INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
(Int Peer Reviewed Journal)
Vol. 05, Issue 09, September 2025, pp : 130-135
e-ISSN : 2583-1062
Impact Factor : 7.001
www.ijprems.com
editor@ijprems.com

# RELAY COORDINATION OF OVER CURRENT RELAY IN DISTRIBUTION NETWORK

**M. Gowtham[1], M. Sundaraperumal[2], Dr. J. Chandramohan[3], M. Padmavathi[4]**

[1]PG Scholar, Department Of Electrical And Electronics Engineering, Gnanamani College Of Technology, Namakkal, Tamilnadu, India.

[2,3,4]Assistant Professor, Department Of Electrical And Electronics Engineering, Gnanamani College Of Technology, Namakkal, Tamilnadu, India.

## ABSTRACT

This study investigates the safety coordination of overcurrent relays (OCRs) in a distributed network, considering its diverse operational modes. Two distinct case studies are explored, specifically: (i) a distribution network integrated with distributed technology (DG) in grid-related mode, and (ii) a distribution system included with DG in islanded running mode. A proposed approach is evaluated the use of the distribution network, comprising 9 buses. Upon fault incidence, changes in fault current degrees without delay impact OCR working times. Consequently, it's far crucial to decide and advise optimized relay settings to reduce working instances and prevent maloperation. In this research, a protection scheme is optimally designed by way of thinking about those aforementioned conditions. Decreasing OCR working instances and keeping coordination are executed via figuring out most suitable time dial placing (TDS) values. The Genetic Algorithm (GA) is applied to decide those highest quality TDS values, thereby impacting OCR working times.

**Keywords:** Distributed Power Assets, Overcurrent Protection Structures, Timing Manage Mechanisms, Evolutionary Optimization Strategies, Grid Synchronization Modes And Stand Running Modes.

## 1. INTRODUCTION

The surge in load demand is necessitating the implementation of unconventional energy assets, along with photovoltaic, wind power, and biomass, to alleviate the burden on traditional utility grids. These non-conventional sources serve as alternatives to mitigate the pressure on traditional infrastructure. Distributed power, additionally known as decentralized strength, is generated thru the amalgamation of small-scale allotted power resources (DER) or allotted mills (DGs). These turbines are generally included into low or medium-voltage distribution networks, concern to constraints within the voltage range they can produce. Based on the interfacing medium, DGs may be labeled into rotating system-primarily based DGs and electronically interfaced DGs. Proper integration of DGs is imperative, because it significantly impacts the overall performance of electrical power distribution structures. The integration of DGs has several repercussions, in the main manifesting as bidirectional energy glide and changes in brief-circuit current ranges. The imperative requisite for an powerful safety device is its capability to hastily isolate the defective section of the network upon incidence of a fault. In traditional distribution systems, power glide is unidirectional from the substation toward the load, while the introduction of allotted generation (DG) consequences in bidirectional strength drift, thereby increasing the complexity of safety coordination. The incorporation of DGs into distribution systems necessitates modifications to existing protection schemes, as they're not capable of functioning efficiently because of the alteration in short circuit present day degrees. The majority of protection schemes hired in contemporary electricity structures are predicated upon the capability of short circuit modern-day sensing.

The introduction of Distributed Energy Resources (DERs) to the distribution network consequences in numerous protection troubles, consisting of blinding of safety, fake sympathetic tripping, reclosure-fuse miss-coordination, lapse of inter fuse coordination, and failed auto-reclosing. Overcurrent safety, that's the maximum broadly employed form of safety in energy systems, relies on the coordination of multiple relays to make certain proper operation. In the event that the primary relay fails to clean a fault, the backup protection ought to initiate operation after a selected coordination time c programming language (CTI).

The coordination of overcurrent relays (OCRs) poses a huge assignment in energy machine safety. Various optimization strategies have been proposed in the literature to address this trouble, with the goal of optimizing the time of operation of OCRs. These techniques consist of the use of combined integer non-linear programming, which can be solved using fashionable algebraic modeling software program. Hybrid genetic algorithms.

