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Protection of Industrial System Using Over Current Relay Co-Ordination-Review

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ABSTRACT: In an industrial system many costly equipment s are used. Protection of that equipment's from the fault, number of circuit breaker and relays are used. Proper co-ordination of this protective equipment's required in emergency or fault condition. In this condition protection system needs to be strong and reliable. This paper contains the protection of industrial system using proper coordination of overcurrent relay .In this paper, the overcurrent relay coordination of 33 kV radial industrial power plants is presented using Electrical Transient Analysis Program (ETAP). It also presents load flow and short circuit analysis of radial industrial system using ETAP. This paper shows the star view of relays which is unique feature of ETAP for coordinating them correctly.

KEYWORDS: Generator, Buses, Circuit breakers, Relays, Current transformers

I. INTRODUCTION

No power system can be designed such a way that it would never fail, one has to live with the failure. In protection engineering the failure is called the fault. The most obvious effect of a shunt fault is sudden built up of current. So it is natural that the magnitude of current be utilized as positive indication of existence of a fault. Therefore the over-current protection is the most widely used form of protection .Overcurrent Relays are the simplest type of protective devices available. In distribution feeders, they play a more important role and there it may be the only protection provided. If primary protective device is fail to protect the system if there is fault then the back protective device will give the protection to the system and clear the fault. In any power system protective devices are coordinated such a way that provide protection to the adjacent equipment.

There are many methods are used for the optimal relay coordination like linear programming method, AI (artificial intelligence) and Natural inspire algorithm, Genetic algorithm, Hybrid GA-NPL method, Duel Simplex Method. The exercise of load flow and short-Circuit analysis for fault current and find the pair of primary and back up protective device are very tedious. But in recent year calculation of TMS of relay calculated such a way that minimum discrimination margin required between the primary relay and it's back up relay. This is possible through the computer programming.

The Electrical Transient Analyser Program, commonly known as ETAP, an interactive power system analysis and design tool. The capability makes ETAP suitable for large industrial facilities, as well as utility systems. The unique feature of ETAP software i.e. the star view is very useful in case of large power systems. Thus, this paper shows the overcurrent relay coordination of a given industrial system using ETAP's star view. For any kind of fault be i

Symmetrical or unsymmetrical, the overcurrent relay has to operate efficiently and provide correct discrimination.

II. SYSTEM DESCRIPTION

Here the 6 bus ring-main industrial system as shown in fig.1, with the power grid of 33 KV with load is two static lamp load of 2 MVA and another static load of 2 MVA also two induction motor of 1000 KW. Also step down transformer which are T1: 50 MVA, 33/11kV; T2 & T6=25 MVA, 11/6.6kv; T3 & T7=2.5 MVA, 6.6/0.416 kV.

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In this system if fault occurs on one side then the generator provide the power in another side by operating the relays in first side. This can be done by relay co-ordination. This resolves the mal operation due to fault.

In below figure all above given data are applied and then the relay co-ordination can be done by manually calculation.

