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ASU Protection System at Machine Learning for Power System Lab

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Guide of Protection System

1. Objective

The objective of this system is to learn overcurrent and directional protection relay for different kinds of faults.

2. Introduction

The system consists of four parts: distribution lines, faults, two sources including feeding from network and a 3 phase autotransformer respectively, and two digital protection systems consisting with digital relays, current transformers, potential transformers and magnetic circuit breakers.

1) Distribution line:

Figure 2.1 is the picture of the distribution line model with fault and protection system. The distribution line model is in the red sequare.

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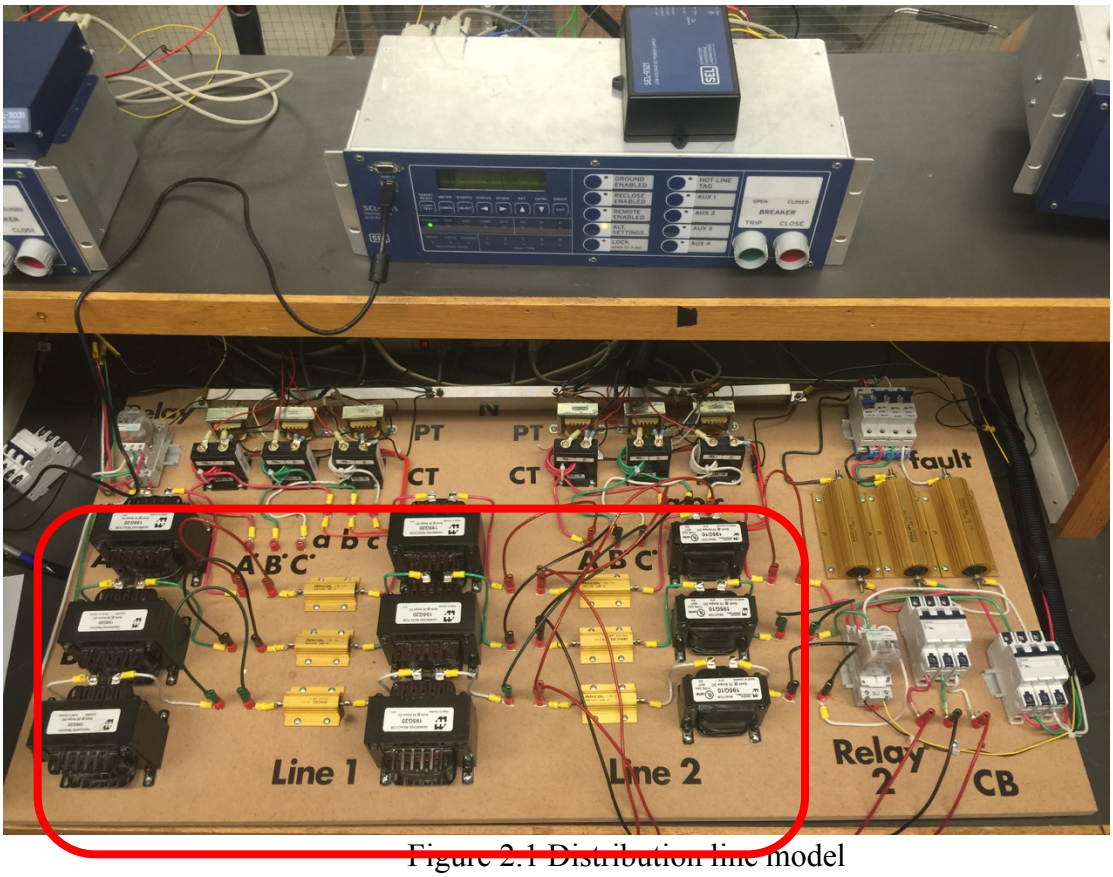

Figure 2.1 Distribution line model

The system mounted on the wooden board is to simulate the 6.9 kV distribution line. The line is divided into two section. Line 1 is 9-mile long and Line 2 is 3-mile long, so the impedance of the two sections is different. Faults can be put in different section in the distribution line. Table 2.1 is the line data.

	R	X
Reactance from the network	0	5 mH
Line 1	5 Ohm	5 mH
Line 2	2 Ohm	5 mH

Table 2.1 Distribution line impedance

2) Transformer:

At left side of the distribution line is 120V 3-phase supply, on the right side the transformer can change the voltage up to 144V(120% of the nominal voltage). The voltage difference will generate current in the system. Usually the transformer voltage is set at the 90% of the nominal

voltage in order to simulate the voltage decrease in the distribution line. Figure 2.2 shows the example output of the transformer.