## 2. METHODOLOGY

### 2.1. Impact of DG on Protection Coordination:

In a allotted strength device, DGs are hired to generate energy at low or medium voltage degrees in tandem with the application grid. The composition of disbursed power structures may additionally range relying on environmental and geographical factors, utilizing either electronically coupled or rotating system-primarily based DG resources. The concomitant presence of a couple of DERs can precipitate an enhancement within the short circuit modern-day coursing via the community. Notwithstanding, given the current score obstacles of silicon devices, the fault contemporary emanating from electronically interfaced DGs must be restrained to a most of approximately two instances their nominal modern, thereby necessitating a reevaluation of protective circuitry. The extended modern-day surges impinging upon relays can impair their time dial settings, inducing a concomitant diminution in operational time and perturbing the coordination of protecting measures. Consequently, the traditional overcurrent safety techniques no longer represent a possible solution for systems integrating DGs into the distribution network. Primary concerns related to the incorporation of distributed strength sources into distribution networks include the blinding of defensive gadgets and the occurrence of false or sympathetic tripping events.

### 2.2. Blinding of Protection:

In distributed strength systems, the fault current measured by way of overcurrent relays is compromised via the bad contribution of distributed generation (DG) interconnected to the system. This reduction in fault present day can lead to malfunction of overcurrent relays, manifesting whilst DGs are incorporated between the primary substation and the fault area. The faded fault present day, motivated by way of DER's contribution, contrasts with the state of affairs with out interconnected DERs, thereby underscoring the want for reassessment of feeder relay responses.

A vital scenario is validated in Figure 1, where relay CB4 fails to respond to fault F2, ultimately coming into a country of "blinding", which could precipitate a relay malfunction..

### 2.1 False/Sympathetic Tripping

Excessive tripping of electrical feeders embedded with Distributed Energy Resources (DERs) can result from outside fault situations now not within the safety zone of a feeder.Fault modern-day contribution from DERs thru their respective feeders can reason non-directional relays on adjoining healthful feeders to inaccurately come across faults, triggering unwanted feeder isolation. The better the fast-circuit capacity, the greater destructive it will become to relay overall performance. In scenarios involving DERs, fault detection can result in misoperational circuit breakers, together with CB4, unnecessarily interrupting wholesome feeders in reaction to a single fault event.

## 3. MODELING AND ANALYSIS

The running time of an Optical Current Transformer (OCR) is inversely correlated with the short circuit current it encounters. The parameters worried in delineating the operational characteristics of a defensive relay, as represented via Equation (1), include the choose-up cutting-edge (Ip) and time dial placing (TDS). In Equation (1), ISC indicates the quick circuit present day, while the coefficients A and B determine the operational characteristics of the relay, thereby distinguishing between normal inversely, very inversely, or extraordinarily inversely characteristics.

In this investigation, it's far presumed that OCRs show off inverse definite traits, consequently, the coefficients A and B are taken as zero.14 and zero.02, respectively. The operational time of OCRs can also consequently be expressed as depicted in Equation (2).The plug placing multiplier (PSM), denoted by using Equation (2), can be decided for a given configuration by way of calculation of ISC and Ip values. The objective nction, T, is the summation of coordination times of all relays, to be minimized, as indicated by using Equation (3). Here, tii represents the running time of the primary relay, i, for a close to-give up fault. Consequently, the working time of an person relay is a function of TDS, as represented by way of Equation (4).In Equation (five), the value of C for every relay is a characteristic of the plug setting multiplier (PSM), requiring computation for various fault locations. The purposeful dating between C and PSM is outlined in Equation (five). Notably, Ci is a regular for the ith relay, the fee of which should be computed for diverse fault places, as shown in Equation (6).The primary intention of this take a look at is to limit the operational time and to calculate the optimized TDS fee for each relay.

