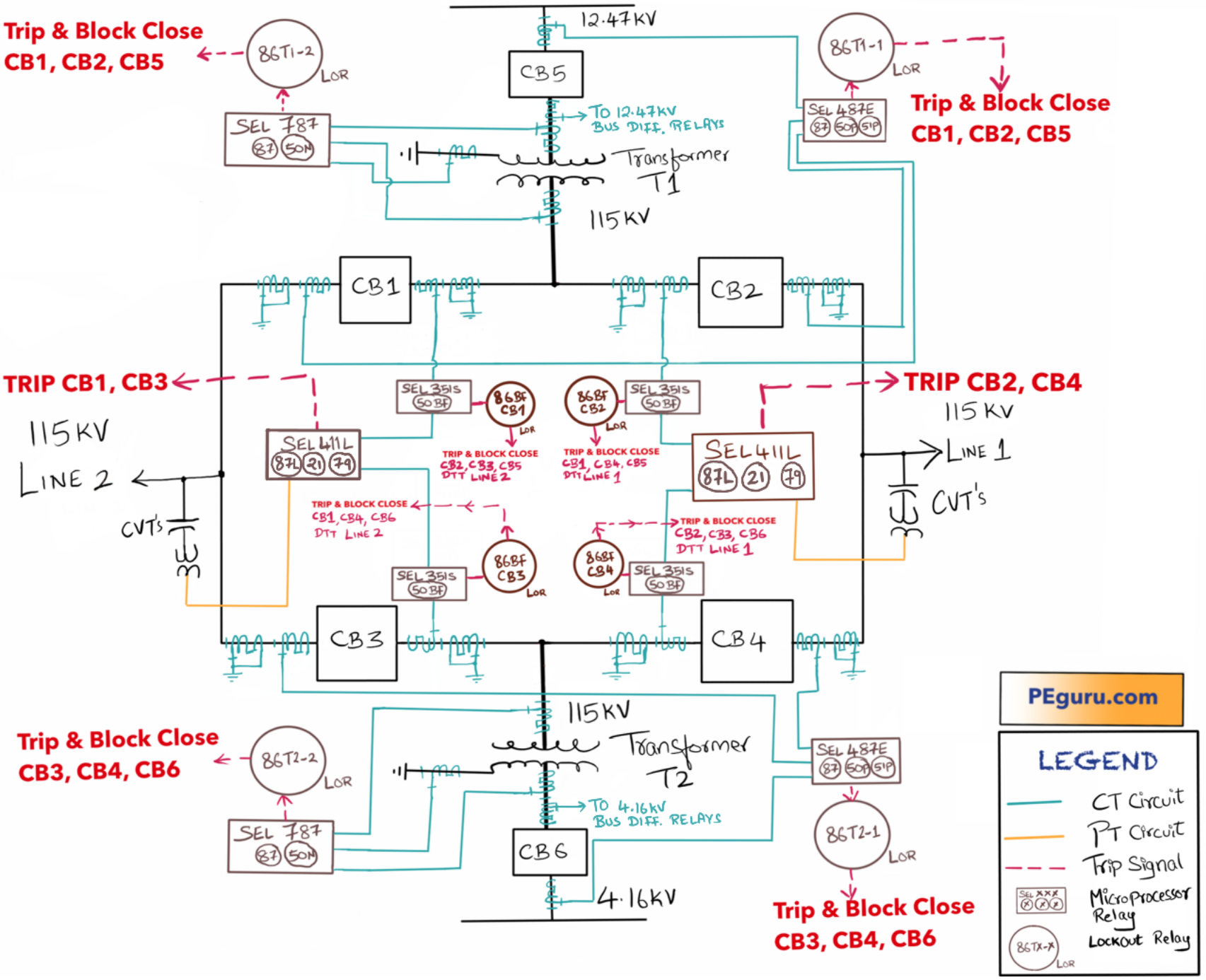
Substation relay oneline

5 EXERCISE
Test your knowledge

01 THE RING SUBSTATION



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 oneline

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.

