POWER SYSTEMS PROTECTION LABORATORY

OVERCURRENT RELAY COORDINATION

Purpose of the Experiment

- Recognition and use of the ROC 200C Overcurrent Protection Relay.
- Obtaining information about relay coordination

Preliminary Preparation

- Give information about relay coordination.

1. Introduction

In a system consisting of feeders lined up one after the other from the source to the extreme consumer, the one that is farther from the source from the relays that see the same fault is called selective **work ; The** adjustment process that enables this way of working is called relay **coordination**.

At the same fault current; the relay close to the source should open its breaker at least time t after the other. This time t includes the runtime errors of both relays, the runtime of the breaker of the remote relay, the time error caused by the inertia of the near relay, and a safety time. Each of these five components that make up time t can be considered an average of 0.1 seconds. In practice, then, the time t can be taken as 0.5 seconds. However, the following question may come to mind here, when the furthest one from the source is set to 1 second among the 4 feeders ordered with fixed time intervals, it is expected to be set to 2.5 seconds, which is closest to the source . In this case, the short circuit endurance periods of the transformers in the network may be exceeded, in which case the protection will lose its function.

It is not correct to try to provide overcurrent relay coordination in a network with many consecutive feeders from the source only by selecting the appropriate time values. Because in this case, the time delay of the overcurrent relay closest to the source will be too high and may not be able to prevent damage to the equipment. For this reason, by choosing the setting values of the operating currents of the relays appropriately, the time values can be prevented from increasing too much as they approach the source. If the coordination of the sudden elements of the relays can be done, then the time value can be reduced even more.

2. ROC 200C Overcurrent Protection Relay

2.1. General Information

The ROC 200C overcurrent protection relay consists of 3 phase overcurrent, one ground overcurrent and one reclosing relay. The reclosing relay can be serviced or serviced with the help of an independent button on the front panel when desired. The reclosing relay makes the desired number of reclosings, up to three times.

Figure 1. Front panel view of ROC 200C 3 phase + 1 ground overcurrent protection relay

For communication, an RS-232 port on the front panel is used to make relay settings with the help of a computer, to access the stored information in the relay memory and to see them on the computer screen. IEC 60870-5-103 via RS-485 port on the back of the relay Protocol Using Remote computer System with communication can be made. With the help of the RS-485 port, it is possible to remotely access and change all settings of the relay, turn the breaker on and off, access and examine all fault records. It is possible to delete.

While the relay is on standby, it shows the current values passing through the 3 phases and the ground, date, day and time on its front panel . The relay constantly checks itself and gives an alarm if it is unable to function. It can record the last 20 faults and records the moment of failure at 1 ms ha. The last fault record is recorded in the relay memory as that silographic record and can be transferred to the computer environment via the GEPA PC SUITE program when desired. In thosesilographic records, the current waveform before and after the fault can be examined. It is connected directly to mainstream transformers without the use of any transducers.

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Relay setting values are displayed via the keypad and communication ports on the front panel, It can be adjusted to the desired values, it can make the function ions active or passive, and it can give the command to open or close the breaker to which it is connected. The fault counter of the relay shows the number of phase and ground faults and the number of re-closures separately, and the fault countercan be reset at any time. It has the ability to be closed on cold load, and this feature can be made active or passive upon request.

It constantly monitors the tripping coil circuit of the breaker and gives an alarm if there is a fault in the tripping circuit. The relay has 4 digital inputs and 6 output contacts. Inputs and outputs can be programmed by the user to undertake the desired functions . There are 8 LEDs on the relay, and the user can determine which LED will show what. The relay monitors the operation of the breaker to which it is connected and notifies in case of any jam or malfunction. The relay can operate with any DC or AC voltage between 24V and 150V. The relay has 13 current-time characteristics , and phase and ground relays can be set to different current-time characteristics.