Figure 2.2 Example of 110 V output transformer

3) Digital relay protection system:

The current transformer and potential transformer are used to measure the voltage and current in the distribution line. The SEL-351S protection system receives the line data and detect whether there is any fault occur in the protection zone, if the fault happens, it will send the trip signal to the relay to break the circuit. Table 2.2 shows the PT and CT parameters.

	Ratio
Current transformer	2:1
Potential transformer	1:1

Table 2.2 PT and CT parameters

3. Connection of the system:

Banana plugs are provided to connect all the equipment, Figure 3.1 shows the connection method.

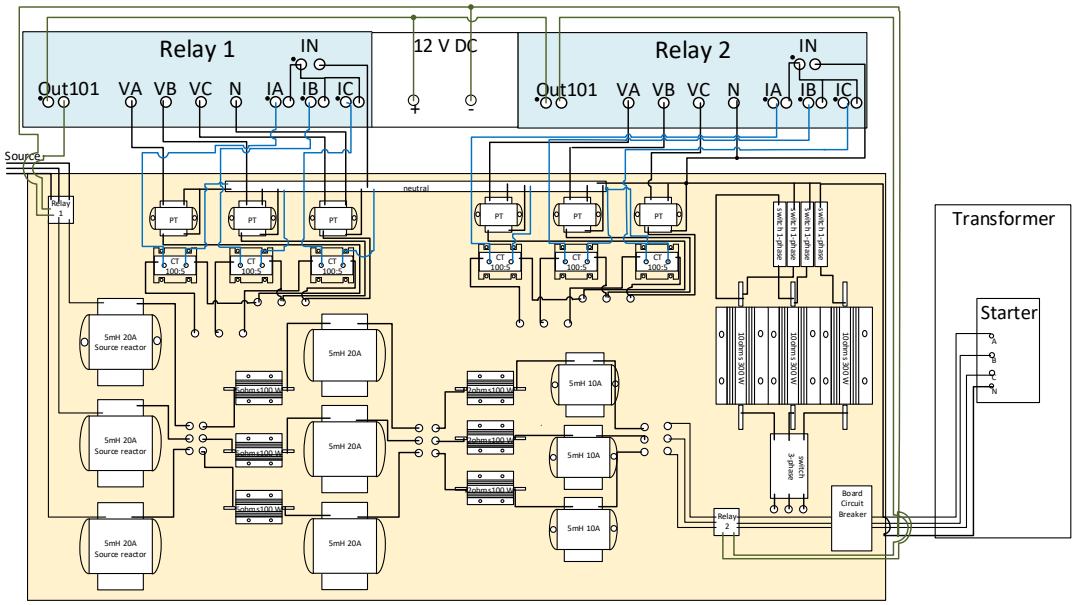

Figure 3.1 The connection method of the distribution line

Attention should be paid that the measurement part should be connected in series in the line(current flows from point A', B', C' to a, b, c). If the fault needs to be put in the line, put banana plugs between the fault part and the section where the fault happens.

Figure 3.2 and Figure 3.3 are two examples of the connection which the fault happens at different side of the protection zone.