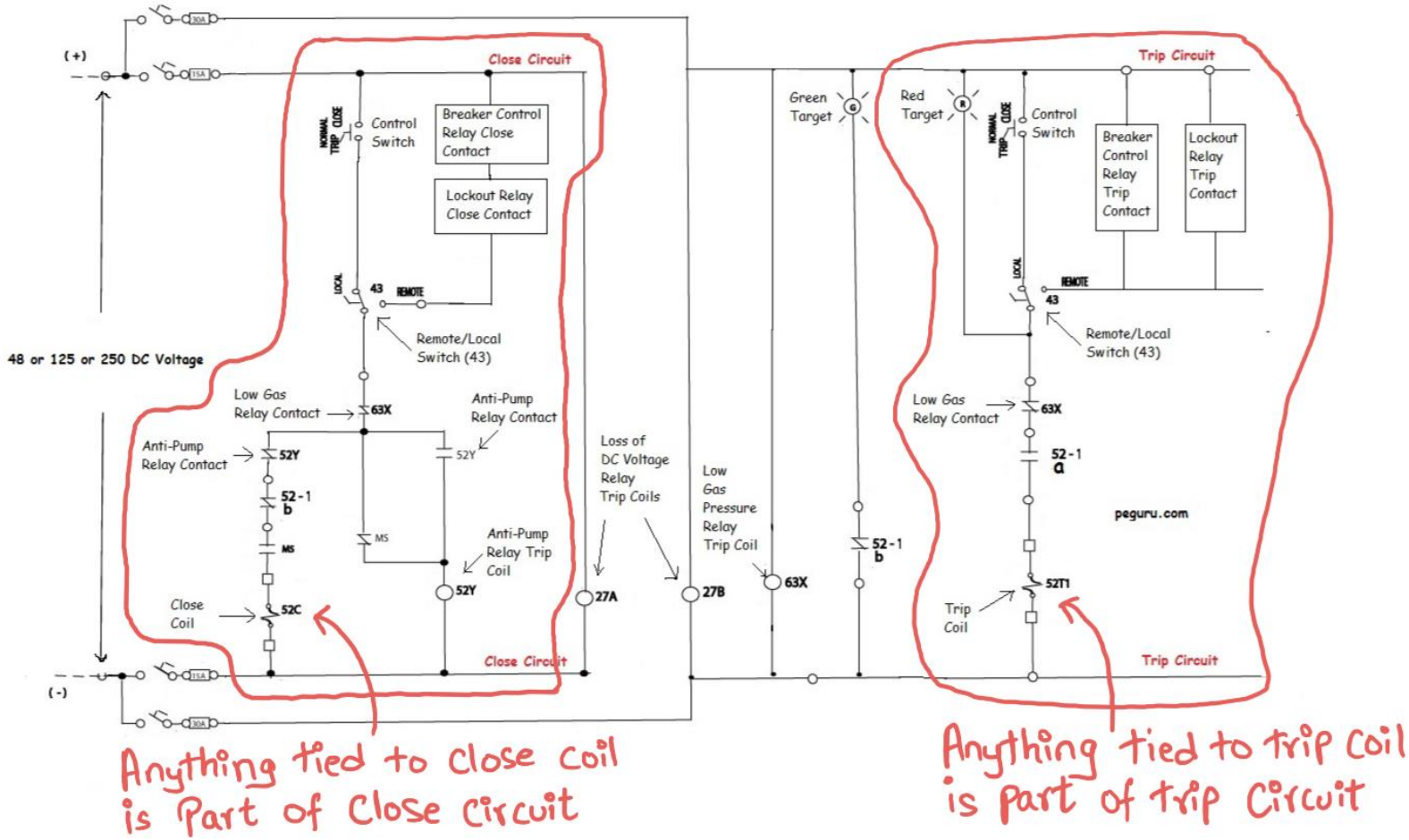
- For **Bus protection** –
  - Ring layouts do not need separate relays for bus protection. All pieces of bus fall inside either transformer or transmission line zone of protection.
  - For any other bus layout (straight, breaker-and-a-half, etc), bus differential relay is required. A short-circuit on 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

