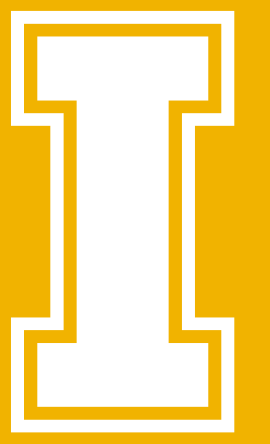




# DETECTING AND LOCATING CANCELING FAULTS IN SHUNT CAPACITOR BANKS



## OBJECTIVE

To develop and build a test bed to test an algorithm that can detect symmetric & asymmetric canceling faults in shunt capacitor banks (SCB). The test bed can also be used in protection classes.

## VALUE PROPOSITION

1. Shunt Capacitor Bank short circuits:

- Capacitors fail shorted, shorts parallel capacitors;
- Overvoltage develops over the other un-faulted series elements, possibly fail;
- Current flows in center branch of H bridge, protective relays can detect faults based on that current.

2. Canceling failures in Shunt Capacitor Banks:

- Failure of capacitors in different legs of H bridge removes voltage and current imbalance. Difficult to detect;
- Our goal is to build a test system to create symmetric and asymmetric canceling failures and provide measurement data to a relay.

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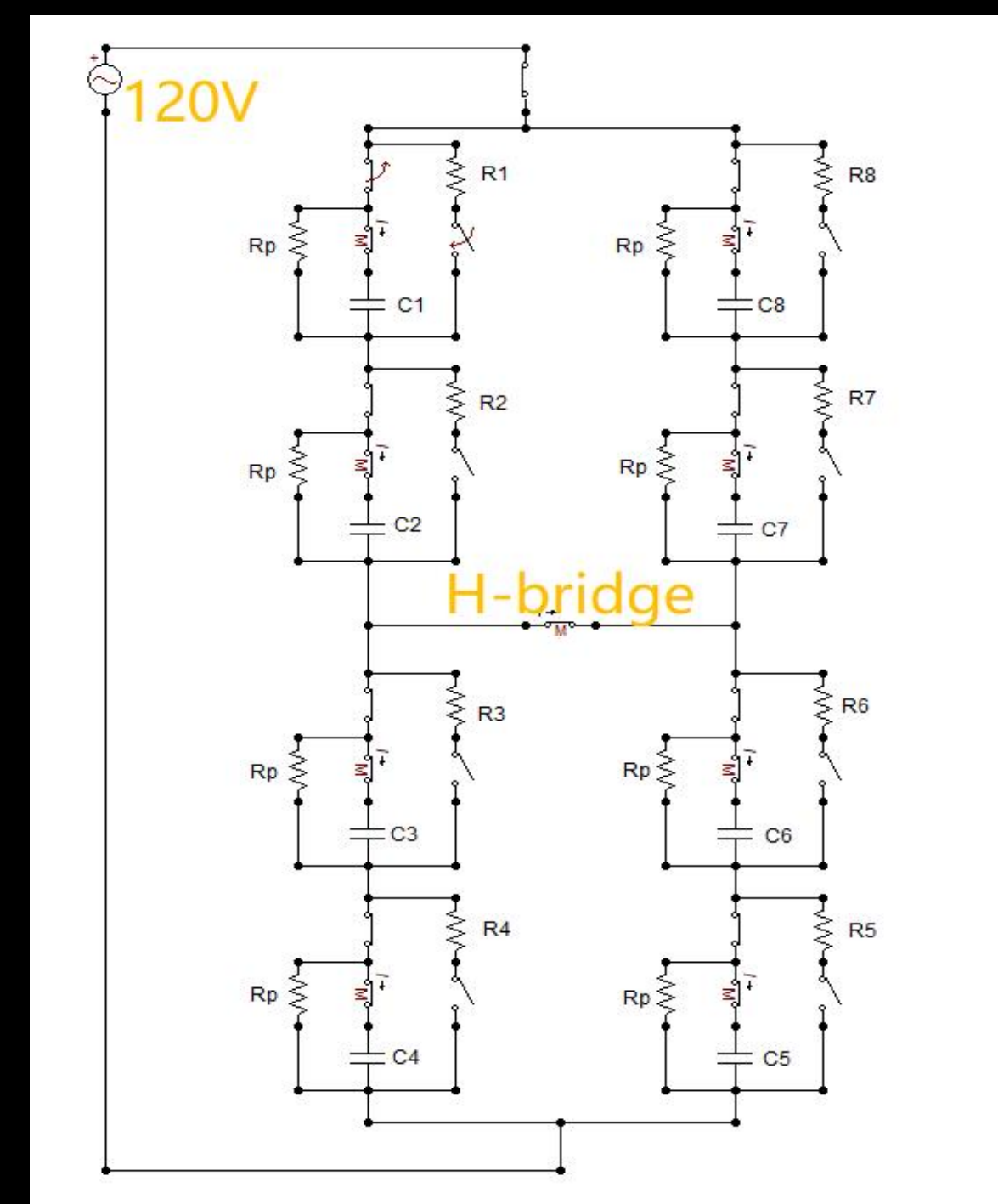