There are a total of 13 current-time curves in the relay, 12 of which are inverse-time and 1 of which are fixed-time. Phase and ground relays can be set to different current-time characteristics. The types of these current-time curves are listed below:

1. Normal Inverse (IEC)
2. Extremely Inverse (IEC)
3. Very Inverse (IEC)
4. Long Time Inverse (IEC)
5. Moderately Inverse (IEEE/ANSI)
6. Very Inverse (IEEE/ANSI)
7. Extremely Inverse (IEEE/ANSI)
8. Fixed + Reverse
9. Normal Reverse **10.** Long Reverse
11. US CO8 Inverse
12. US CO2 Short Time Inverse
13. Fixed time

2.2. Computer Communication and GEPA PC SUITE Interface Program

The ROC 200C Overcurrent Relay can communicate with local computers via the RS-232 port on the front panel. For this, GEPA PC SUITE software is used. Thanks to this software, all transactions made on the computer can be done on the computer. Today, new computers have a USB port instead of an RS-232 port. On computers that do not have an RS-232 port, communication is provided using the "USB-RS232" converter.

When the GEPA PC SUITE program is run, a window like the one below will appear on the screen.

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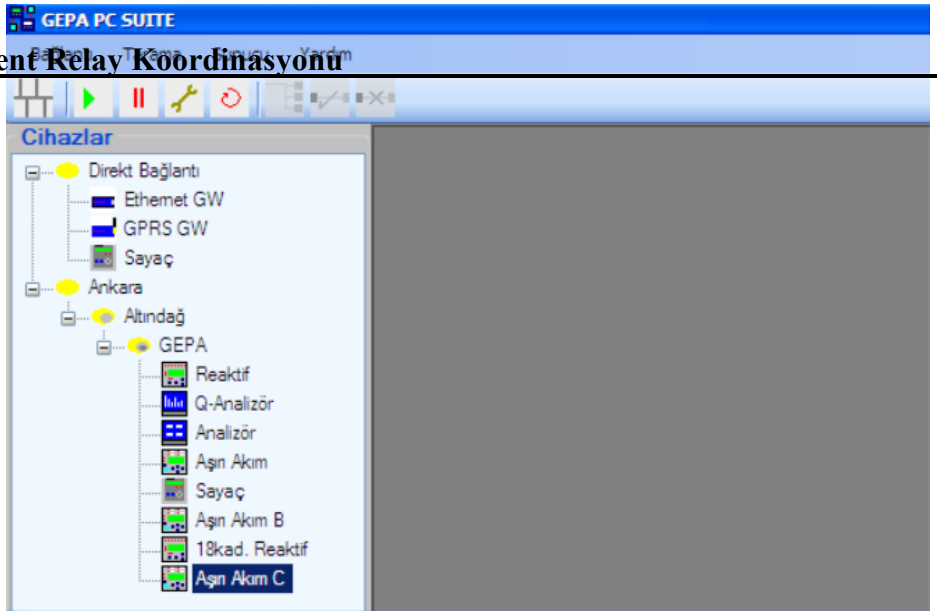
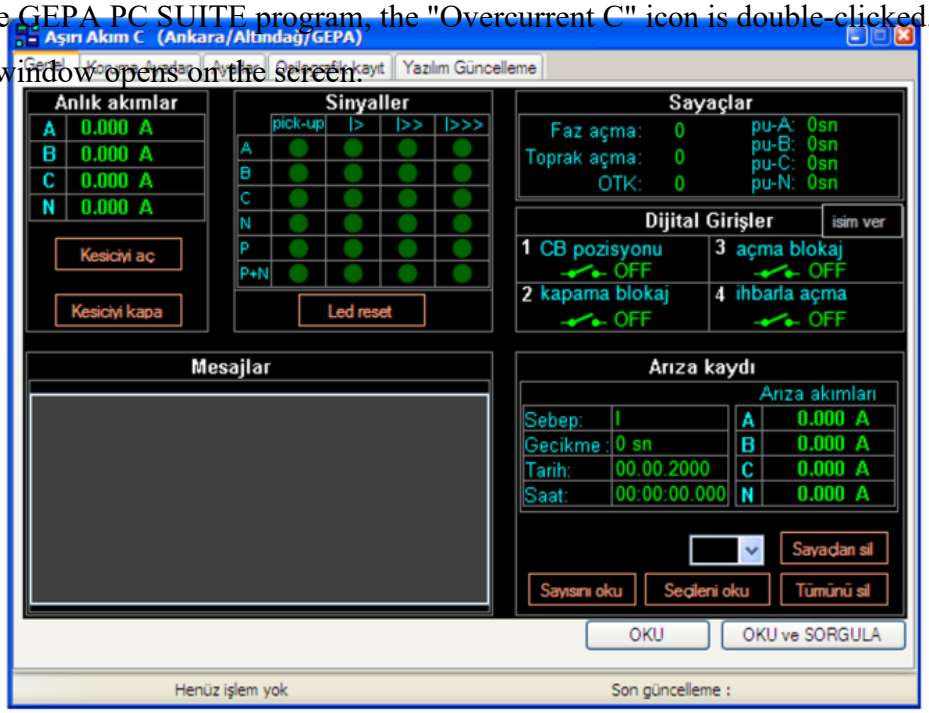