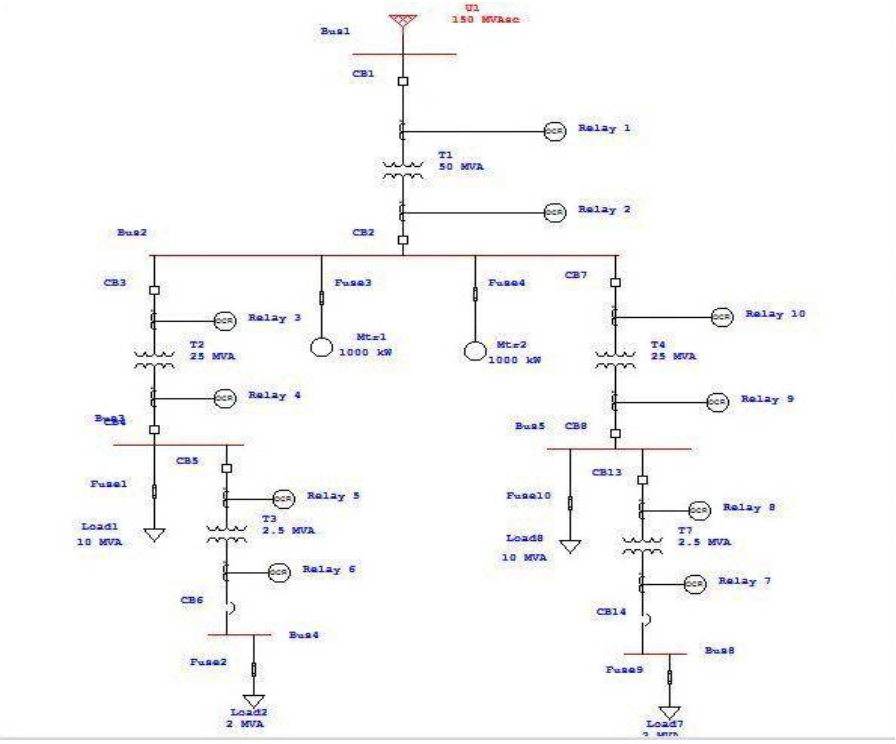

Fig.1 Industrial ring-main system

III. LOAD FLOW AND SHORT CIRCUIT ANALYSIS OF SYSTEM MODEL

[A] Load flow analysis of industrial power plant Model using ETAP

For the planning and operation of electrical systems load flow studies are essential. Selection of the size of capacitors, transformer, feeder, transformers, and CLR (current-limiting reactors) based on the load flow study results. Load flow analysis is performed on system for check its load-generation balance. The load flow analysis gives the current, voltage and Power flow of line, bus, transformer, circuit breakers, motors and other equipment's. Using the load flow study, we can decide the plug setting of relay. At the time of designing a new system, or analysing the system, factors such as voltage drop, load capacity, power factor constraints, steady-state stability limits, transformer tap settings, and generator excitation levels must be considered.

[B] Short circuit analysis of industrial model using ETAP:

Here, the short circuit of model and its generated report using ETAP are presented. Calculation of short-circuit currents for industrial power systems tend to be more complex because of the mixture of sources contributing currents to the fault. In a typical modern industrial system the basic sources of fault currents are the utility, the in-plant generation, and synchronous and induction motors. The short circuit view of the system in ETAP is shown in appendix I. In ETAP, the report can be generated for LLL, LL, LG, LLG LLLG (symmetrical and asymmetrical both)

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fault. Here, shown three phase fault and LG fault is created at bus 5. . The short circuit report when three phase and LG at bus 5 is generated as shown in Table 1.

Relay	Fault current (kA) (Three phase)	Fault current (kA) (LG)	CTs	CT ratio
R6(R7)	38.35	27.04	CT6(CT7)	4000:1
R5(R8)	38.35	10.84	CT5(CT8)	300:1
R4(R9)	7.60	10.84	CT4(CT9)	2500:1
R3(R10)	7.60	9.17	CT3(CT10)	1500:1
R2	6.06	9.17	CT2	3000:1
R1	6.06	1.38	CT1	500:1