Figure 1: Simulation Model

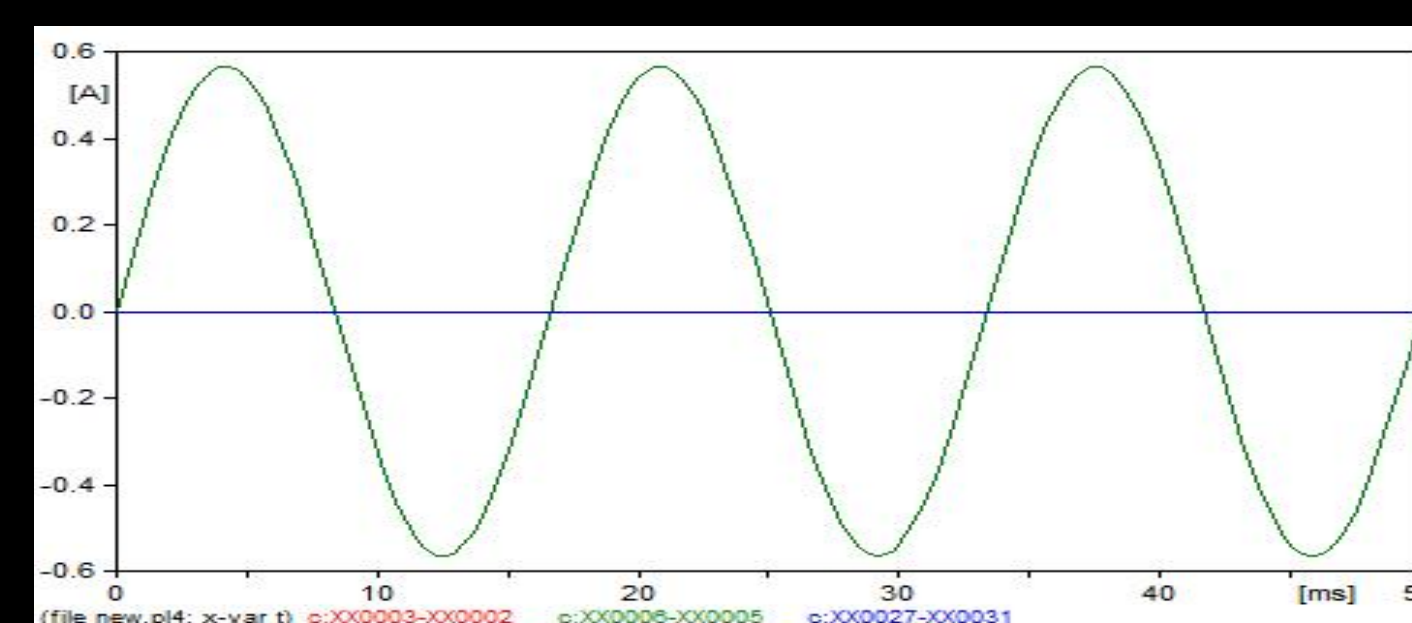


Figure 2: Balanced situation,  
Blue Line:  $I_{H\text{-bridge}}=0A$ ;  
Green Line:  $I_{C1}=0.59A$