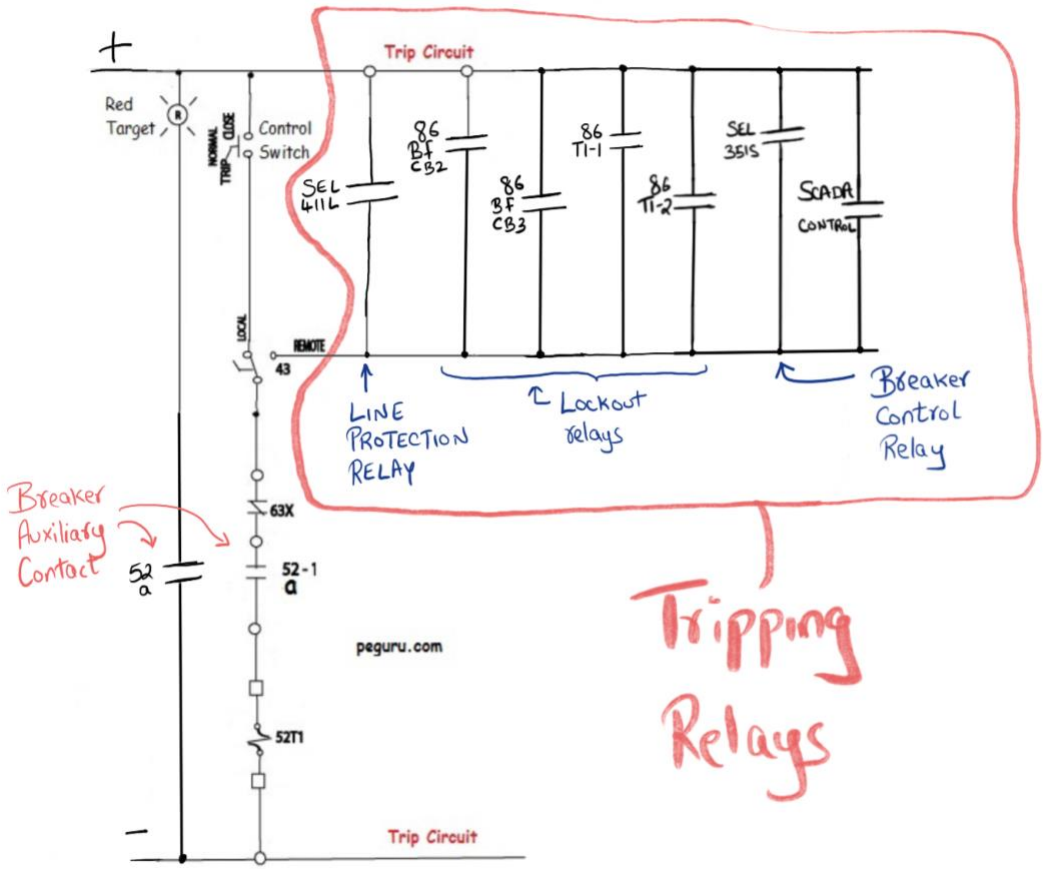
[PLEASE DONATE AND READ MORE IN THIS SECTION. THANK YOU FOR SUPPORTING THE BLOG]

03 BREAKER CONTROL SCHEME

Generic breaker control scheme. Details of this schematic drawing are provided here.



03 BREAKER CONTROL SCHEME



Tripping scheme for 115kV circuit breaker CB1

115kV circuit breaker CB1 from the ring bus substation is chosen.