In the GEPA PC SUITE program, the "Overcurrent C" icon is double-clicked. The following window opens on the screen:



In this window;

1. Currents (three phase and ground) passing through the line to which the ROC 200C is connected, **2.** Signal LEDs on the front panel of the ROC 200C,

3. Opening numbers (phase and ground opening) and reclosing numbers, **4.** The status of digital entries,

5. You can see fault records and messages given by the relay,

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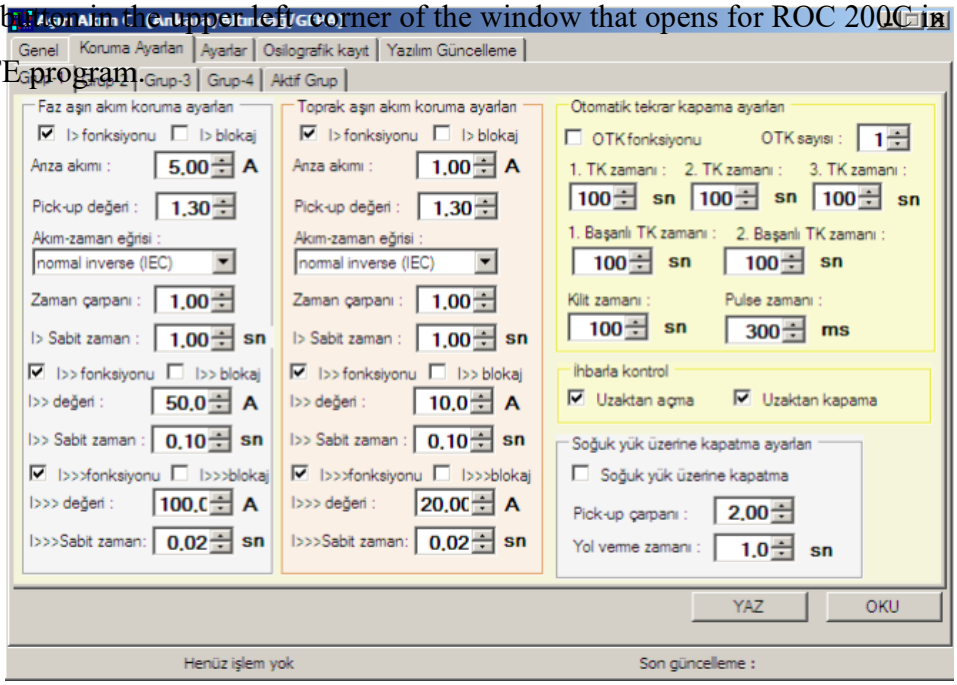
6. It can turn on and off the breaker to which the relay is connected; can reset signal LEDs, You can delete the counters and give the digital entries the name you want.

For communication with the relay, the "READ" or "READ and QUERY" button is pressed. If everything is done correctly, communication is established with the relay and where the message "No action yet" appears at the bottom, there is the message "Communication successful".

To adjust the settings of the relay with the help of a computer, click on the "Protection Settings" button in the upper left corner of the window that opens for ROC 200C in the GEPA PC S UITE program.



