

## Lab 4 - TA Version

Draft 2

### Background Information:

Commissioning is the process of installing a new device into both a physical system and SCADA system. In this laboratory exercise, students will attempt to install a new device into their existing system and customize its logic according to a provided sheet of specifications. Students must demonstrate that their system behaves as intended by applying different scenarios, and must make adjustments as necessary.

The relay introduced in this laboratory exercise is the SEL 351 Protective Relay. The SEL 351 is most commonly used to provide distribution feeder protection and event metering. The device provides plenty of customizable settings and logic. In this exercise, students will configure the SEL 351 and their AcSELeRator project to respond to simulated fault conditions. When a fault is applied, the students' system should trip and open an output contact on the SEL 351. Students will also need to configure logic in the SEL 351, SEL 849, and AcSELeRator RTAC software to trip the SEL 849 when a fault is applied to the SEL 351.

Commissioning requires engineers to test the actual response of a new device to field conditions. Students will use the KoCoS Automatic Relay Test System to apply secondary voltages and currents to the SEL 351. This system will be used to simulate different scenarios students must prepare the SEL 351 to respond to. The KoCoS will be remotely operated using a computer with the software ARTES installed.

### Learning Outcomes:

- Implement a new device into an existing system.
- Practice following a commissioning plan.
- Communicate between two different field devices through the use of a client device.

### Equipment Needed:

- Computer Workstation
- SEL RTAC
- SEL 351
- SEL 849
- KoCoS ARTES 460

### Cables Needed

- KoCoS Voltage and Current Leads x8
- SEL C662 USB to Serial cable
- Ethernet cable x2
- Serial Cable x3
- Serial Cable - Male to exposed leads

### Software Needed:

- SEL Quickset
- SEL AcSELeRator RTAC
- KoCoS ARTES Software

## Lab Walkthrough

## Initial Lab Set Up

1. Log into the main workstation computer.
  - a. User: engr-cs
  - b. Password: Pfaf2148
2. Open a session of SEL AcSELERator RTAC
3. Log into the AcSELERator RTAC database.
  - a. User: admin
  - b. Password: TAIL
4. Open the project the group created for Lab 2.

**Additional Steps:** Follow if students did not create a project for Lab 2 or did not save it:

1. Create a new project.
2. Connect to the SEL 849 Relay.
  - a. Connect the SEL 849 to the RTAC via a serial connection.
  - b. In AcSELERator, add an SEL 849 device to the project.
    - i. Use serial communication.
  - c. Connect the device to the SEL RTAC's serial port 2.
  - d. Configure the baud rate to 9600.
  - e. Save to ensure settings are correct, and connect to the RTAC.
  - f. Check to ensure the SEL 849 relay is connected.

## Setting up the SEL 351

1. Energize the SEL 351.
2. Connect the SEL 351 to the computer via the C662 USB to serial cable.
  - a. Plug the cable into the SEL 351's port F, and into any USB port on the workstation computer.
3. Open SEL Quickset.
4. Click the "Communication" button.
5. Set communication to Serial.
6. Find the settings of the SEL 351 by using the SEL 351's front panel button interface:
  - a. Click on the SET button.
  - b. Navigate to PORT and click the SELECT button.
  - c. Navigate to "F" and click select.
  - d. Navigate to "Show" and click SELECT.
  - e. Click the down arrow and find the settings labeled "SPEED." This is the baud rate of the device.
7. Enter the baud rate of the SEL 351's Port F into the communication setup window.
8. Click connect. Check the bottom left of the QuickSet's display window to ensure a connection is made.
9. Open the SEL Terminal window.
10. Log into the 351 by entering the following commands:
  - a. |acc
  - b. |Password: OTTER
  - c. |>2ac