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

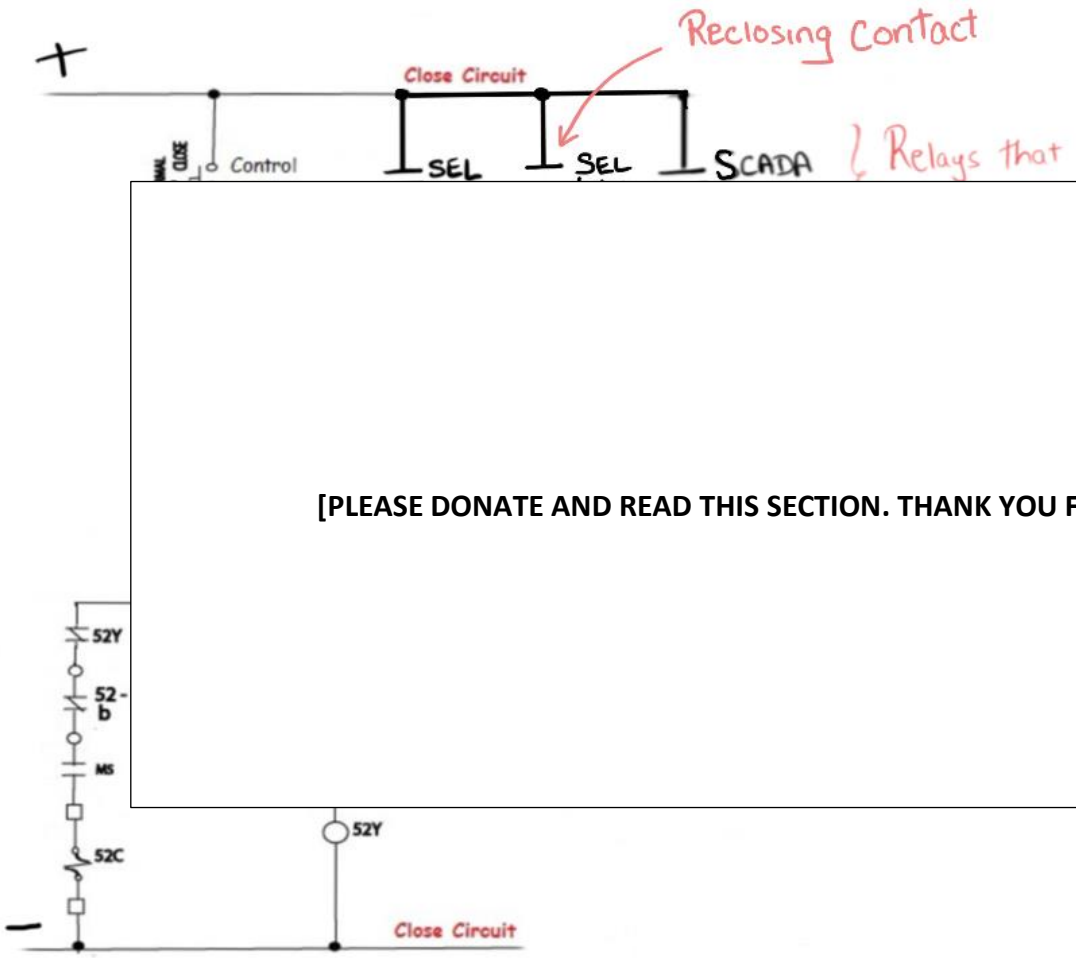
Reasoning for selecting shown relays to trip the breaker:

- 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, 86T isolates transformer, 86BF-CB3 isolates CB3, etc.

03 BREAKER CONTROL SCHEME



Closing scheme for 115kV circuit breaker CB1

[PLEASE DONATE AND READ THIS SECTION. THANK YOU FOR SUPPORTING THE BLOG]

