Handout no. 13

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EXPERIMENT # 13

Earth Fault Warning Relay

Objective:

At the end of this lab session students will be able to

- Use De Lorenzo power system Protection kits.
- Implement Under voltage & Overvoltage by using De Lorenzo power system Protection kits.
- Relay behaviour in three phase systems for Under Voltage and Over Voltage by changing load.
- Determination of resetting ratio.

Introduction:

A relay is usually an electromechanical device that is actuated by an electrical current. The current flowing in one circuit causes the opening or closing of another circuit. Relays are like remote control switches and are used in many applications because of their relative simplicity, long life, and proven high reliability. Relays are used in a wide variety of applications throughout industry, such as in telephone exchanges, digital computers and automation systems. Highly sophisticated relays are utilized to protect electric power systems against trouble and power blackouts as well as to regulate and control the generation and distribution of power. In the home, relays are used in refrigerators, washing machines and dishwashers, and heating and air-conditioning controls.

Although relays are generally associated with electrical circuitry, there are many other types, such as pneumatic and hydraulic. Input may be electrical and output directly mechanical.All relays contain a sensing unit, the electric coil, which is powered by AC or DC current. When the applied current or voltage exceeds a threshold value, the coil activates the armature, which operates either to close the open contacts or to open the closed contacts. When a power is supplied to the coil, it generates a magnetic force that actuates the switch mechanism

Apparatus:

- 1DL 7901TT Overhead Line model
- 1DL 2108T12 Under/Over voltage relay
- 1 DL 2109T3PV Moving iron Voltmeter
- 1 DL Buz Acoustic continuity tester
- 1 DL 1017R Resistive Load
- 1 DL 2108T02 Power Circuit Breaker
- 1 DL 2108T18 Earth Fault Warning Relay

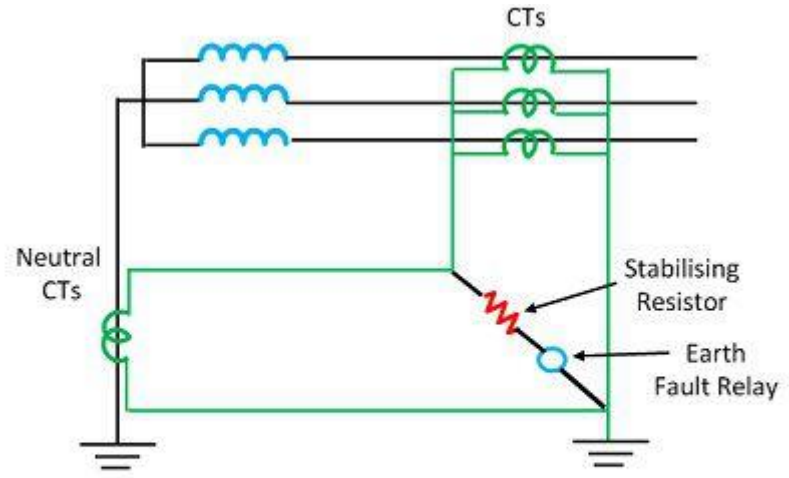
- 1 DL 1080TT Three phase transformer
- 1 DL 2108TAL-SW Three Phase Power Supply

Earth Fault WarningRelay:

Earth fault is the unintended fault between the live conductor and the earth. It also occurs, because of the insulation breakdown. When the fault occurs, the short-circuit currents flow through the system, and this current is returned through the earth or any electrical equipment. This fault current damaged the equipment of the power system and also interrupted the continuity of the supply. The earth fault can be dispersed by using the restricted earth fault protection scheme. The earth fault protection scheme consists the earth fault relay, which gives the tripping command to the circuit breaker and hence restricted the fault current.

The earth fault relay is placed in the residual part of the current transformers shown in the figure below. This relay protects the delta or unearthed star winding of the power transformer against the fault current. The connection of earth fault relay with the star or delta winding of the transformer is shown in the figure below.