With the help of the functions in this window,

1. Phase overcurrent protection settings,

2. Ground overcurrent protection settings,

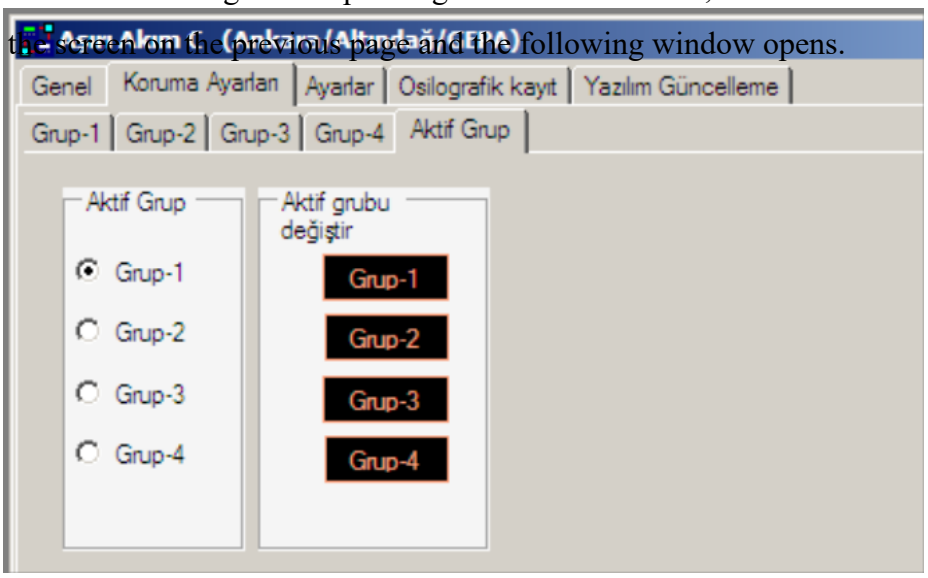
3. Automatic re-closing settings, remote opening and remote closing, closing settings on cold load are made.

In this experiment, since the relay connection is made for phase overprotection, only phase protection settings will be made. The ROC 200C Overcurrent Relay has 3 levels of current settings. These; Delayed opening and two levels are sudden opening. The first setting encountered in the phase overcurrent protection settings section is the "I> function" setting. When this setting is activated, delayed opening will be activated. The "fault current" value or the 1st threshold value can be set to the desired value in steps of 0.01 A between 0.25-10 A. The " pick-up value" is set to the value at which the pick-up is desired to be made at how many times the 1st threshold value is set. From the "Flow-time curve" and "Time multiplier" menus, the flow-time curve and time multiplier to be studied are selected. Thus, the current flowing through the current coils of the relay is above the fault current value and the pick-up value (for example;

pick-up value is "1.30", fault current value is 1.30 x 5.00 = 6.50 A for "5.00 A"),

At the end of a time delay depending on the type of current-time curve selected and the time multiplier, the relay will trip the breaker to which it is connected. The last setting that can be made in this section is the "I> Fixed time" setting. When the time delay curve is selected in fixed time with this menu , the delay adjustment is made. It can be adjusted in steps of 0.01 between 0.05 and 20 seconds. In order to activate the 2nd threshold and the 3rd threshold sudden opening, the "I>> function" and "I>>> function" must be activated, respectively. The 2nd threshold value is set with the "I>> value". With "I>> Fixed time", the time delay is set for the 2nd threshold current setting. The 3rd threshold value is set with the "I>>> value". With "I>>> Fixed time", the time delay is set for the 3rd threshold current setting. Fixed times can be set between 0.01–5.00 sec.

There are 4 separate adjustment groups in the ROC 200C Overcurrent Relay. If desired, each group is set to individual values. When necessary; According to the need, the desired group is activated according to the operating conditions. For this, click the "Active Group" button on the screen on the previous page and the following window opens.



In this window, whichever group will be active is marked. Since "Group-1" is marked on the left, "Group-1" is active in this relay. The relay will operate according to the values set in Group-1. If another group was marked, it would work according to the set values in that group. When a change is made to any setting on the protection settings screen, press the "WRITE" button to transfer the change to the relay.

2.3. ROC 200C Current-Time Curves

In the ROC 200C relay, each of the 12 inverse time curves has its own formula. However, all curves are inferred from a common formula. The common formula is given

below:

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$$t(\text{sec}) = K \times \left(\frac{A}{\left(\frac{I}{I_s}\right)^N - 1} + C \right)$$

K : Time multiplier

ИI_s : Ratio of fault current to set current value A,C,N

: Constants varying according to the curve

The function of the Normal Inver se (IEC) curve to be used in this experiment is as follows.

$$t(\text{sec}) = K \times \left(\frac{0.14}{\left(\frac{I}{I_s}\right)^{0.02} - 1} \right)$$

Figure 2 shows the curves that can be selected according to the time multiplier K in the Normal Inverse (IEC) curve.