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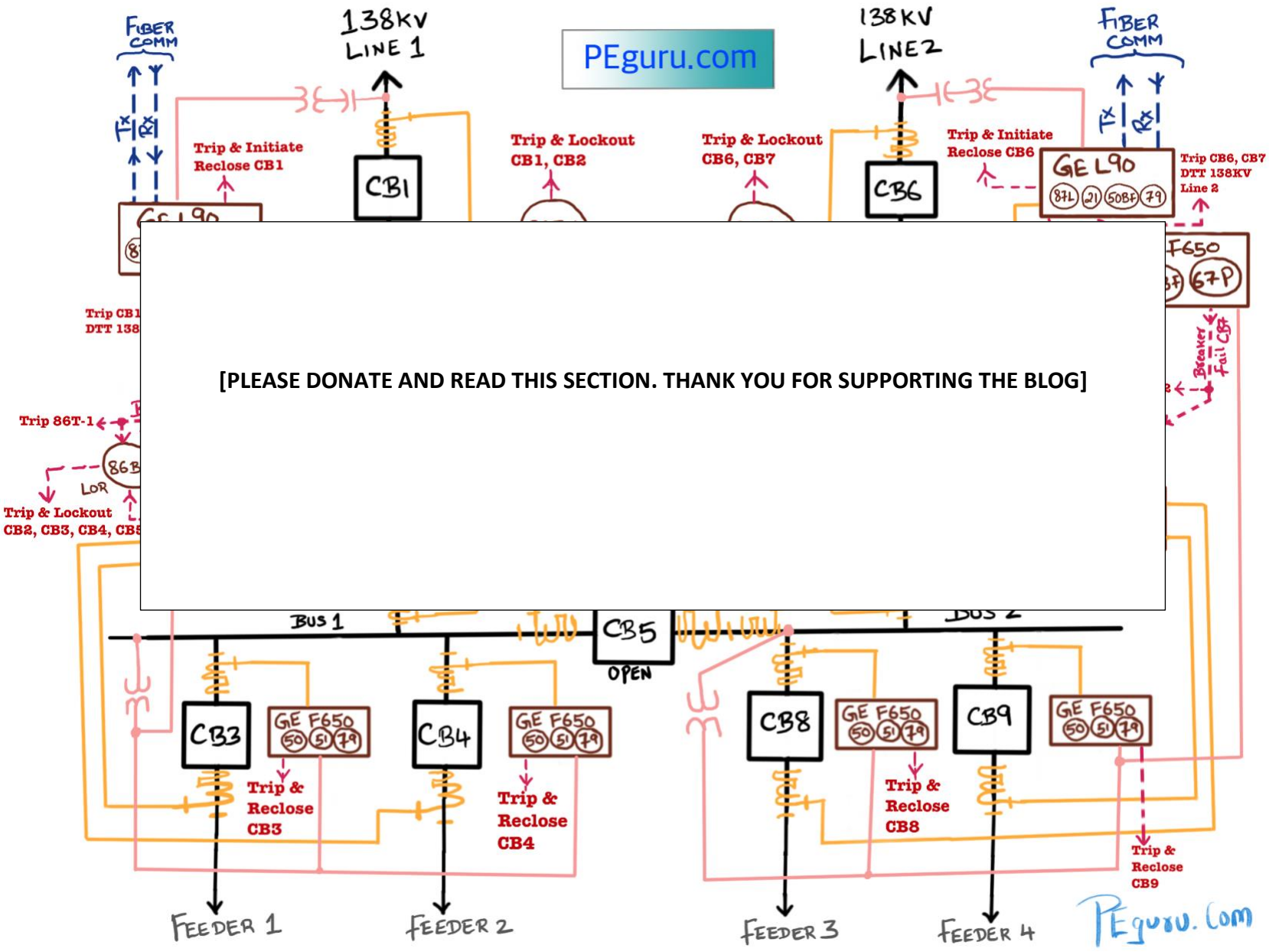
