DIFFERENTIAL RELAY EXPERIMENT

1. Preparation Questions

1- Explain the working principle of the differential relay and specify the places of use.
2. What is transformer inrush current? Associate with transformer differential relay protection.
3- What do the terms difference current and Bias current mean? Explain the blocking and working regions curve given in Figure 2.

2. General Information

Differential relays are generally used to protect generators, busbars and transformers. The figure shows the differential protection method for the line (for a single phase).
If there is no fault in the line, I1 = I2 and for the same current transformers, I1′ = I2′. In this case, the relay does not work because the current flowing through the relay working coil is zero. However, in a fault such as phase-phase or phase ground short circuit that will occur on the line, there will be I1≠I2 and I1≠I2′. The I1′- I2 differential current flows through the relay working coil and may cause the relay to operate. These relays are called differential relays as the operation of the relay depends on the differential current and the protection diagram is given in Figure 1.

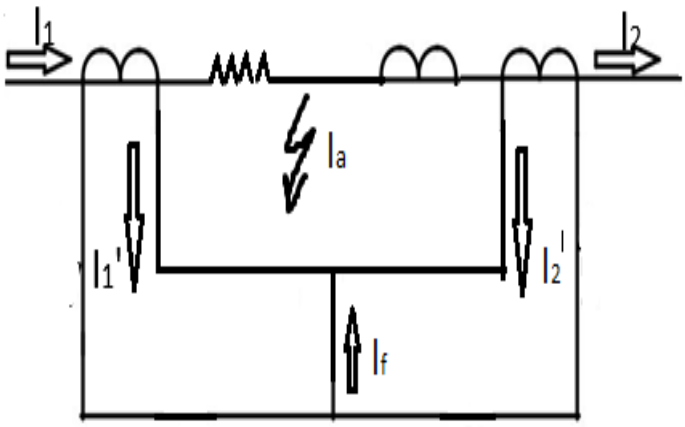

Figure 1: Differential Relay Protection

$$I_1=I_2 \Longrightarrow I_F=0$$
$$I_1'\neq I_2' \Longrightarrow |I_F|>0$$
$$I_1=I_a+I_2$$
$$Z_{sargı}=R_1+jX_1+R_2+jX_2$$

The curve that gives the difference current-bias current relationship for the relay we use is given in Figure 2. As it can be understood from this, the slope is 20% up to 1 pu and 80% thereafter, and varies in the range of 0.1-0.5 pu in the vertical direction as seen in the curved graph in question.

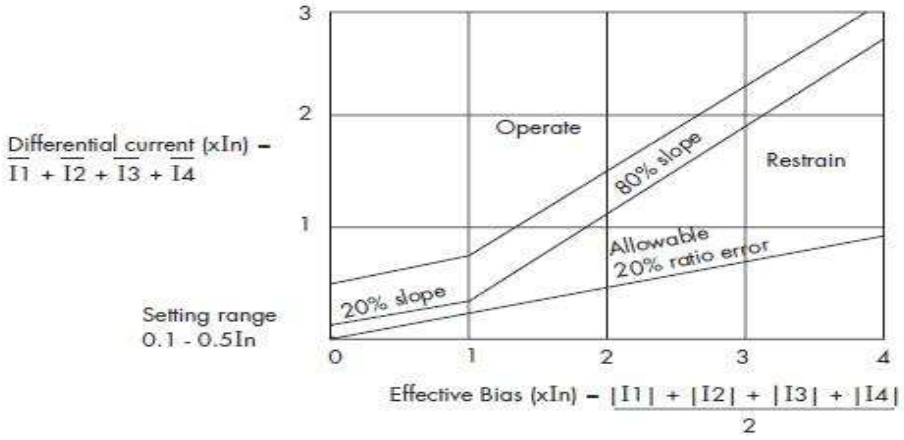

Figure 2. Differential current-bias current curve graph of the differential relay used

3. Conducting the Experiment

The operation of the differential relay will be examined in the experiment. The current flowing through a transmission line will be compared with the help of a differential relay and when it exceeds a certain percentage, the relay will open. The experiment will be run as a single phase system. The capacitive effect that will occur in the line will be neglected. The relay to be used is the Differential Protection Relay of the brand and type "Alstom KBCH 120". The front face of the relay is shown in Figure 3.