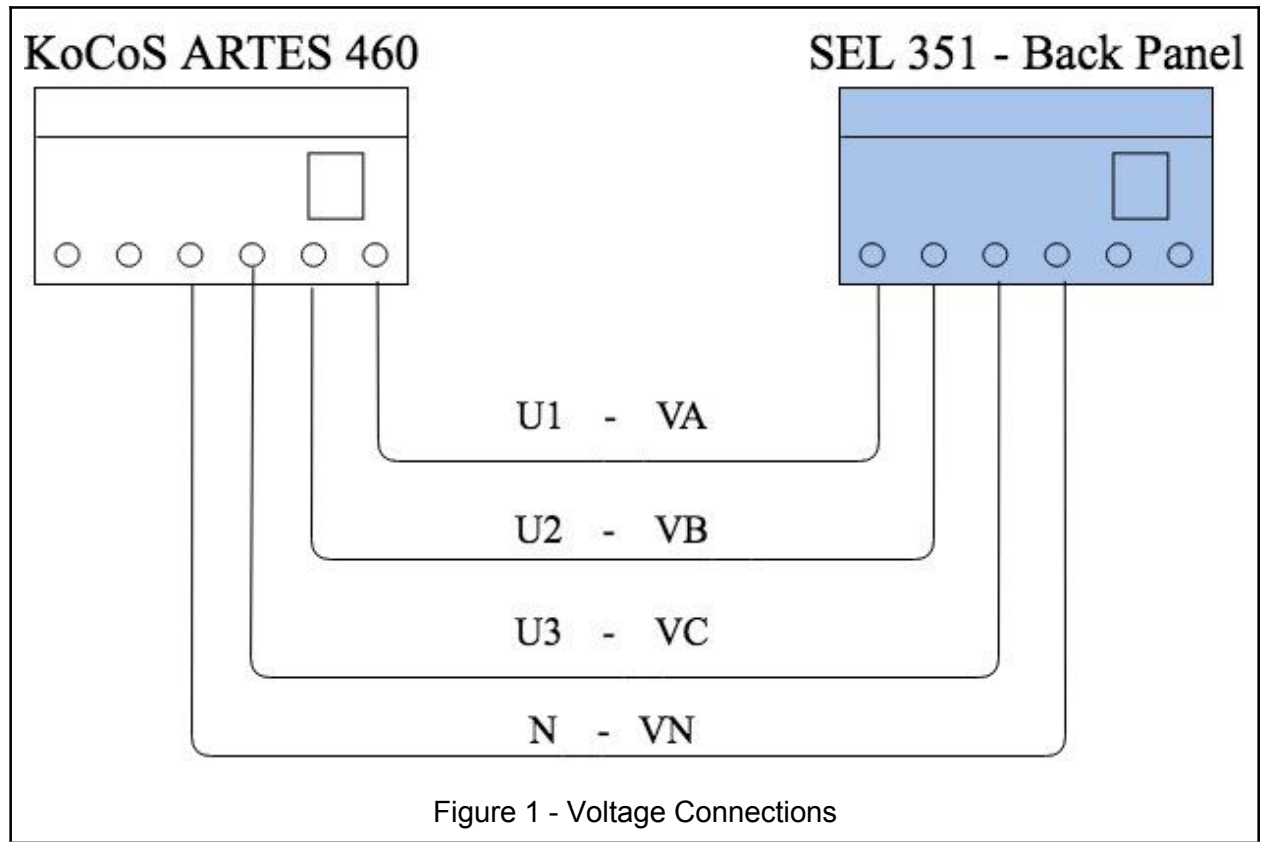
- d. |>Password: TAIL
- 11. Display the current device settings.
  - a. |>>sho
- 12. Configure the settings to those calculated in the prelab.
  - a. >>Set 1
    - i. CTR: 480
    - ii. CTRN: 480
    - iii. PTR: 180
    - iv. PTRN: 180
    - v. E50P: 2
    - vi. 50P1P: 2.00
    - vii. 50P2P: 4.00
    - viii. 67P1D: 4
    - ix. 67P2D: 0
  - b. Leave all other settings as default.
  - c. To change a single setting at a time (ex. CTR):
    - i. >>Set 1 CTR
  - d. Approve Settings.
- 13. Minimize SEL QuickSet.