$$t = A\frac{TDS}{\left(\frac{I_{SC}}{I_p}\right)^B - 1} \qquad (1)$$

$$t = A\frac{TDS}{(PSM)^B - 1} \qquad (2)$$

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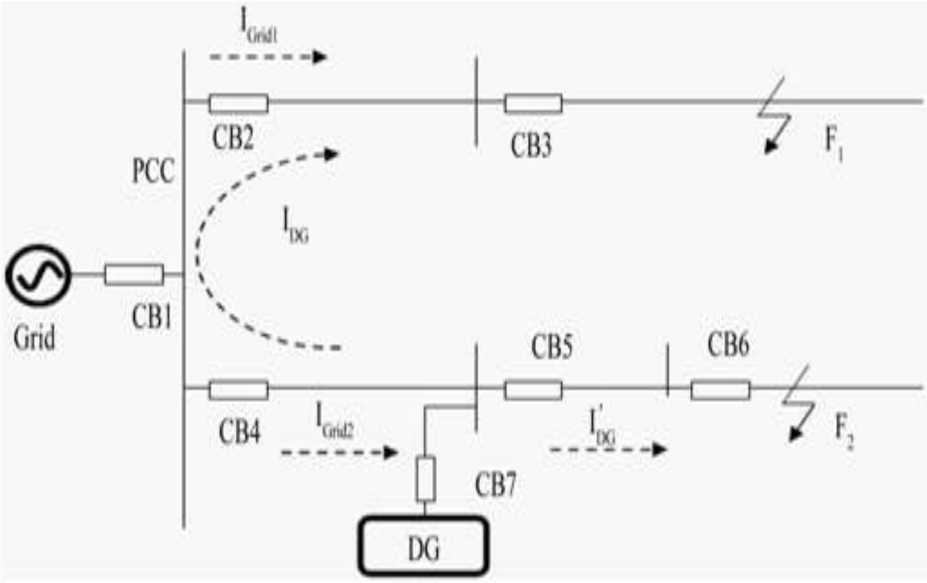


**Figure 1:** Operating of relay for different fault location

$$\min T = \sum_{i=1}^{m} t_{i,i} \quad (3)$$

$$t = C\,(TDS) \quad (4)$$

$$C = \frac{A}{(PSM)^{B} - 1} \quad (5)$$

$$\min T = \sum_{i=1}^{m} C_{i}\,(TDS)_{i} \quad (6)$$

The radial nature of the distribution device is disrupted in presence of DG (allotted era), thereby resulting in every fault being associated with number one relays, one from every course, which in turn is connected to up to 2 backup relays. Protection coordination studies among the Offline Change Relays (OCRs) within this machine had been comprehensively investigated across 3 awesome eventualities: namely, the distribution system with out DG, the DG-incorporated device running in grid-related mode, and the DG-included device running in islanded mode of operation.

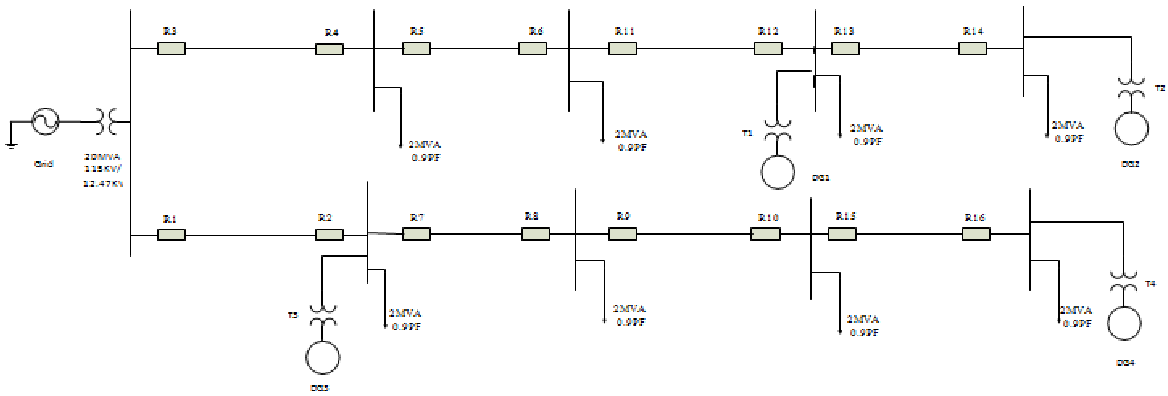


**Figure 2:** Distributed Network

## 4. SIMULATION RESULTS AND DISCUSSION

Simulink, evolved by Math Works, is a industrial device for modelling, simulating and analysing multi area dynamic structures. Its primary interface is a graphical block diagramming tool and a customizable set of block libraries. It offers tight integration with the rest of the MATLAB surroundings and may either pressure MATLAB or be scripted from it. Simulink is broadly used in control concept and digital signal processing for multi area simulation and design.