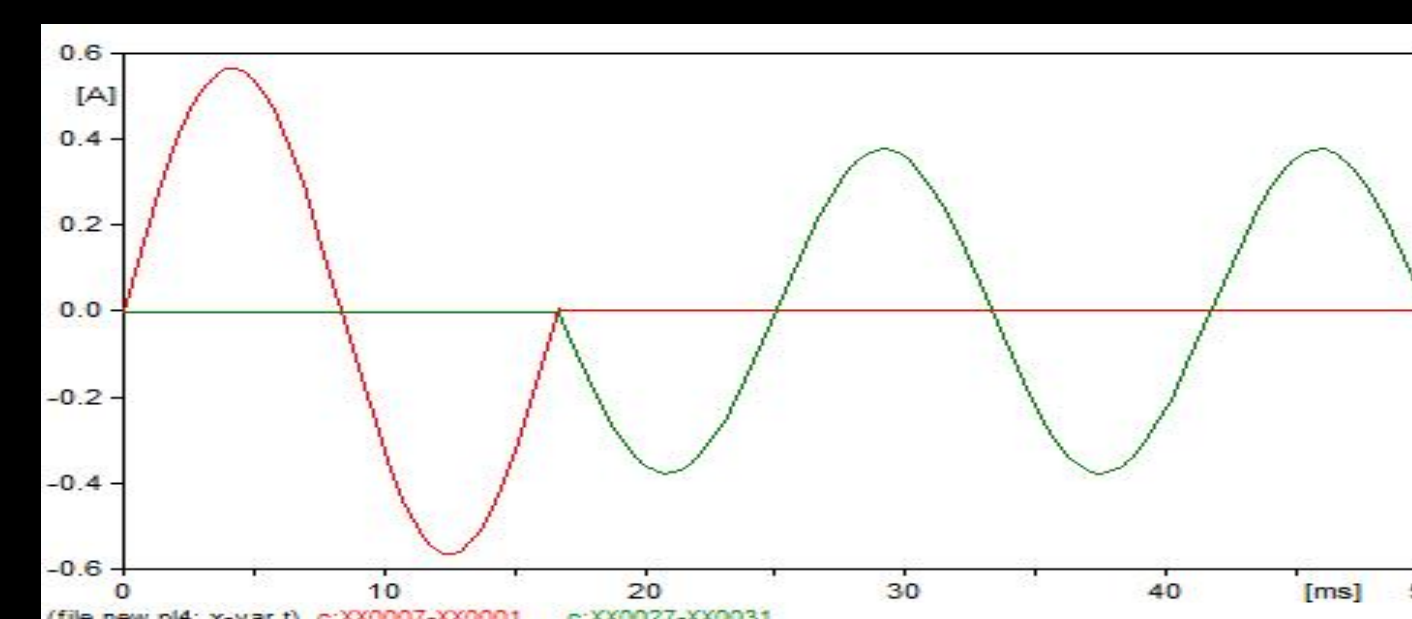


Figure 3:  $C_1$  is shorted,  
Green Line:  $I_{H\text{-bridge}}=0.39A$ ;  
Red Line:  $I_{C1}=0A$

