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PR CONTROLLER-BASED FAULT DETECTION AND CLASSIFICATION IN POWER TRANSMISSION LINES

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Abstract: An overhead power transmission system is a network of wires that a power station uses to provide electricity to residences and businesses. The exposed nature of the conductors makes them more vulnerable to damage. These defects have a major effect on the efficiency of the transmission system because they create power losses and supply discontinuities. A dependable and efficient power transmission system must have the ability to identify and fix such problems. The suggested research produced a technique for fault detection and classification in transmission lines by use of a Proportional Resonant (PR) controller. For this purpose, we run our simulations using the MATLAB/Simulink platform. When problems arise with transmission lines, the PR controller can identify them.

IndexTerms **- Transmission line faults; PR controller line fault detection.**

I. INTRODUCTION

The importance of power increased as the population rose. To meet the market's ever-increasing demands, a transmission system that is resilient to loss, highly reliable, and scalable is essential. Historically, one of two options the underground transmission system or the overhead transmission systems have been used to transmit power from generators to residences. Overhead power lines (OHPTLs) are used by India's electrical transmission networks, as they are by other developing countries. The exposed conductors of an OHPTL make it impossible to predict when a transmission line would break. It is essential to accurately identify errors and fix them quickly in order to improve the OHPTLs' efficiency and dependability. Error classification may provide light on the nature of the issue and the steps it impacted. However, pinpointing the exact location of the issue might allow for a speedier restoration of power [6].

A wealth of information is available about systems for detecting, classifying, and correcting transmission lines [1]. Over the years, many approaches to defect detection and classification have been developed [1–5]. Some examples of these methods include ANNs, fuzzy based expert systems, ANFIS, public relations controllers, evolutionary algorithms, and numerical techniques.Many people are satisfied with PR controller fault classification because it takes into account a lot of information from the transmission system, such as the starting angle of the fault, the resistance to fault propagation, the six-phase voltages and currents, the data from the single end, the parameters of the traveling waves, and so on.

Because PR controller can detect symmetrical and unsymmetrical faults and permits offline data to be utilized for training, it is of interest to many researchers in the area of fault classification [2-3]. The PR controller is an economical and versatile choice due to its adaptability to various transmission line lengths, voltages, powers, etc. This study showcases a PR control technique for fault classification and detection using six-phase voltages and currents as inputs. When training the network, we use a range of fault distances, resistance levels, and fault situations.

II. TRANSMISSION LINE FAULTS

Electrical faults may be defined as any anomaly that disrupts the regular flow of current inside the electrical system. This article describes the many types of transmission line breakdowns [6].

Due to the series connection between the line and the open circuit fault, another name for it is a series fault. The failure of one or more conductors causes this defect, which lowers the system's dependability.

A short circuit defect occurs when several conductor phases come into contact with one other, a live line, or another circuit component, leading to a high current flowing through one or more phases of the system. Short circuit failures, or shunt faults, are the most prevalent kind of defect. You may find short circuits that are symmetrical and those that are unsymmetrical.

A symmetrical or balanced fault occurs when all three phases of a system are shorted at the same time.The direction of the stream flowing through a symmetrical fault change by 120 degrees. In around 2% to 3% of cases, such errors manifest. Symmetrical faults interrupt all three phases at once, which is why they inflict serious damage even though they occur less often than other transmission system failures.

Disproportions in phase and amplitude of current between phases characterize an asymmetrical fault. They occur significantly more often than other transmission system problems.

III. PROPOSED SYSTEM

3.1 Design of Transmission System

For the medium power transmission line inquiry, a 100-kilometer cable with 220 kilovolts and 50 hertz was chosen. The design's intended use is modelling. The per-kilometre values [5] for the transmission system model are determined by carrying out the calculations presented in Table.1 using (1).

$$Per\ Km\ value = \frac{Original\ Value}{Length\ of\ the\ line} \qquad (1)$$

The three-phase transmission system's basic block diagram is seen in Figure 1.

In Figure 2, we can see how the voltage and current measurements are taken before and after a failure occurs, and how they are sent to the fault detection and classification module.