Table 1-The fault current of each relay

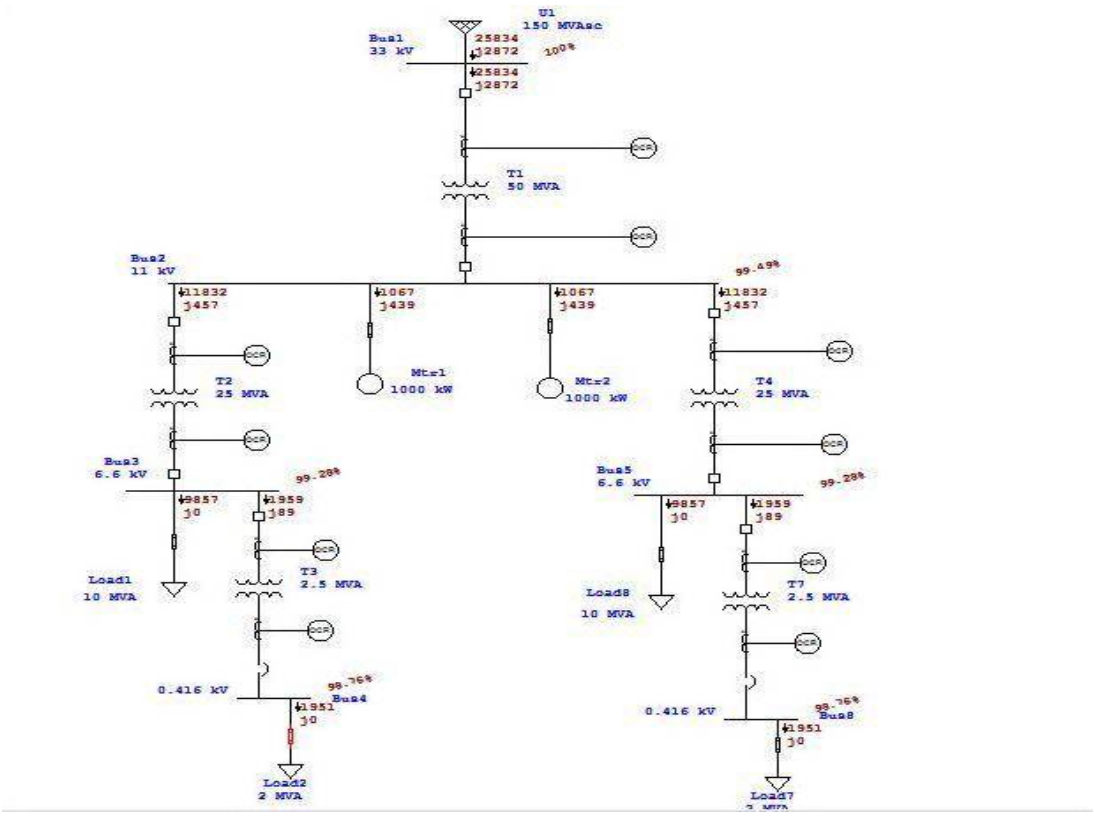

Fig. 2 Load flow analysis of industrial system

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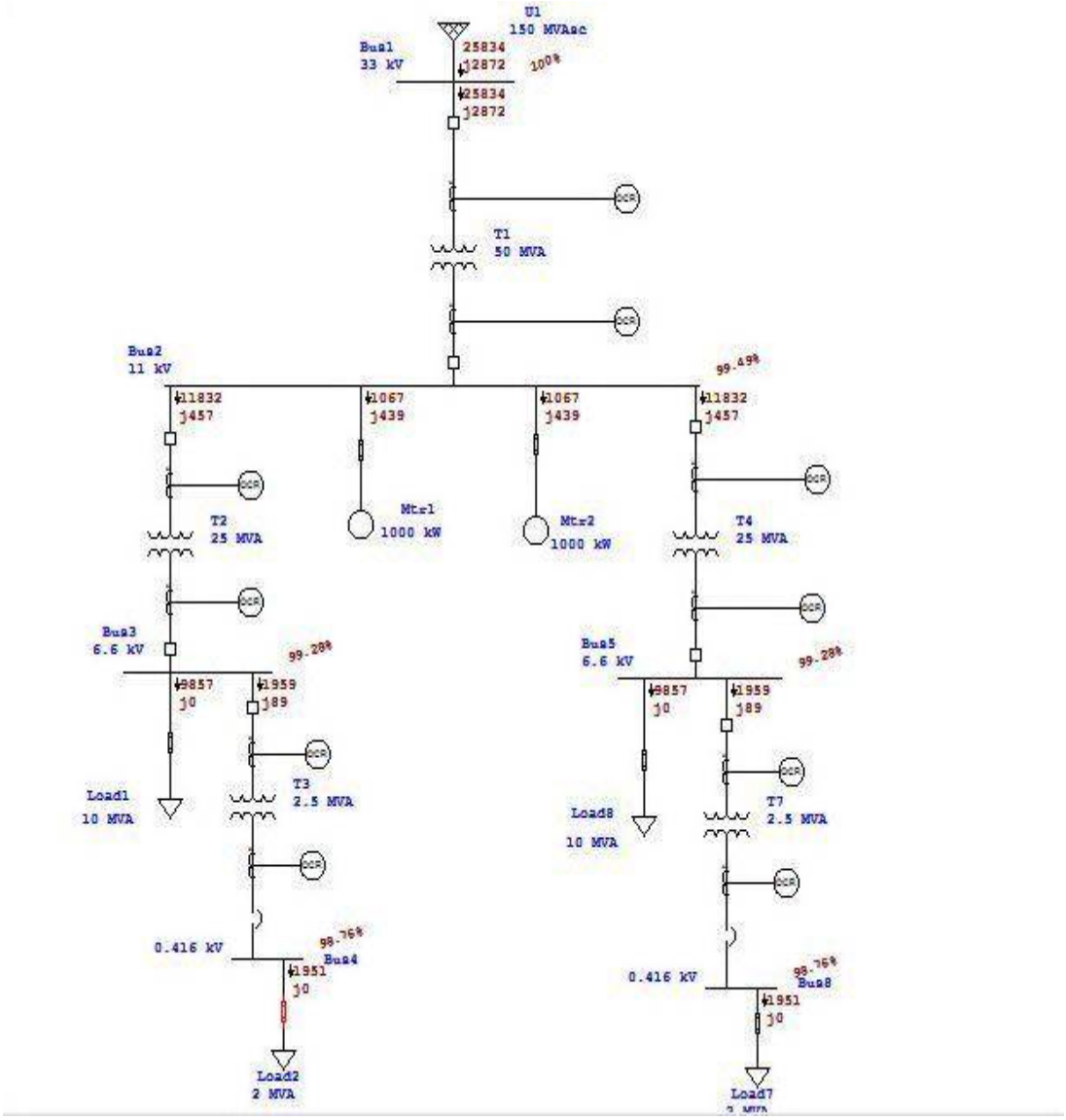

Fig. 3 Short circuit analysis of radial system

IV. RELAY CO-ORDINATION MANUAL CALCULATION

For relay co-ordination PSM and TSM settings are calculated .And this can be done by using the equations of Non-linear program method.

After Manually calculation of PSM, TMS of the all phase relays of systems are calculated as shown in Table 2.

This two table shows the all data such as time of operation of relay, plug setting multiplier, time multiplier setting, plug setting etc.

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Relay	P.S. (%)	PSM	TOP at TMS 0.1 Sec.	T.M.S.
R6(R7)	100	9.59	0.301	0.1
R5(R8)	125	6.45	0.551	0.15
R4(R9)	100	3.04	1.245	0.2
R3(R10)	125	2.51	1.495	0.198
R2	100	2.02	2.951	0..3
R1	125	1.610	3.200	0.22

Table 2- All Parameter of System after Manual Calculation for phase relay

V. RELAY SETTING IN ETAP

Here considering, the three phase fault is occurred at load 2 on bus 4 then to protect it first fuse 2 is operates, after that relay R6 is operates as primary relay and R5 operates as secondary or backup relay of R6 as shown in figure 4