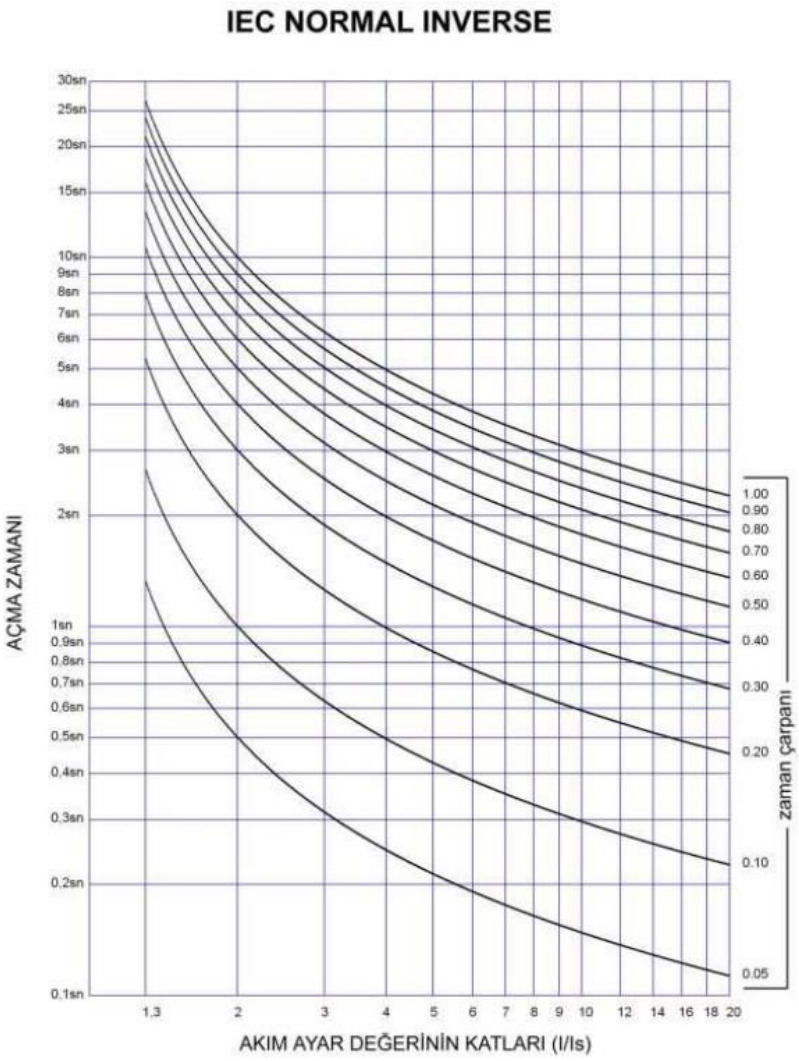

Figure 2. Reverse time overcurrent relay curve selection

3. Conducting the Experiment

1. Make the connections given in Figure 3.

2. Calculate the current setting values (TS) of relays 1 and relays 2 with a maximum load of 100 W on the second bus and a maximum of 200 W on the third busbar. (Both loads connected to the busbars are omic. The rotation ratios of current transformers are 5:5. Relay current setting values will be taken as 20% more than the max simum load current found.)

3. According to the current setting values you find, the time delay settings of the relays (TDS) SNormal Inver given in figure 2if (IEC) curve. (Here, we set the current-time curve of the overcurrent relay to GEPA PC SDo not forget to set it to "normal inverse (IEC)" from the UITE program interface. Busbarssimum fault current values 1st bus 15 A, 2nd bus 10 A and 3rd bus 5 A, $T_{Esici} = 0.1$ sec and $T_{father} = 0.3$s will be taken as.)

4. Set relays 1 and relay 2 on the GEPA PC S UITE program using these calculated values. (In the "Fault current" section given in the GEPA PC SUITE interface, the relay setting value you found will be divided by the pick-up value. In this experiment, take the pick-up value as 1.20.)

5. Set the load connected to the second busbar to 100 W and the load connected to the third busbar to 200 W. Make sure the fuses are turned off.

6. Energize the experiment set. The breakers are initially in the open position. Turn off both breakers by pressing the "START" button.

7. Open the fuse of the loads connected to the second and third busbars in order, measure and record the current and voltage values from the measuring instruments connected to the first and second busbars.

8. Set the value of the load connected to the third busbar to 300 W. Observe the status of relay 1 and relay 2.

9. Return the value of the load attached to the third busbar to its original position. Reset the relays. (For reset, the "Click the "DELETE" button.) Turn off the breakers again and allow current to flow from the line .