A new hybrid topology is acquired on the simulation for the ring bus protection of an alternator design with the intention to increase the reliability. The quantity of output degrees accelerated in the layout so that the harmonic distortions are reduced and also lessen the switches. The load is hooked up on the receiving quit. Generator and bus is added to the simulation block.

Three section generator is hooked up to circuit breaker and their voltage and current are measured through CT and Pt and related ring predominant protection among sending cease and receiving stop of the transmission line with their masses.

Under fault situation

Receiving end any symmetrical and unsymmetrical fault arise in any of the bus of the feeder the hoop most important safety experience the modern and voltage, journey the corresponding feeder of the receiving facet.

Under No fault condition

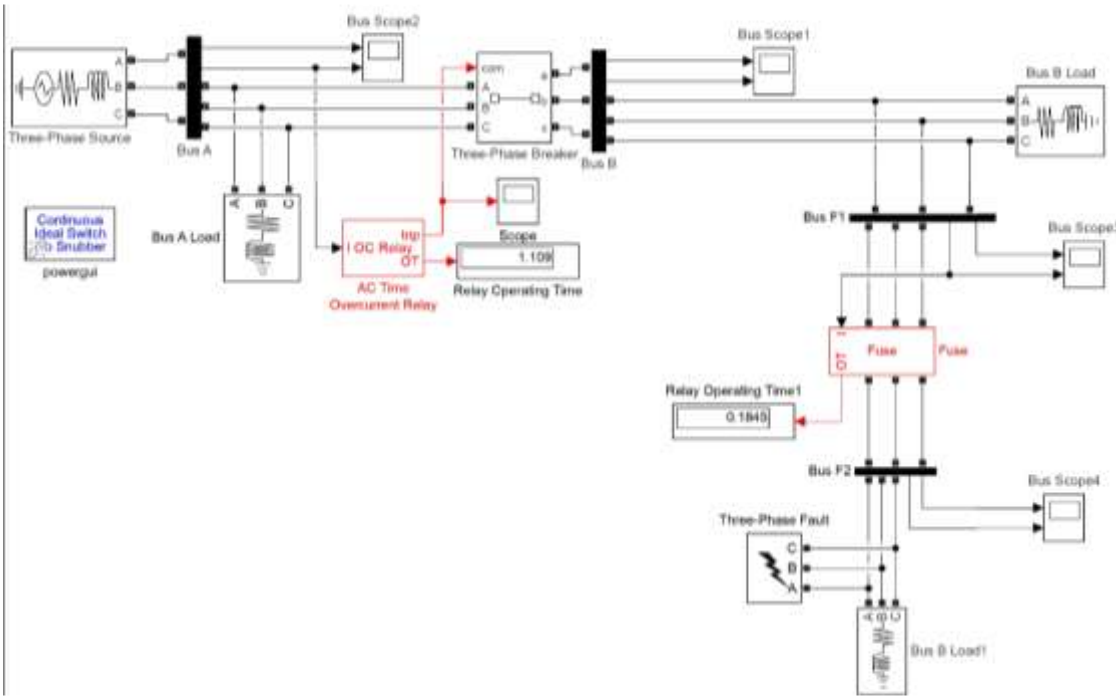


**Figure 3:** Simulation Circuit Diagram

Receiving end no fault occur in any of the bus of the feeder the hoop principal protection experience the contemporary and voltage , breaker underneath usually closed position and the deliver flowing to the the corresponding feeder of the receiving side.