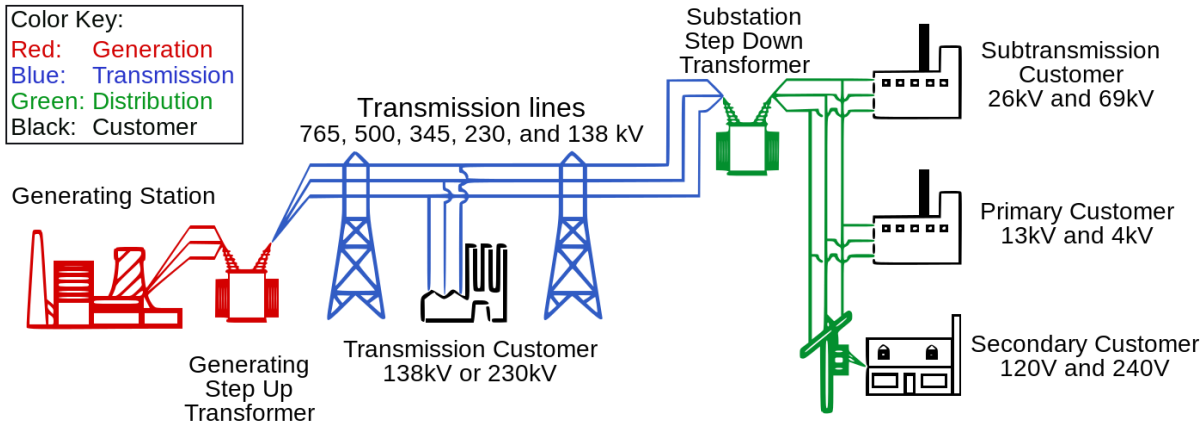
The current transformers are placed on both sides of the protective zone. The secondary terminal of the current transformer is connected in parallel with the relay. The output of the current transformer is equal to the zero sequence current flows in the line. The zero sequence current is absent for the external fault and for the internal fault it becomes twice the value of fault current.



Neutral Earthed within the Protected Zone of the Star Winding of the Transformer

HV transmission Lines:

High-voltage transmission lines are used to transmit electric power over relatively long distances, usually from a central generating station to main substations. They are also used for electric power transmission from one central station to another for load sharing. High voltage (HV) transmission lines are made of high voltage (between 138 and 765 kilovolts) overhead and underground conducting lines of either copper or aluminum.



Earth Fault Warning Relay Basic Diagram:

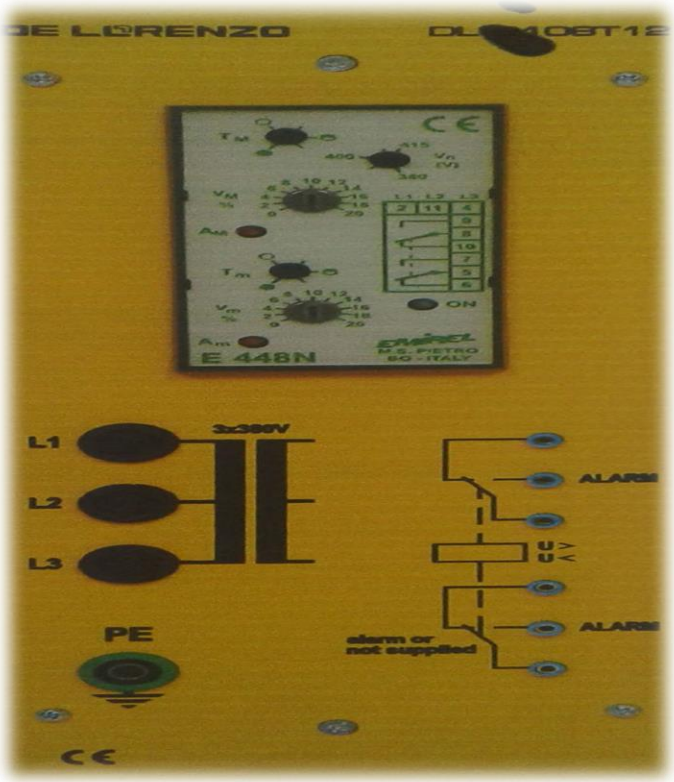


Figure 1 : VT internal wiring Diagram

Circuit construction:

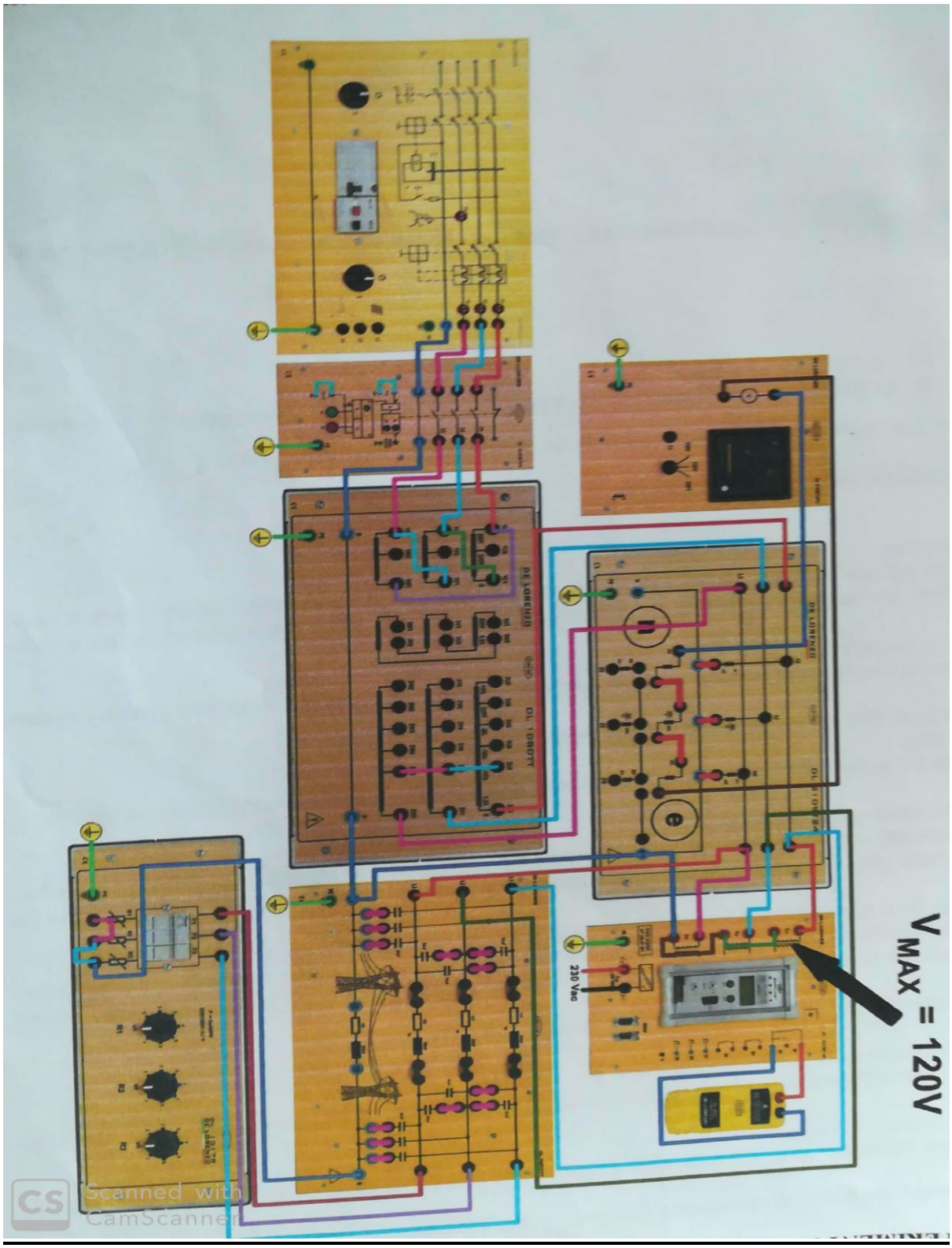


Figure 2:Earth Fault Warning Relay in HV Lines

Procedure:

- Connect circuit as shown in Fig 2.
- Set three phase power supply voltage 380v and relay is not in operation
- Observe over voltage reference voltage w.r.t to three phase supply and set load at R2.
- Slowly increased Load and observe overvoltage condition w.r.t to set values.
- Observe Over voltage reference voltage w. r .t to three phase supply.
- Slowly increase Load and observe under voltage condition w.r.t to set values.
- Observe Under voltage reference voltage w. r .t to three phase supply.
- After this observe value of phase to ground fault value by connecting each phase with neutral in three phase potential transformer and write value in table.

Table 1:

Overvoltage Setting

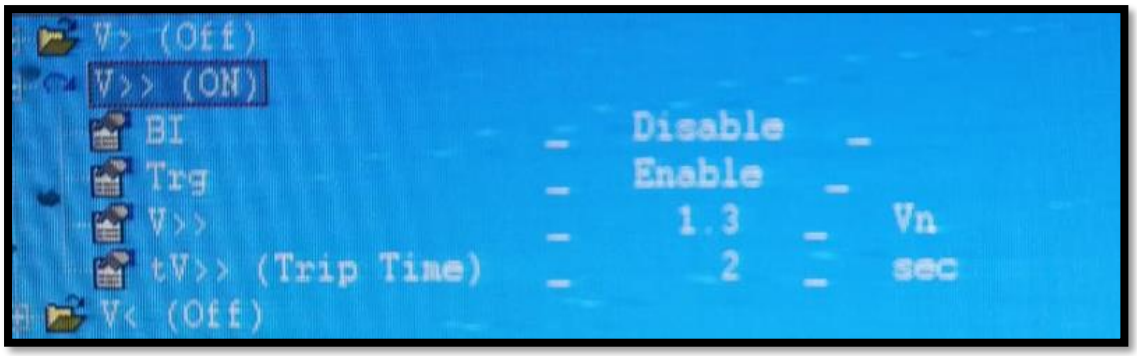
Vset (Volts)	Load Values
1.2	R1=2 R2=1 R3=-1
1.3	R1=4, R2=1, R3=1

Ea	Eb	Ec	f	V0	V1	V2
4049	5304	7035	50.27	5336	91	1
3509	5558	7845	50.38	8020	91	3

Table 2:

V>:

V>>:



Undervoltage Setting

Vset (Volts)	Load Values
0.7	R1=3 R2=1 R3=1
0.65	R1=4 R2=1 R3=1

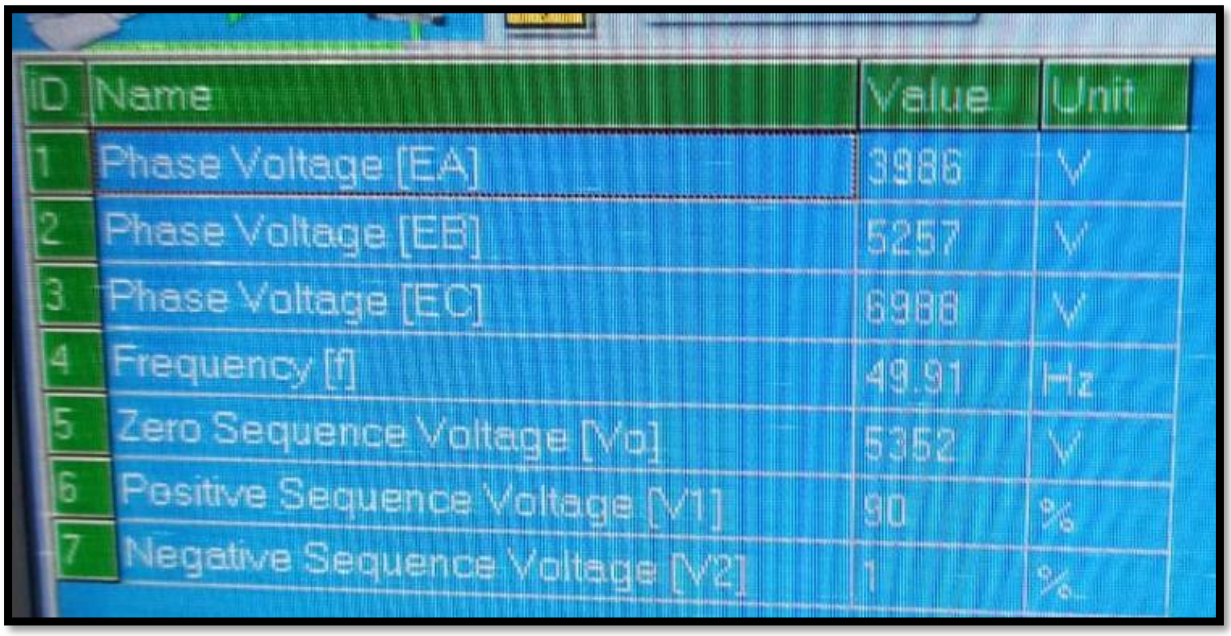
Ea	Eb	Ec	f	V0	V1	V2
3986	5257	6988	49.91	5352	90	1
3430	5511	7750	49.66	7893	90	3

Table 3:

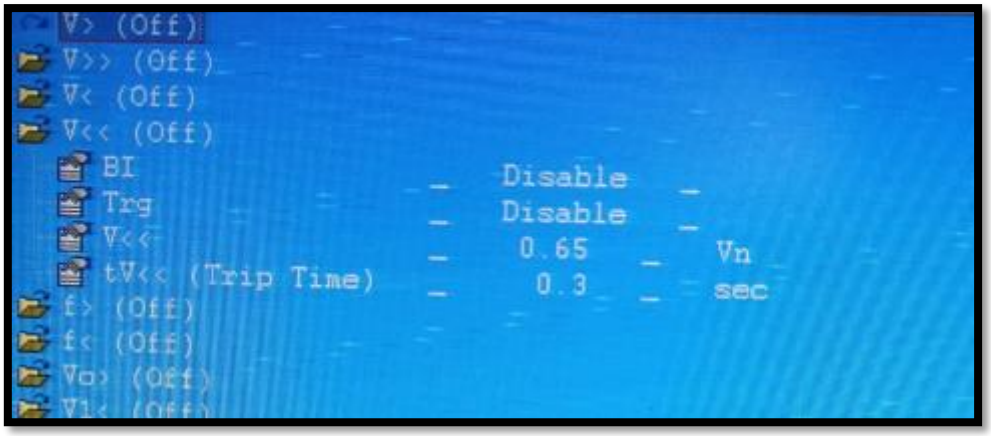
V<:

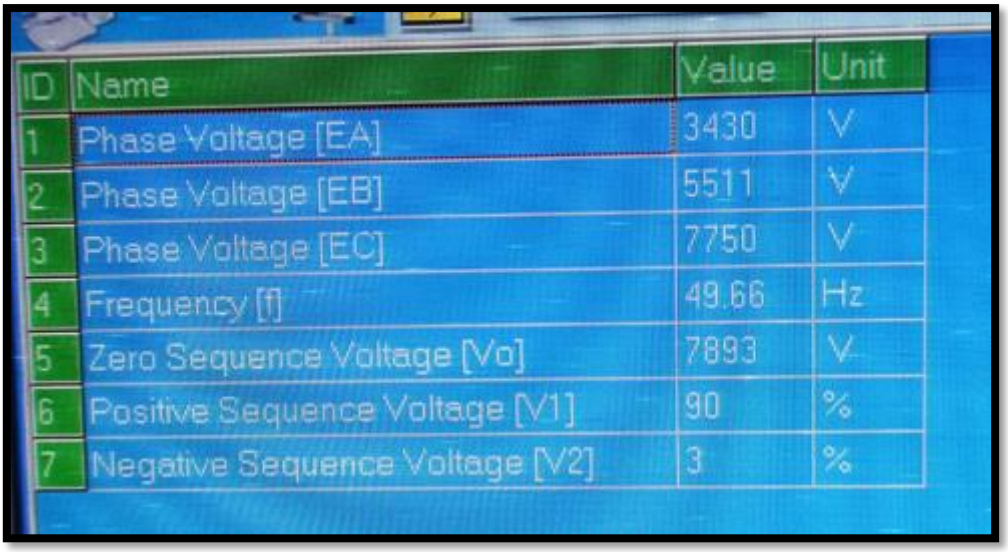

P = 3x400W
220/380V Δ / Y
DL 1017R
DE LORENZO
F2 F3
R1 R2 R3
PE
off
off
off
R1
R2
R3
RESISTIVE LOAD


V> (Off)
V>> (Off)
V< (ON)
BI
Trg
V<
tV< (Trip Time)
V<< (Off)
f> (Off)
f< (Off)
Vo> (Off)
Disable
Enable
0.7
3
Vn
sec


ID Name Value Unit
1 Phase Voltage [EA] 3986 V
2 Phase Voltage [EB] 5257 V
3 Phase Voltage [EC] 6988 V
4 Frequency [f] 49.91 Hz
5 Zero Sequence Voltage [Vo] 5352 V
6 Positive Sequence Voltage [V1] 90 %
7 Negative Sequence Voltage [V2] 1 %

V<<:





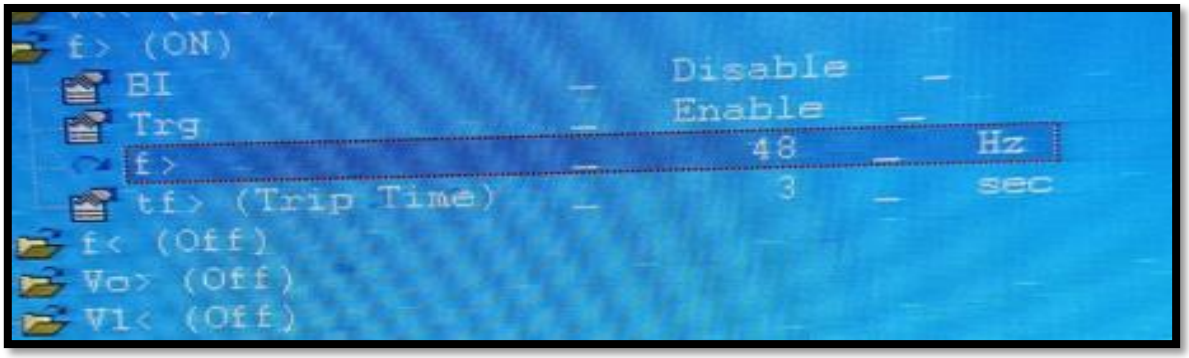
ID	Name	Value	Unit
1	Phase Voltage [EA]	3430	V
2	Phase Voltage [EB]	5511	V
3	Phase Voltage [EC]	7750	V
4	Frequency [f]	49.66	Hz
5	Zero Sequence Voltage [Vo]	7893	V
6	Positive Sequence Voltage [V1]	90	%
7	Negative Sequence Voltage [V2]	3	%

Frequency Setting:

Set Frequency Value: 48Hz

F>:

Ea	Eb	Ec	f	V0	V1	V2
3367	5511	7607	49.66	7877	88	3



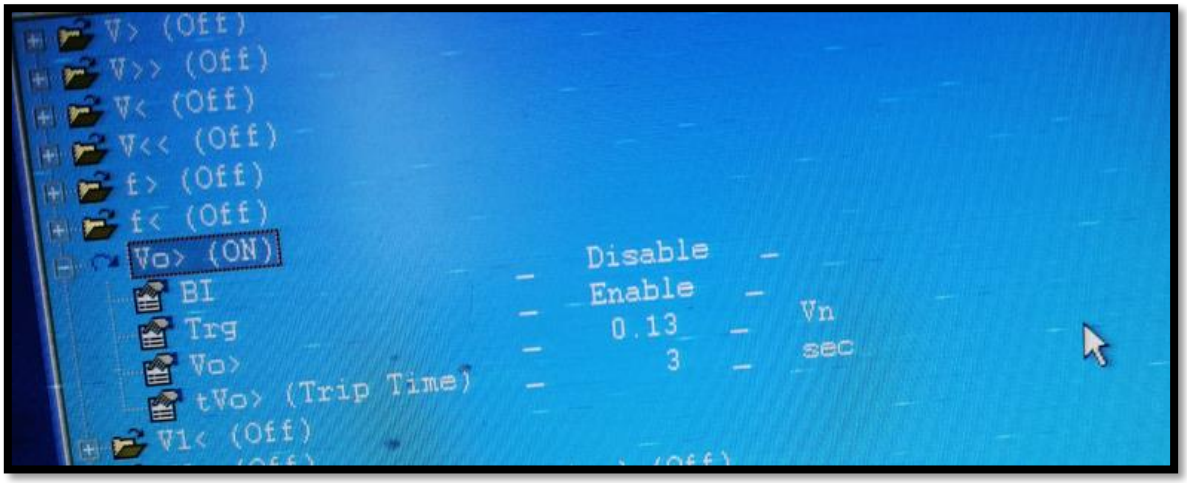
Set Frequency Value: 51
F<:

Ea	Eb	Ec	f	V0	V1	V2
3382	5558	7539	49.67	7861	89	3

Zero Sequence:

Vo=0.13

Ea	Eb	Ec	f	V0	V1	V2
4971	5272	6051	50.38	1937	93	1



Earth Voltage	Transformer Voltage
Phase L1	100÷√3
Phase L2	100÷√3
Phase L3	100÷√3

Observation:

In this lab, we learn about the Earth Fault Warning Relay to protect Under/Overvoltage and Under/Over frequency protection in HV Lines by using De Lorenzo protection kit. This relay can perform multiple function e.g. voltage, frequency and more. First of all, we set the voltage 100V and 120V for over voltage condition. Then we gradually increase the load and find out the over voltage condition on which Earth fault warning relay detect this abnormal condition and send tripping signal to breaker. Similar is the case done in under voltage condition for 90V and 85V. All tripping values are mentioned in above over voltage and under voltage table.

Then we perform experiment for over and under frequency using this relay.

- In case of over frequency, we set value 50Hz. When frequency increase from this value, relay detect this abnormal condition and sends signal to breaker. We set 52Hz as reset value in over frequency condition.
- In case of under frequency, Relay sense the abnormal condition when value of frequency fall below a certain value. For this, we set the under frequency relay value 51Hz on which relay trip and breaker open the line. To reset the relay, we choose under frequency value is 48Hz