### **Connect the SEL 351 to the existing system**

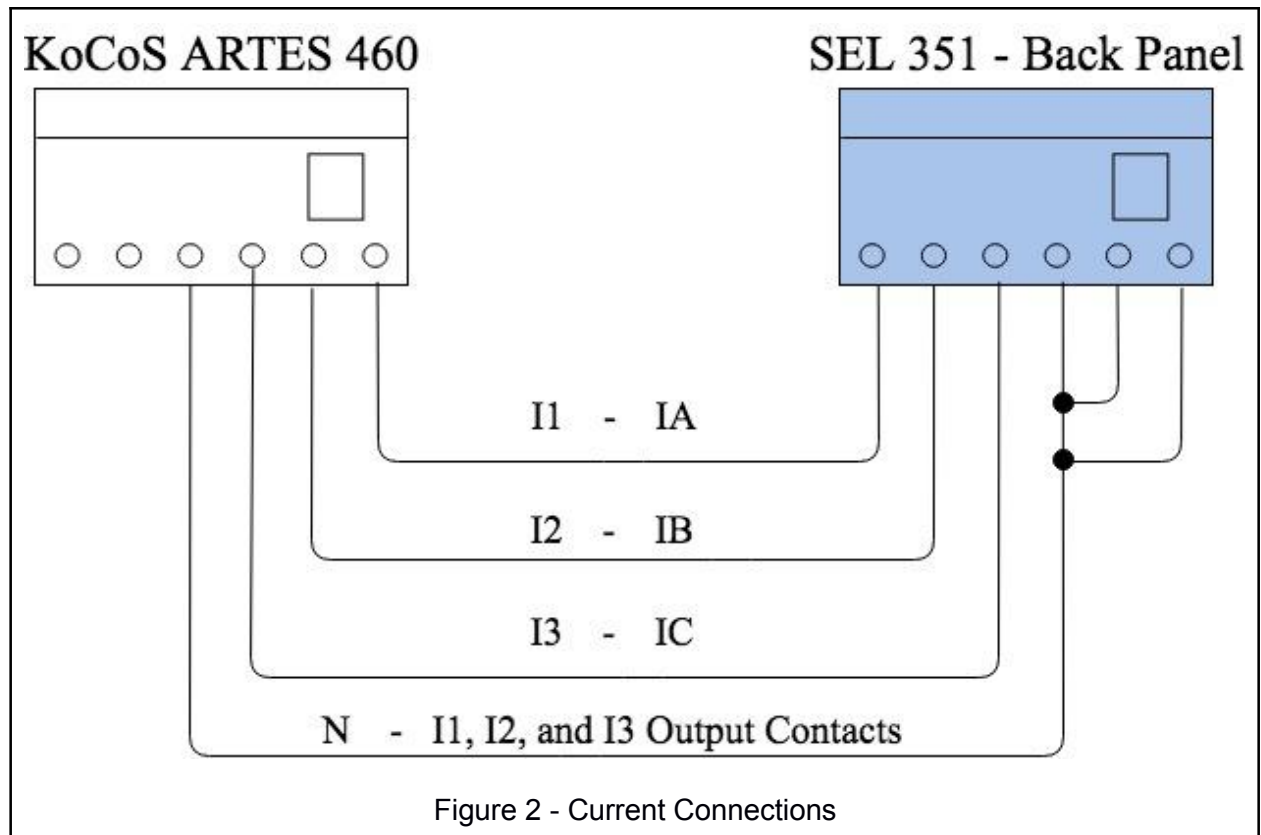
1. Connect a serial cable from Port 2 of the SEL 351 to Port 1 of the SEL RTAC.
2. On the workstation computer, open the SEL AcSELERator RTAC window.
3. Under the "Devices" folder, add in an SEL 351 device. The connection type is serial.
4. On the SEL 351 front panel, find and note the baud rate of Port 2.
  - a. Typical Baud Rate: 9600
5. In AcSELERator, update the Baud rate of the SEL 351 device based on the displayed value.
  - a. Select the device and navigate to the "Communications" tab.
6. Update the other communications settings of the SEL 351 to match those of the physical device.
  - a. Serial Communications Port: Com\_01
  - b. Serial Communications Port Type: EIA232
7. Click "Go Online."
  - a. Username: admin
  - b. Password: Asdf123\$
8. Check that the SEL 351 connects to the RTAC.
  - a. Click on the SEL 351 under the devices folder.
  - b. Navigate to the "Controller" tab in the left hand folder.
  - c. Check to see if the "Offline" tag is false.
  - d. If the Offline tag stays true, check to see if the baud rate was entered correctly.
9. Click "Go Offline."

### **Connect the KoCoS to the SEL 351**

1. Ensure that the KoCoS system is turned off.
2. Connect the voltage contacts to the SEL 351 back panel voltage contacts in a Wye connection as shown in the figure below.



3. Connect the Current contacts in a Wye connection as shown in the figure below.



4. Energize the KoCoS system.

#### Run the KoCoS using ARTES Software

1. Log in to the computer to the left of the main desktop.
  - a. User: engr-cs
  - b. Password: Pfaf2148
2. Open the software ARTES.
3. Click the "Home" symbol, then click "Open"
4. Open the device labelled SEL 351-7
5. Click on the "Test System" Tab.
6. Expand the button labelled "Connections," and open settings. Ensure that the settings match those shown below.
  - a. Connection: Serial
  - b. Port: COM1
  - c. Baud Rate: 57600
7. Save the settings, click the "Connections" button again, and click "Connect" to start communication with the KoCoS system.
  - a. If a connection is not made to the KoCoS, review that settings are correct.
  - b. Check to see if the KoCoS system is both plugged in and turned on.
  - c. Once connected, the "Connections" button will don a green circle.
8. Under the "Start" Tab, expand the "Monitors" button and select "Test Plan"
9. Once in the test plan tab, click "Open."