**4.1 Three phase source and Bus A Load Three Phase Voltage**

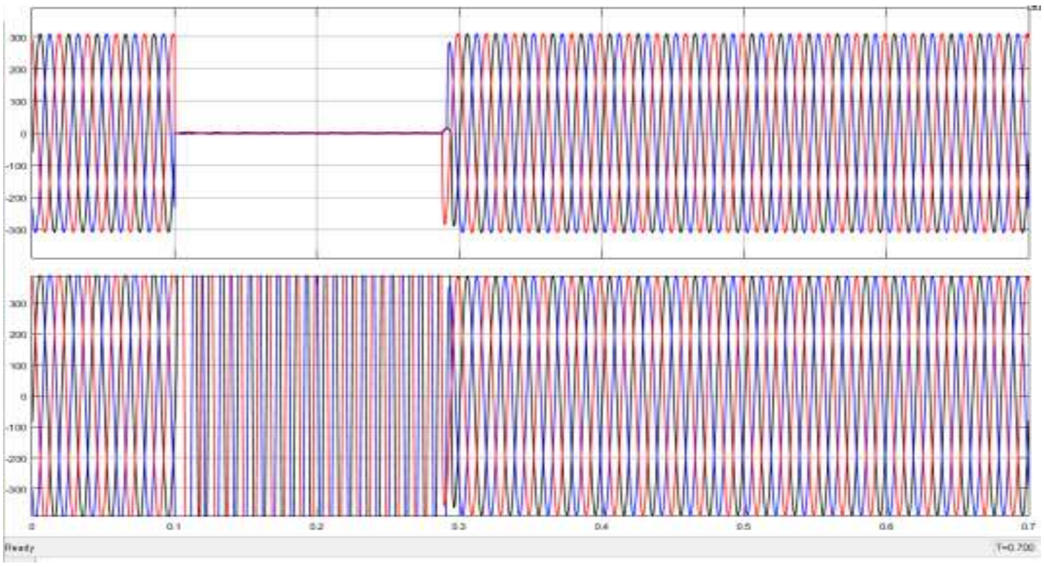

**Figure 4:** Three phase source and Bus A Load Three Phase Voltage (Measure at Scope 1)

The above simulation plot illustrates the Sending end VI three phase measurement block measured the Vabc input voltage from three phase source, the input voltage is 400 V peak voltage and the output voltage after the process is 400 V as pictured above and this remains constant over the period of stable operation . During faulty condition on input

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side phase B phase maximum peak overshoot 0 V and by means of ring protection of generator voltage level brings to zero voltage ( Vabc) due to circuit breaker opened as shown in below waveform

**4.2 Circuit Breaker Sending End with respect to Phase Voltage**

The below simulation plot illustrates the Sending End VI three phase measurement block measured the Va input voltage from three phase source, the input voltage is 7000 V peak voltage and the output voltage after the process is 2000 V as pictured above and this remains constant over the period of stable operation . During faulty condition on input side phase B phase maximum peak overshoot 11000V and by means of ring protection of generator voltage level brings to zero voltage ( Va) due to circuit breaker opened as shown in below waveform.