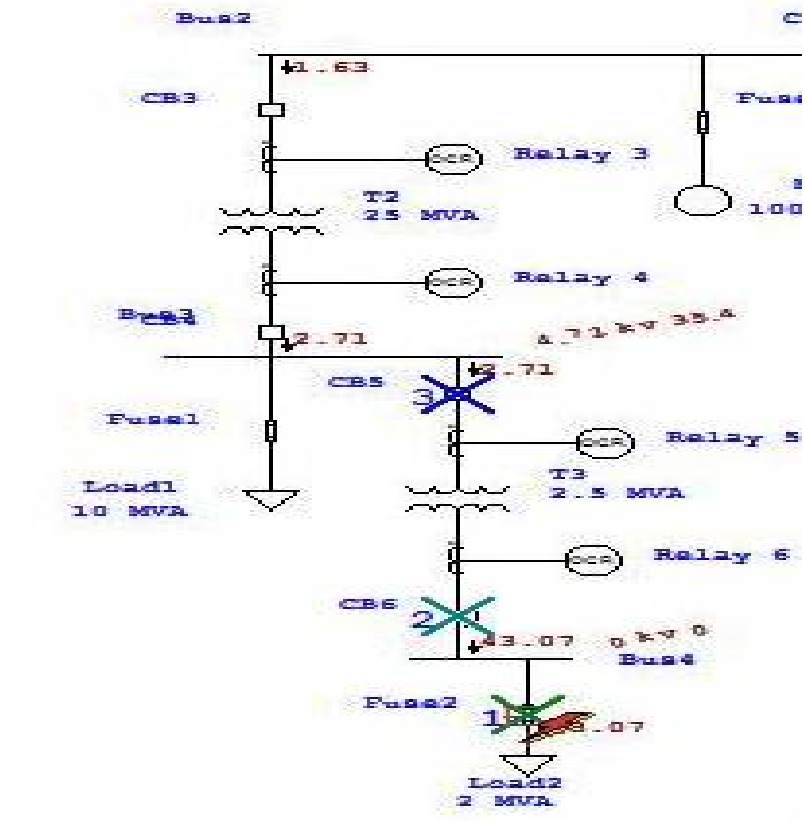

Figure 4: fault occurs at load 2

Same way if fault occurs at bus 3 then first relay R4 is operated as primary relay then relay R3 is operated as

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secondary relay or backup relay of R4 and after that if relay R3 fails to operate then relay R2 operates as backup of relay R3 as shown in figure 5.