10. Open the test plan labelled “ECE 444 Lab 4 Test Plan.”
11. Select all test steps, and click “OK” to import the test plan.

### **Select Tags to Watch in the SEL 351**

1. Within the AcSELeRator RTAC project, navigate to the “Meter” tab of the SEL 351.
2. Near the bottom of the meter window, find the following tags and enable them to **True**.
  - a. SEL\_351\_1\_SEL.FM\_INST\_IA
  - b. SEL\_351\_1\_SEL.FM\_INST\_IB
  - c. SEL\_351\_1\_SEL.FM\_INST\_IC
  - d. SEL\_351\_1\_SEL.FM\_INST\_VA
  - e. SEL\_351\_1\_SEL.FM\_INST\_VB
  - f. SEL\_351\_1\_SEL.FM\_INST\_VC
3. Upload the new settings to SEL RTAC by clicking “Go Online” and logging into the device.
4. Once the project has been uploaded to the RTAC, navigate to the “Tags” tab in the SEL 351 window.
5. Check to make sure all tags are listed.
  - a. If a tag is missing, take the project offline and enable it, then upload the project again.
6. Voltages and Current values can be viewed by expanding a tag and then expanding the vector labelled “instCVal.”

### **Test the SEL 351 under Ideal Conditions**

1. Expand the test plan and click on the test step labelled “Ideal Conditions.”
2. With the Ideal Conditions test step open, navigate to the “Start” tab.
3. Run the test by clicking “Start”
  - a. Warning: Starting the test will energize voltage and current outputs.
4. Record the following values from the SEL 351.
5. Stop the test in the ARTES program.
6. Questions:

### **Test the SEL 351 under Symmetrical Fault Conditions**

1. Change the test step to “Symmetrical Fault Conditions.”
2. Run the test step.
3. View the event report in SEL SyncroWave Event.

### **Test the SEL 351 under Single Phase Fault Conditions**

1. Change the test step to “Unbalanced Fault Conditions.”
2. Run the test step.
3. View the event report in SEL SyncroWave Event.

**Steps that I am unable to accomplish from Home**

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## **Screenshots of SEL QuickSet, AcSELeRator, and ARTES**

Need to walk through the lab and take screenshots of software to better explain steps. This would take about three hours of work maximum to take screenshots, edit, and retake assuming familiar with equipment.

## **Link a Remote Bit in AcSELeRator to the SEL 351 Trip Signal**

Students will have to configure remote bit settings within the SEL 351, the AcSELeRator RTAC Project, and the SEL 849. The RTAC will monitor the status of Remote Bit 1 (RB1) in the SEL 351, and will periodically send the status to a remote bit in the SEL 849. If this bit is enabled in the SEL 849, the SEL 849 will trip. I have done this once and do not know enough about it to summarize in this report. I expect that this would take about three hours to walk through, document, and summarize in the reports.

## **Configure the SEL 849 to trip when the SEL 351 trips using remote bits**

See above summary.

## **Configure settings of ARTES Faults**

Need to configure the settings of test steps in ARTES software. All conditions require that the settings be changed from a default setting to correct voltages, currents, and frequencies. Symmetrical and unbalanced faults must be updated to stop the test after a certain amount of time. I forgot to properly save my settings, be sure to do so. This would not take very long to do, I expect 20-30 minutes max. I did not need any resources to figure out how to configure the output voltages and currents in the ARTES 460.

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## **Notes**

**April 7th** - I originally intended to add screenshots to this lab guide, but because of the stay at home order I cannot access the necessary software to do so. Screenshots would explain some steps much more effectively than words could.

**April 7th** - Lab 4 could be moved to be after Lab 2 (IED Lab) and before Lab 3 (HMI Lab). This lab does not require an HMI and builds directly off of the concepts in Lab 2. If the system in this lab was used in Lab 3 (HMI Lab), then students would have more variables to work with and would be able to further understand and simplify the complex system this lab has them create.

**April 29th** - To protect against loss of data, students should export their projects at the end of an experiment for later usage. This would apply to all labs except lab 1.