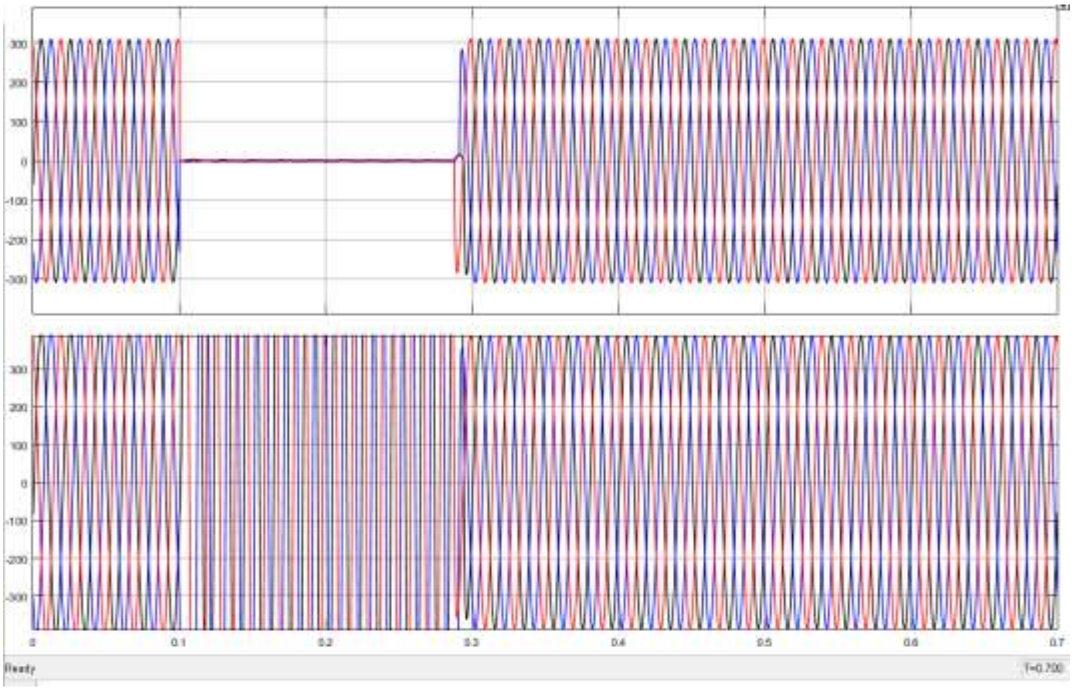

**Figure 5:** Circuit Breaker Sending End with respect to Phase Voltage output Waveform (Measured at Scope 2)

**4.3 Bus F1 and Bus load B along Fuse Relay Coordination Output**

The above simulation plot illustrates the output voltage. The Value of RMS Value of Discrete waveform the range begin from zero, attain stable 4500 with respect to time, during fault condition it reaches maximum overshoot but due to ring protection RMS value Reaches to Zero .until the faulty condition recover it still attain zero voltage due to circuit breaker opened in sending and receiving end side.

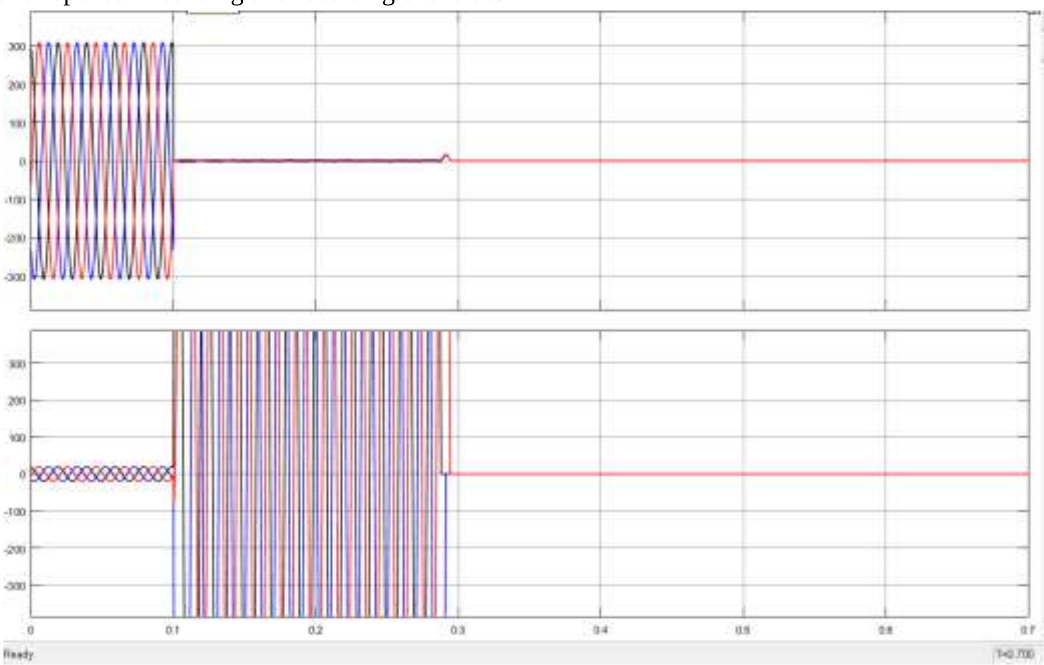

**Figure 6:** Bus F1 and Bus load B along Fuse Relay Coordination Output Waveform ( scope 3)

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### 4.4 Bus B1 and Three Phase Fault output