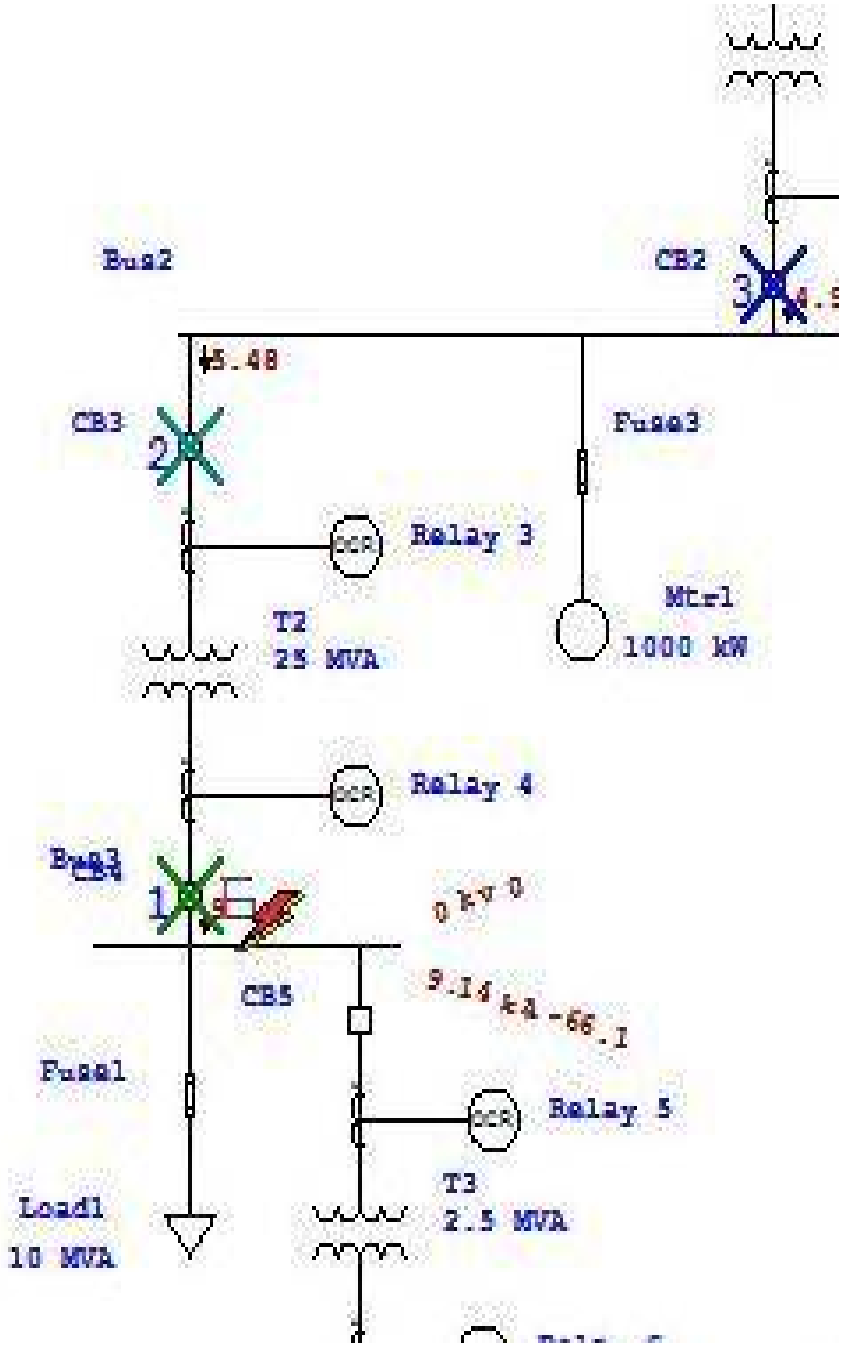

Figure 5: Fault occurs at bus 3

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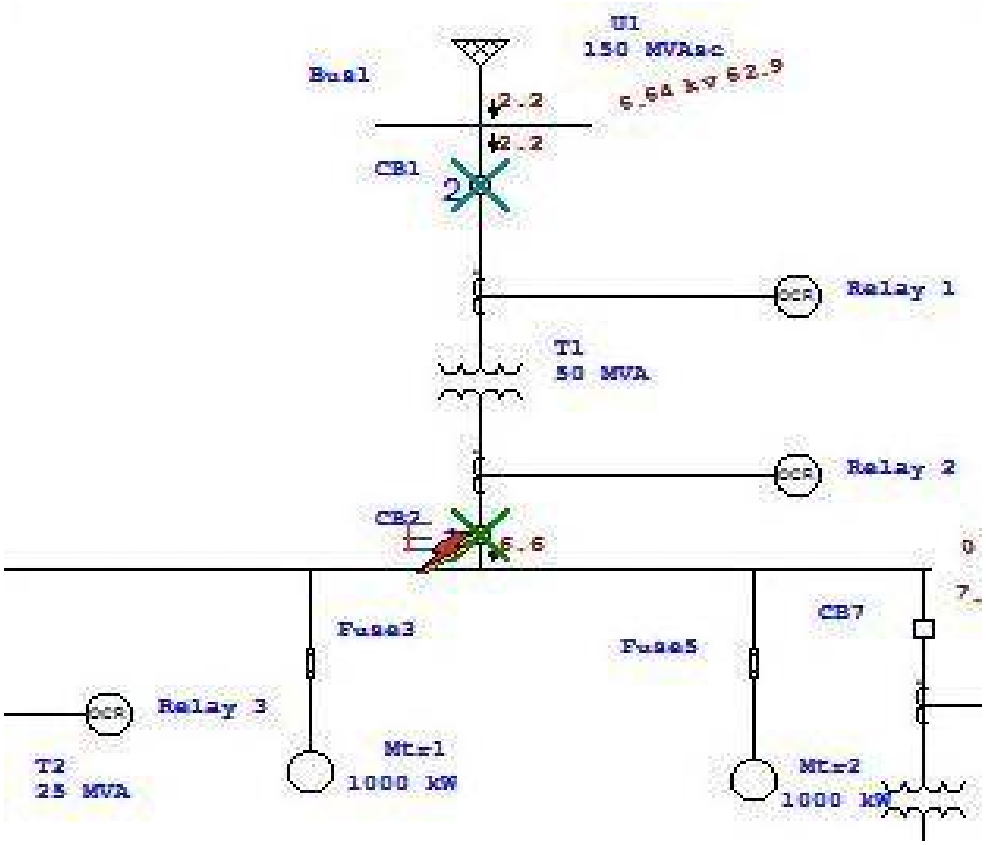