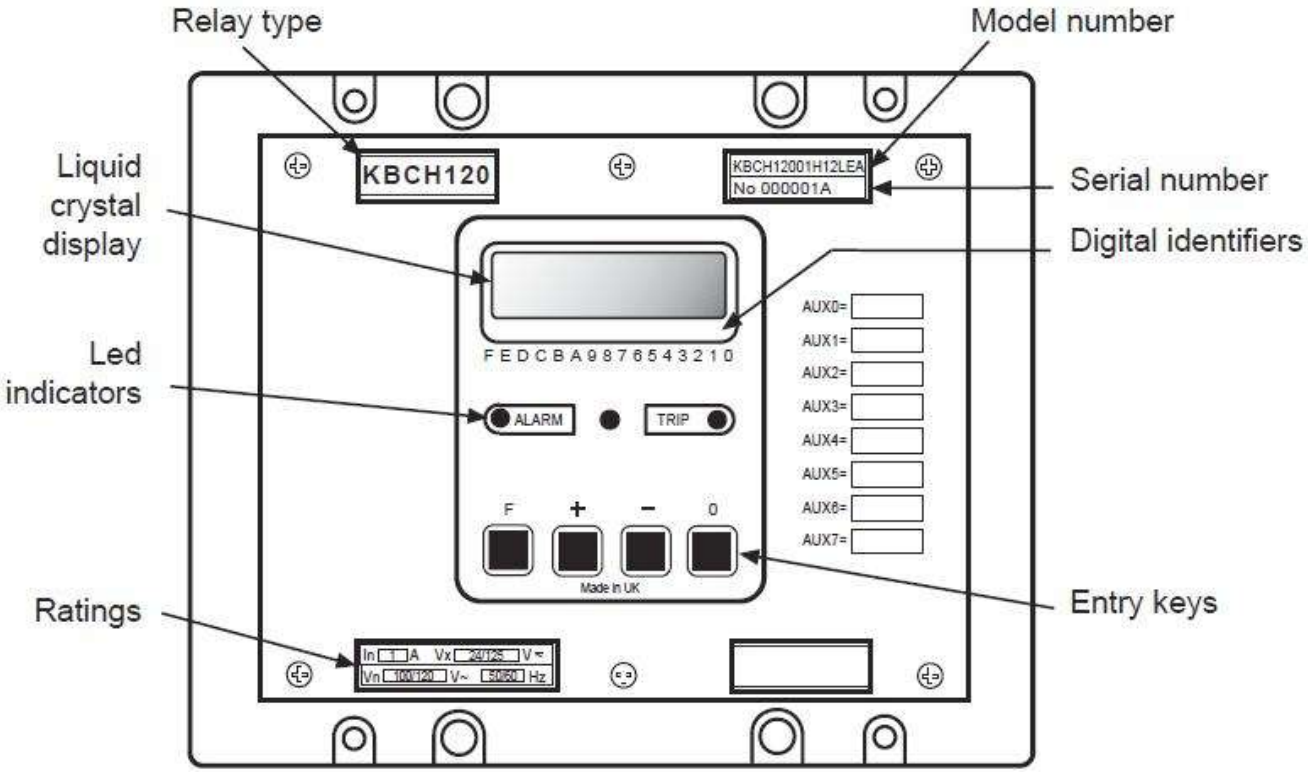

Figure 3. Alstom KBCH 120 brand differential relay front

Other elements to be used in the experiment;

- ✓ 2 Pieces Cutter
- ✓ 2 Current Transformers
- ✓ Transmission Line
- ✓ Load Bank

In the experiment, the load drawn from the grid will be carried by the transmission line. The effect of the differential relay on the system will be examined by creating a current difference between the beginning of the line and the end of the line.

Conducting the Experiment:

- Make the connections in Figure 4.