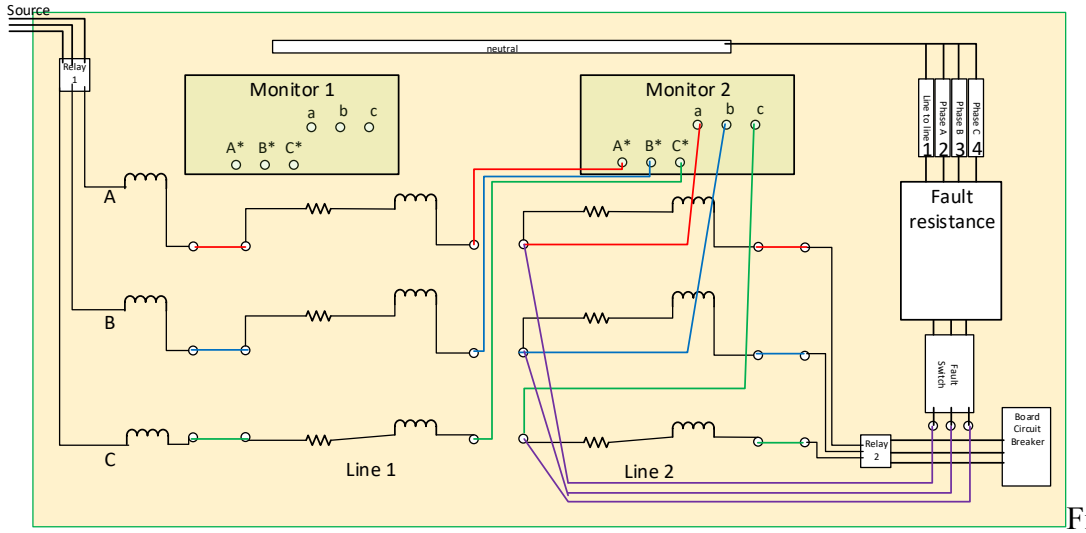

Figure 3.2 Fault happens at the forward side of the protection zone

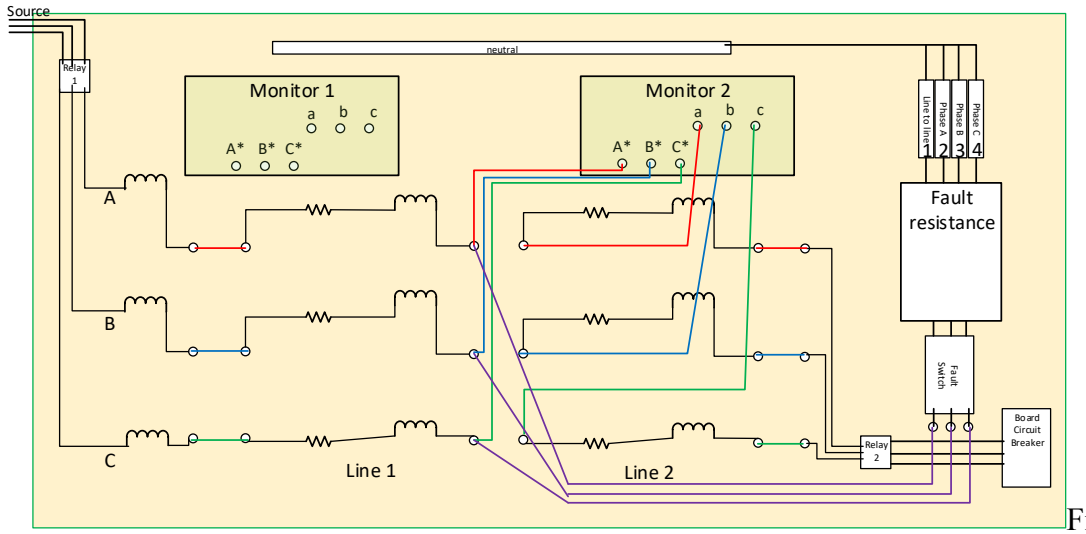

Figure 3.3
Fault happens at the reverse side of the protection zone

4. Type of the system:

Attention should be paid that make sure the circuit is break and the switch controls the fault connection is off when operate on the fault connection. What's more, if the fault didn't trip the relay, cut off the fault manually in case the fault current cause damage to the resistor. Figure 4.1 shows the fault switch.

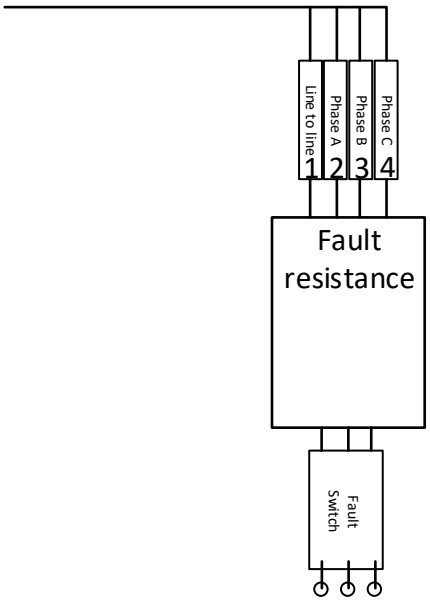

Figure 4.1 Fault part

1) Single line to ground fault:

Make sure the fault switch is off, close switch 2(Phase A) or switch 3(Phase B) or switch 4(Phase C).

2) Double line to ground fault:
Make sure the fault switch is off, close any two of the switch from switch 2 to switch 4.

3) Three line to ground fault:
Make sure the fault switch is off, close switch 2(Phase A) and switch 3(Phase B) and switch 4(Phase C).

4) Line to line fault:
Make sure the fault switch is off, close switch 1(Phase A and Phase B).

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