Figure 6: Fault occurs at bus 2

Now if fault occurs at bus 2 then relay R2 is operated as primary relay and relay R1 is operated as secondary relay or backup relay of R2 as shown in figure 6.

Now if fault occurs on motor 1 then to protect other lines first fuse is operated which is connected with it. If fuse fails to operate then to protect all lines relay R2 is operated as primary relay and relay R1 is operated as backup relay of relay R1 as shown in figure 7.

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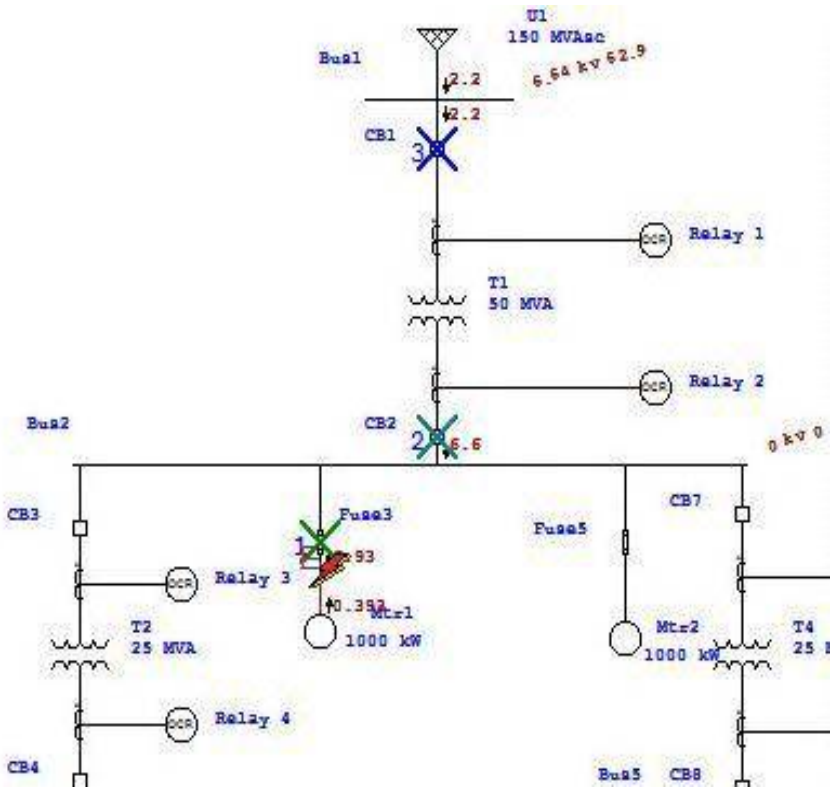

Figure 7- Fault occurs at motor 1

VI. CONCLUSION

The overcurrent relays are the most important protection devices in a distribution system. They need to be set properly so that they provide correct discrimination and act as primary as well as back up protection devices.

Hence in this paper the over current relay coordination for earth and phase faults using the star view of ETAP software is clearly shown. The coordinated curves for phase and earth faults are shown and the settings for each relay are shown in the table. The procedure for overcurrent relays using the unique star view of the ETAP software is clearly shown.

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