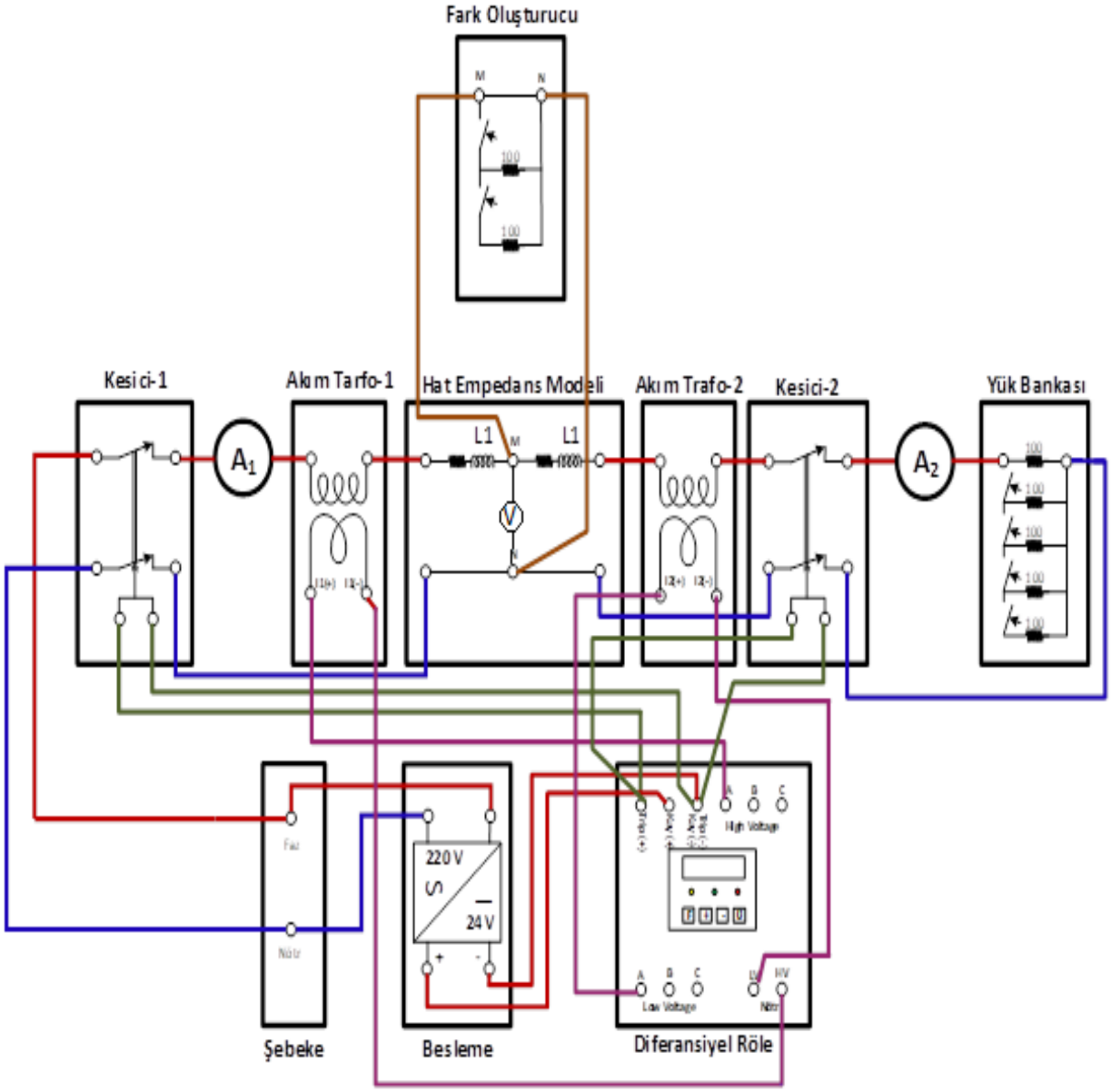

Figure 4: Test connection setup

- By long pressing the "function – F" button of the relay each time, navigate between the main headings of the relay functions.

- Come to the "setting" menu by pressing the relay F button "long" a sufficient number of times.

In the "Setting" menu, press the "F" button a sufficient number of times and for a short time to select I_d sub.
tab.

- In the Id Sub-tab, the differential current magnitude can be changed to be between "I_d> 0.1-0.5". First, press the + or – keys enough times to make I_d = 0.1 pu. Press the F key and then the + button again and record the value I_d=0.1 in the relay.

- Long press the F key to the main menus floor. Clear the "trip" signal by pressing the "0" button for a long time.

- First, set your load value to 100 W and perform your measurements. If the breakers are activated, press the F key for a long time to go to the main menus floor. Clear the "trip" signal by pressing the "0" button for a long time.

- Repeat the experiment for your load value of 200 Ω, 300 Ω, 400 Ω, 500 Ω, respectively, and fill in Table 1. Calculate the theoretical current value with the help of the voltage you measured and record it in Table 1.

Load (W)	Trip (Yes/No)	A1 (A)	A2 (A)	Voltage (V)	$A_{Theoretical}$ (A)	Differential Current	Bias Current
100							
200							
300							
400							
500							

Table 1

- Set your load rating to 100 W and record Id=0.1 in your relay. Then perform your measurements by increasing your fault stage to 1-10 and record them in Table 2.
- Repeat the above step for Id=0.2, Id=0.3, Id=0.4 and record your results in Table 2.

100 W	id=0.1									
	1	2	3	4	5	6	7	8	9	10
A1 (A)										
A2 (A)										
Differential Current										
Trip (yes/no)										
100 W	id=0.2									
	1	2	3	4	5	6	7	8	9	10
A1 (A)										
A2 (A)										
Differential Current										
Trip (yes/no)										
100 W	id=0.3									
	1	2	3	4	5	6	7	8	9	10
A1 (A)										
A2 (A)										
Differential Current										
Trip (yes/no)										
100 W	id=0.4									
	1	2	3	4	5	6	7	8	9	10
A1 (A)										
A2 (A)										
Differential Current										
Trip (yes/no)										

Table 2

- Set your load value to 500 W and record the value Id=0.1 in your relay. Then increase your fault stage to 1-10 and perform your measurements and record them in Table 3.
- Repeat the above step for Id=0.2, Id=0.3, Id=0.4 and record your results in Table 3.

500 W	id=0.1									
	1	2	3	4	5	6	7	8	9	10
A1 (A)										
A2 (A)										
Differential Current										
Trip (yes/no)										
500 W	id=0.2									
	1	2	3	4	5	6	7	8	9	10
A1 (A)										
A2 (A)										
Differential Current										
Trip (yes/no)										
500 W	id=0.3									
	1	2	3	4	5	6	7	8	9	10
A1 (A)										
A2 (A)										
Differential Current										
Trip (yes/no)										
500 W	id=0.4									
	1	2	3	4	5	6	7	8	9	10
A1 (A)										
A2 (A)										
Differential Current										
Trip (yes/no)										

Table 3