The above simulation plot illustrates the Ring Protection of Generator waveforms. During normal condition it attain stable waveform of value one. Whereas under faulty condition protection circuit operated it reaches zero value with respect to time. Until faculty section cleared it shows zero output i.e circuit breaker open condition.

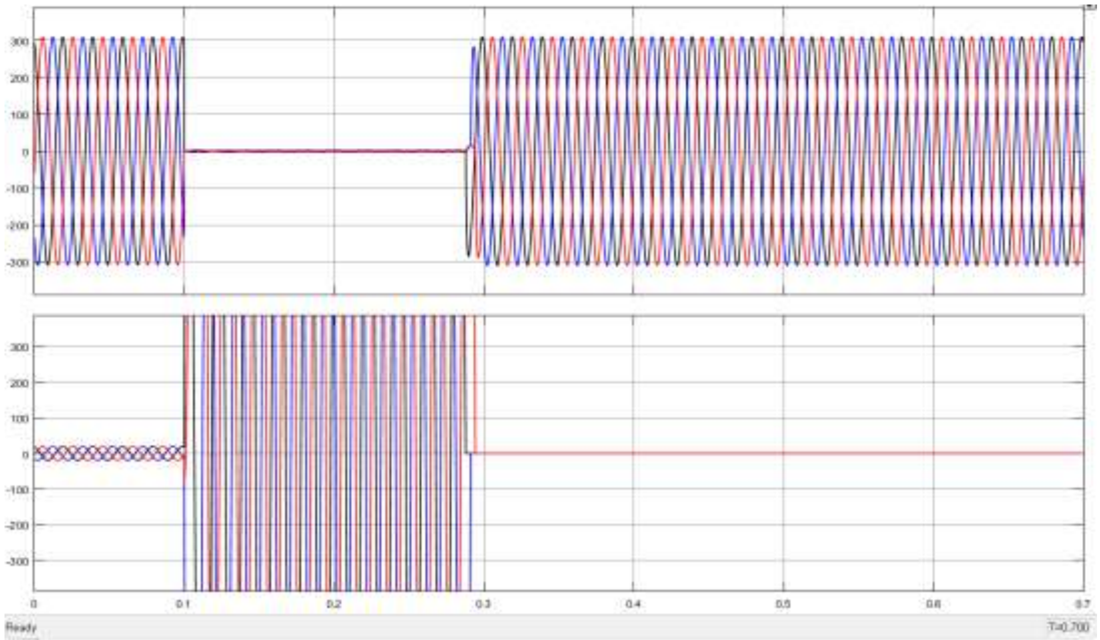


**Figure 7:** Bus B1 and Three Phase Fault output Waveform ( Scope 4)

## 5. CONCLUSION

A comparative investigation into protection coordination of Overcurrent Relays (OCRs) is undertaken in this paper, focusing at the disparate network configurations each with and without the incorporation of Distributed Generators (DG). The implications of DG penetration at the number one protection coordination demanding situations, which includes the 'blinding' of protective devices and the incidence of fake/sympathetic tripping, are tested inside the preliminary segment, supported with the aid of simulation results.

A novel technique to calculating the Time-Domain Security (TDS) criterion is introduced, wherein fault area is taken into account at each the close to and distant ends. A comparative analysis is then supplied in the secondary phase, comparing the TDS estimates and working instances of defensive relays. Furthermore, this paper elucidates that the safety coordination variety can be augmented by using integrating various styles of Fault Current Limiters (FCLs) at strategically appointed locations.

In this have a look at, an equal supply model, derived from DGs, is hired as a surrogate for actual Distribution Generators. Consequently, the efficacy of the proposed approach can be demonstrated for electronically interfaced DERs (converter-primarily based DGs).

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