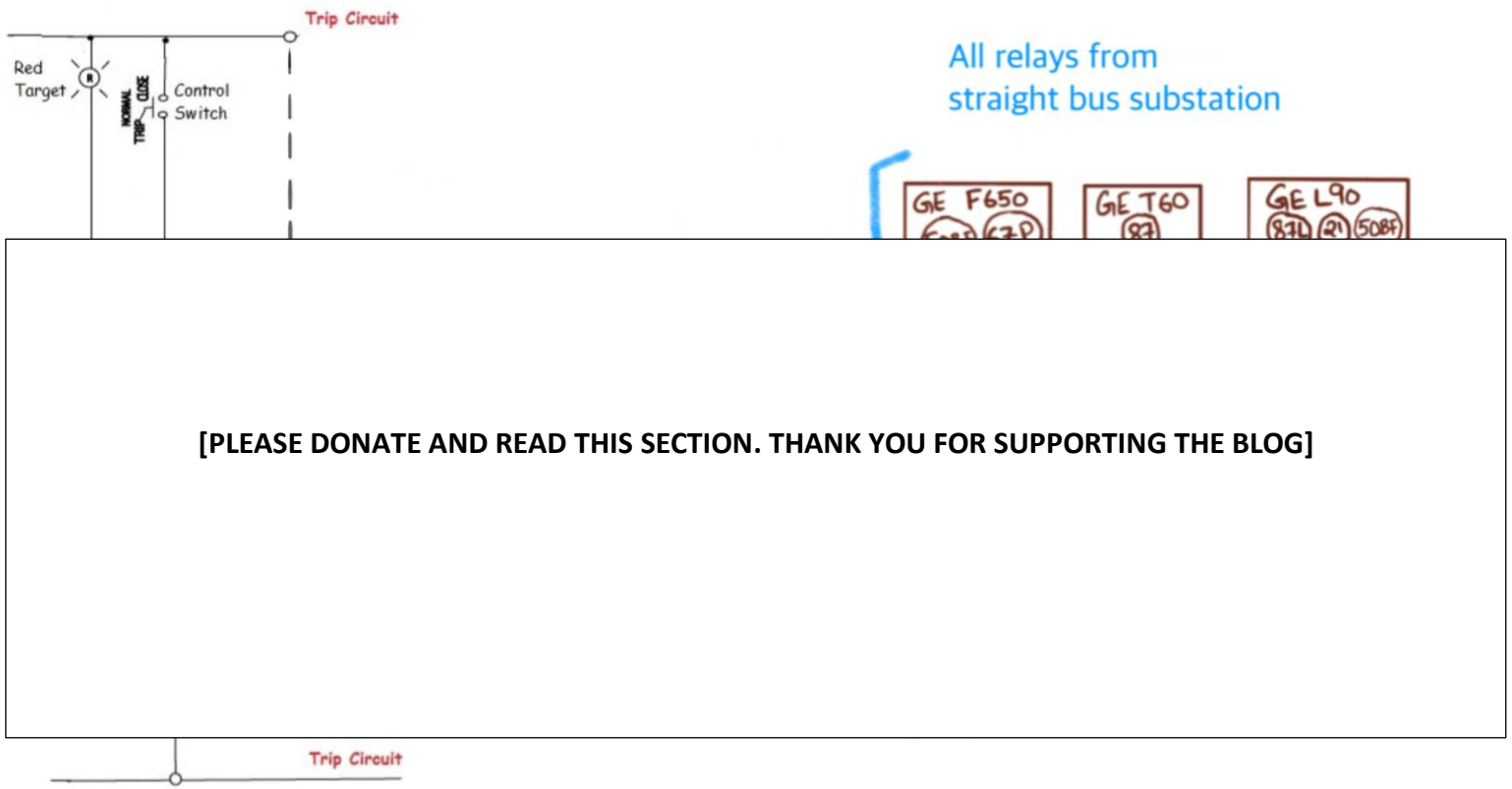
04 THE STRAIGHT BUS SUBSTATION