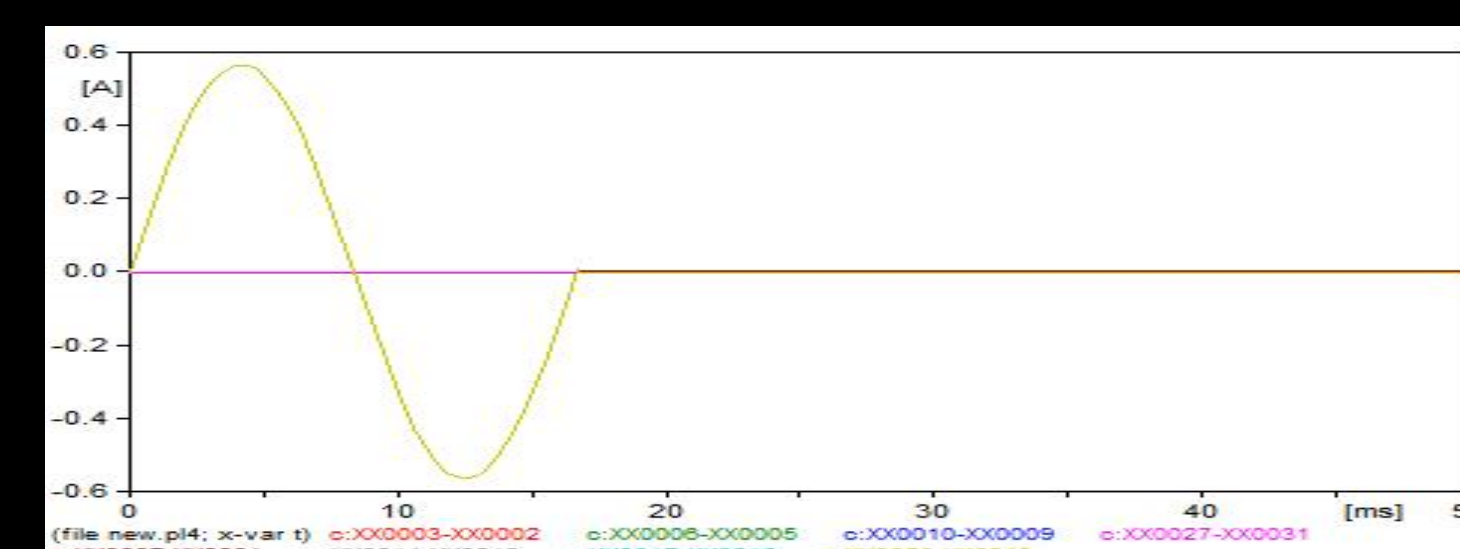


Figure 4:  $C_1$  &  $C_8$  are shorted,  
Pink Line:  $I_{H\text{-bridge}}=0A$ ;  
Brown Line:  $I_{C1}=I_{C8}=0A$