10. Set the value of the load connected to the third busbar to 500 W. Observe the status of relay 1 and relay 2. How has the opening time of the relay changed compared to the previous situation?

11. Return the value of the load attached to the third busbar to its original position. Reset the relays. Turn off the breakers again and allow current to flow from the line.

12. Set the value of the load connected to the second busbar to 200 W. Observe the status of relay 1 and relay 2.

13. Return the value of the load connected to the second busbar to its original position. Reset the relays. Turn off the breakers again and allow current to flow from the line.

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14. Set the value of the load connected to the second busbar to 400 W. Relay 1 and relay 2 Observe the situation. Compared to the previous situation, the opening time of the relayhas changed. **15.** Return the value of the load attached to the second busbar to its original position. Reset the relays.

16. Deactivate relay 2. (Remove the supply terminals of Relay 2.) Turn off the breakers again and allow current to flow from the line.

17. Set the value of the load connected to the third busbar to 300 W. Observe the status of Relay 1.

18. Return the value of the load attached to the third busbar to its original position. Reactivate relay 2. (Connect the supply terminals of Relay 2.) Reset the relays.

19. Adjust the TDS value determined for relay 1 using the GEPA PC SUITE program for relay 2 and the TDS value determined for relay 2 using the GEPA PC S UITE program for relay 1.

20. Turn off the breakers and allow current to flow through the line.

21. Set the value of the load connected to the third busbar to 300 W. Observe the status of relay 1 and relay 2.

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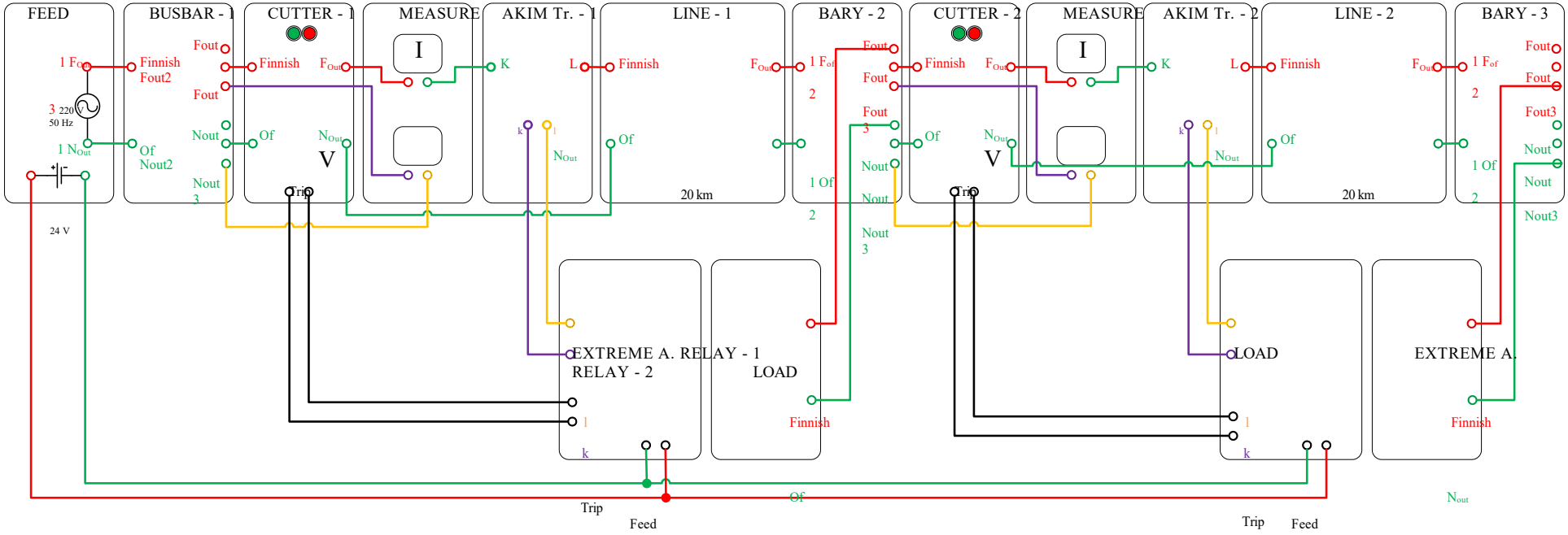

Figure 3. Experiment wiring diagram