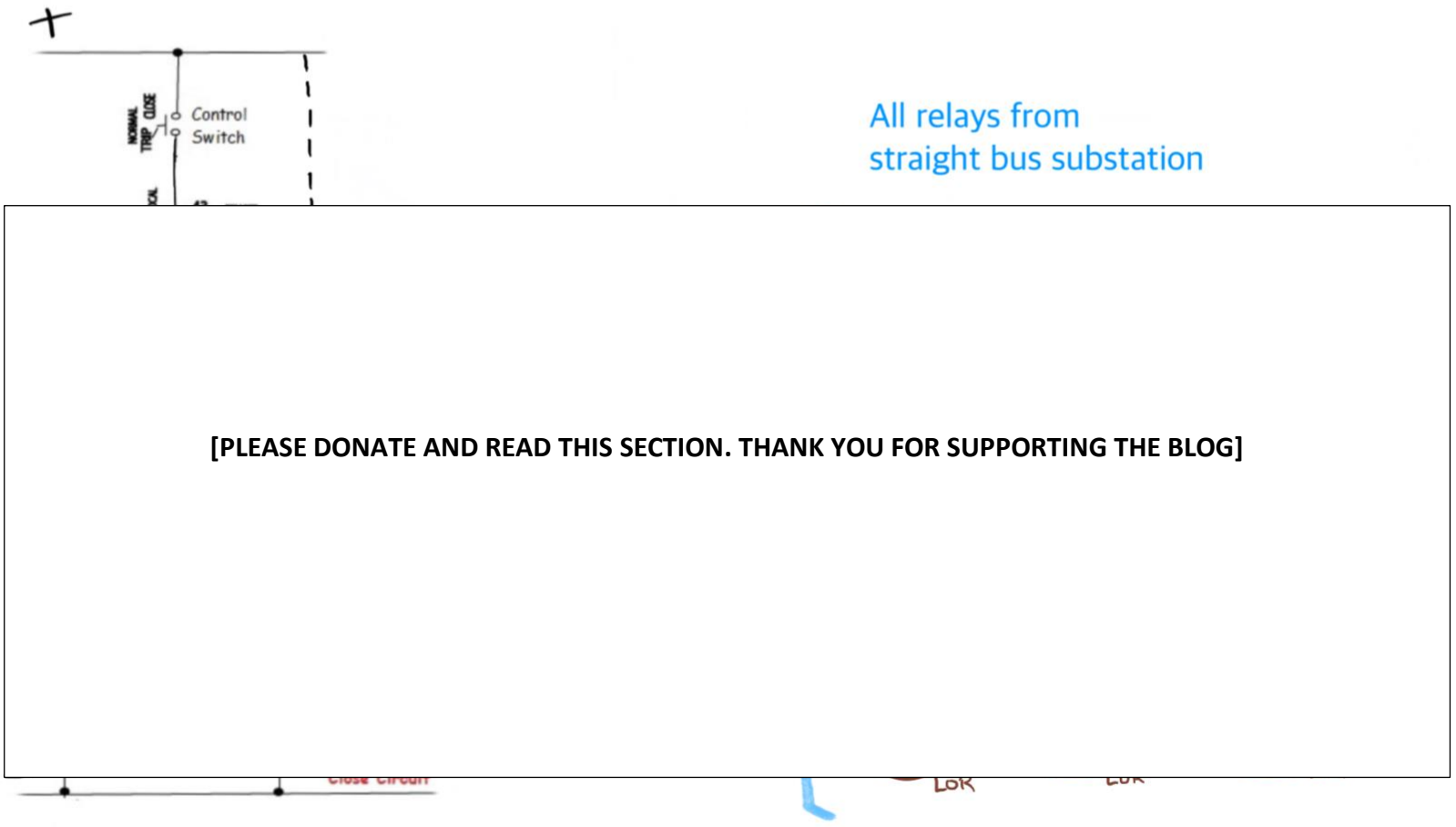


05 EXERCISE

Practice problem - CB2 Trip Circuit



Practice problem - CB2 close circuit



05 EXERCISE

SOLUTION

Practice problem - CB2 Trip Circuit

SOLUTION

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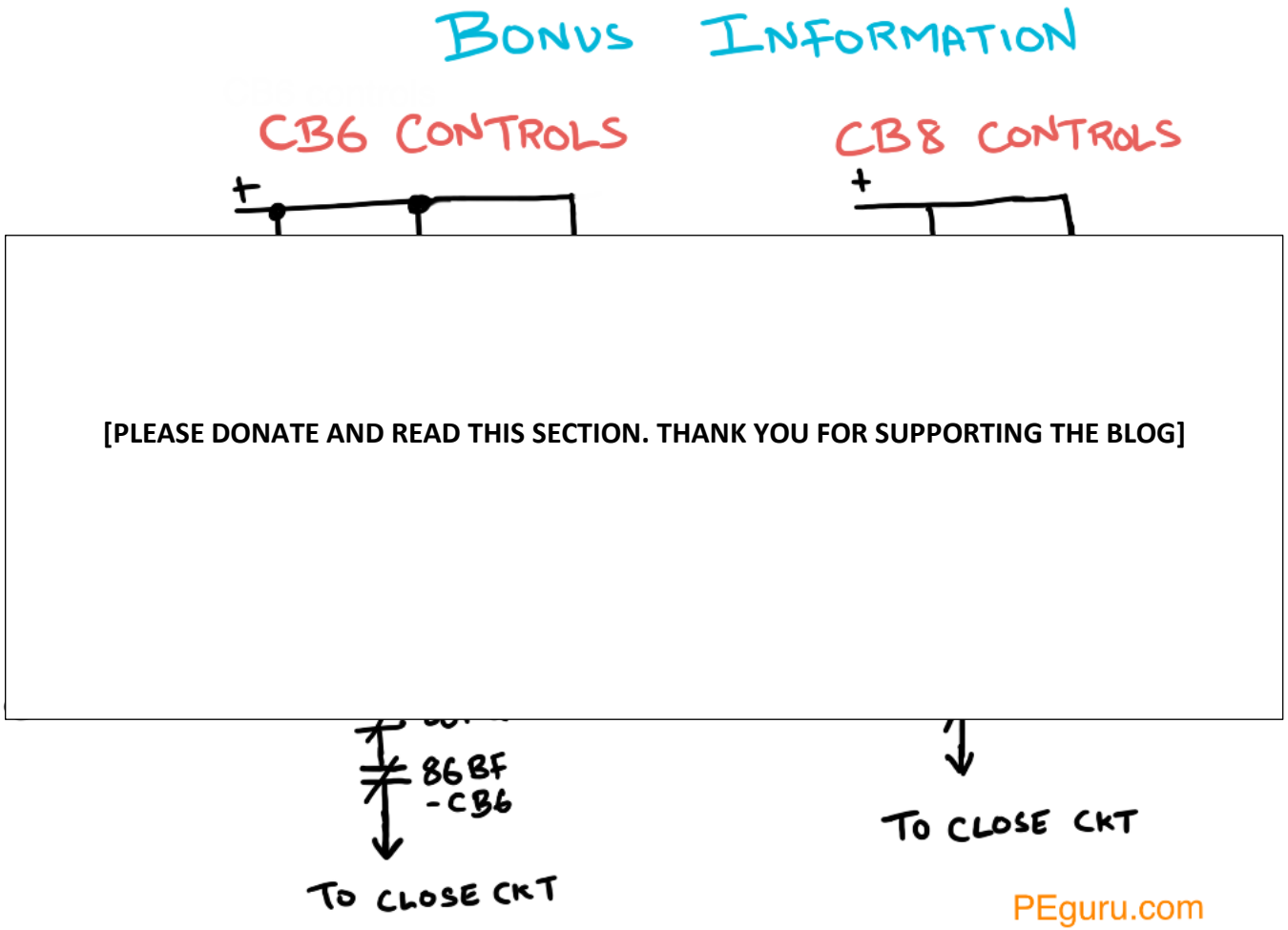
Practice problem - CB2 close circuit

SOLUTION

[PLEASE DONATE AND READ THIS SECTION. THANK YOU FOR SUPPORTING THE BLOG]

05 EXERCISE


BONUS INFORMATION
CB6 CONTROLS
CB8 CONTROLS
+
+
[PLEASE DONATE AND READ THIS SECTION. THANK YOU FOR SUPPORTING THE BLOG]
86BF
-CB6
TO CLOSE CKT
TO CLOSE CKT
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Questions? Ask at https://www.reddit.com/r/SubstationEngineering/

For additional information on substation engineering, visit https://peguru.com