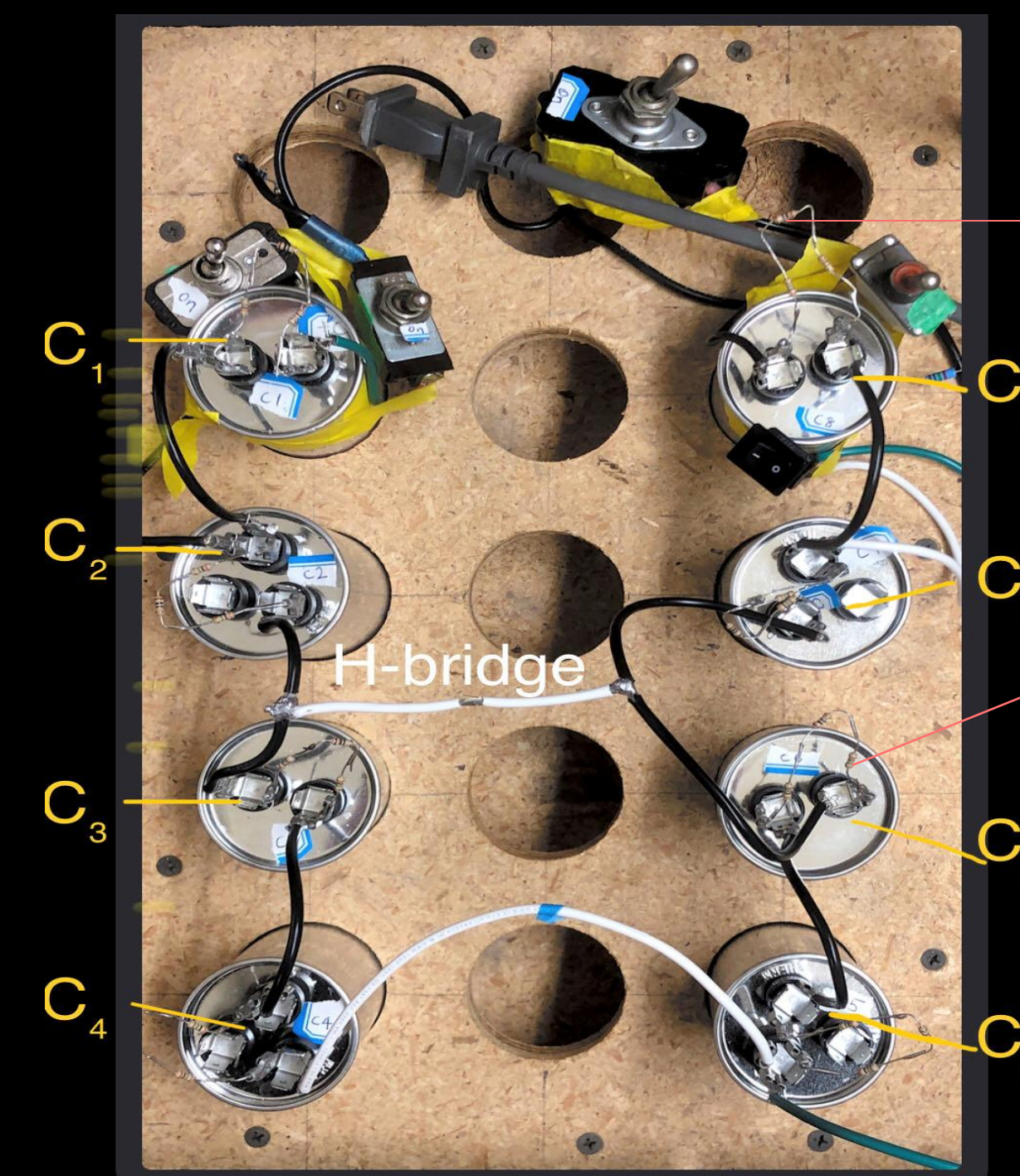


Figure 5: Lab Model



Figure 8: Balanced situation,  
 $I_{H\text{-bridge}}=0A$ ;  $I_{C1}=0.59A$



Figure 9:  $C_1$  is shorted,  
 $I_{H\text{-bridge}}=0.39A$ ;  $I_{C1}=0.02A$

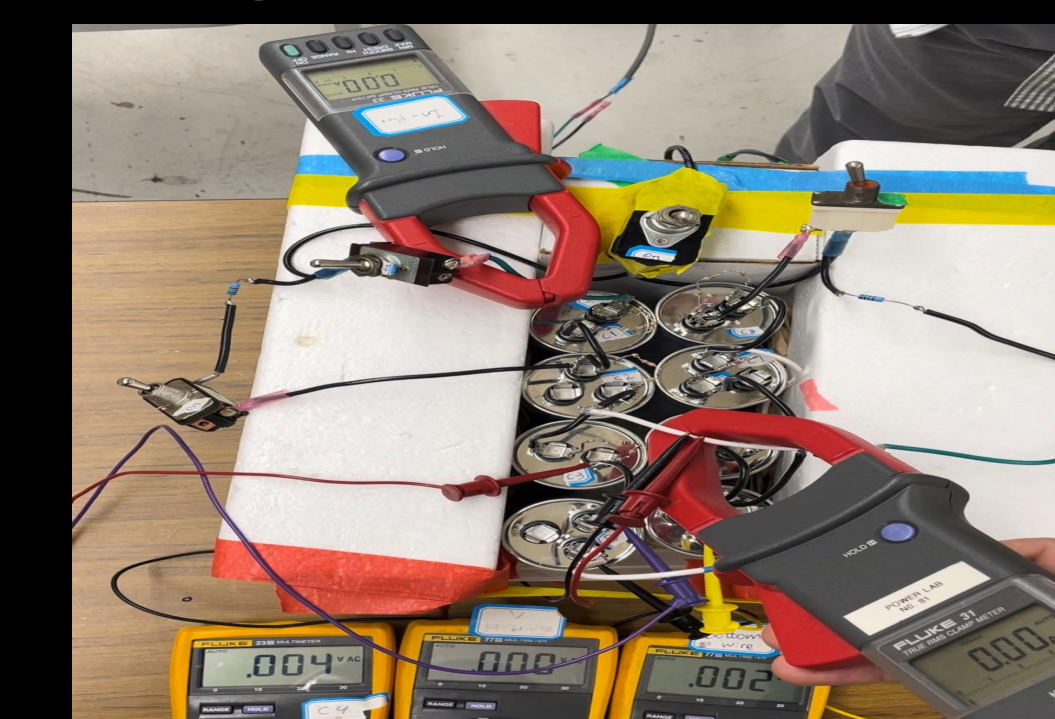


Figure 10:  $C_1$  &  $C_8$  are shorted,  
 $I_{H\text{-bridge}}=0A$ ;  $I_{C1}=I_{C8}=0A$



Figure 6:  
 $R_p=16.73M\Omega$ ;  
 $R_{1-8}=1M\Omega$ ;  
Cost: Free



Figure 7:  
 $45+5\mu f \pm 5\%$   
 $440VAC$   $50/60Hz$   
Cost=\$15.85 per unit

## KEY REQUIREMENTS

- ATP model and lab scale model should be able to create symmetric and asymmetric canceling faults.
- Voltage and current measurement points should be added to the H-bridge.
- Fault connection points must be with switches.
- Simulation model should match the physical test bed.

## CONCEPT DEVELOPMENT & CONCLUSION

First version: Using 4 capacitors to build the H-bridge at "ATP" simulation; Second version: Using 8 capacitors to build the H-bridge in "ATP" and hardware model; Third version: Using 8 capacitors in "ATP" and hardware model then connect protective resistors and short the capacitors using switches in parallel. Finally, build the final lab version.

## TEAM MEMBER

Mohammad Al Ebedan,  
Zesheng Guo,  
PeiCheng Ji,  
Zeying Chen