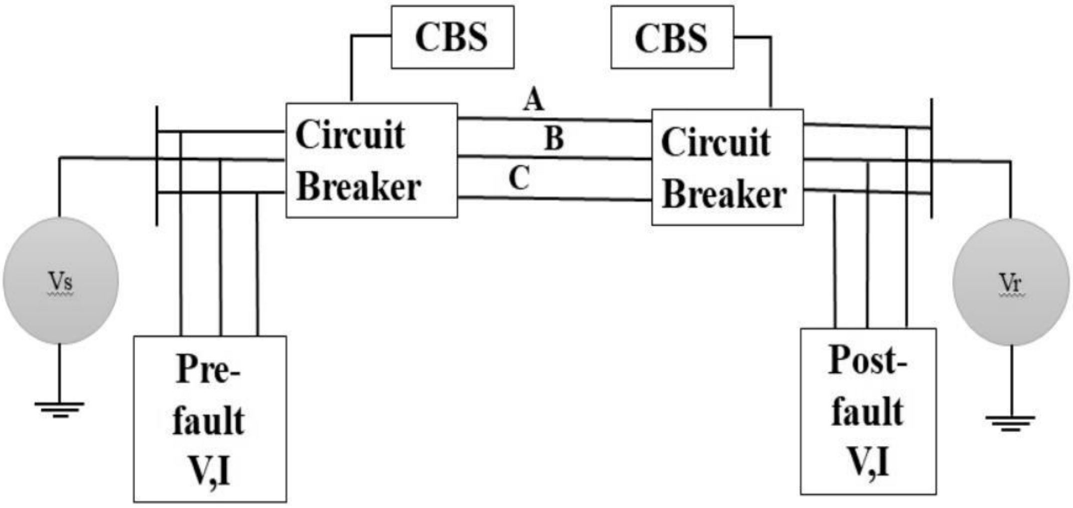

Figure 1: Block diagram of a three-phase transmission system.

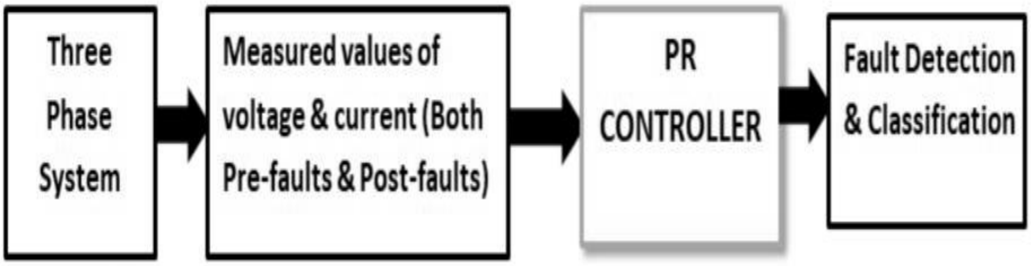

Figure 2: Workflow diagram of proposed system.

Table 1: Transmission line parameters

Parameter	*Specification*
Input Voltage	*220 kV*
Frequency	*50Hz*
Transmission line length	*100kM*
Positive sequence resistance Ω/km	*0.01809*
Zero sequence resistance Ω/km	*0.2188*
Positive sequence inductance H/km	*0.92974e-3*
Zero sequence inductance H/km	*3.2829e-3*
Positive sequence inductance F/km	*12.571e-9*
Zero sequence inductance F/km	*7.8555e-9*
Three phase RLC load Ω/km	*20*

3.2 PR Controller

This system makes use of a PR current controller, as seen in Figure 1 below. The main systems—the inverter, filter blocks, and controller—are shown here. At last, the filtering process checks the present Ii against its standard, Ii*. The control mechanism is fed the resulting error.

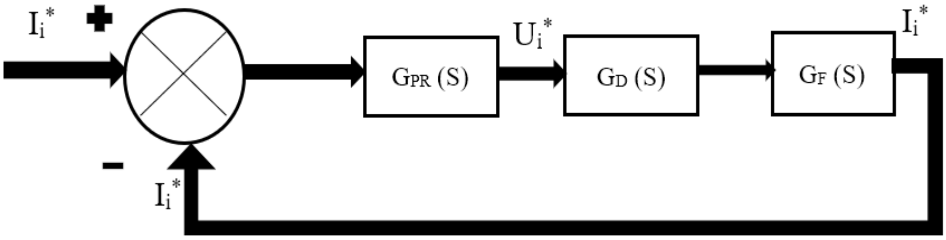

Figure 3: The inverter system's block diagram including the PR current controller.

Power inverter systems using pulse width regulate (PR) controllers are shown in Figure 3. The GPRs, or PR current controllers, are shown in this schematic as:

$$G_{PR}(S) = K_P + K_I \frac{s}{s^2+\omega_0{}^2} \qquad (2)$$

The integral gain term is denoted as Ki, the resonant frequency is $\sigma 0$, and the proportional gain term is γp.

IV. SIMULATION RESULTS

The suggested system's MATLAB/SIMULINK schematic is seen in Figure 4.

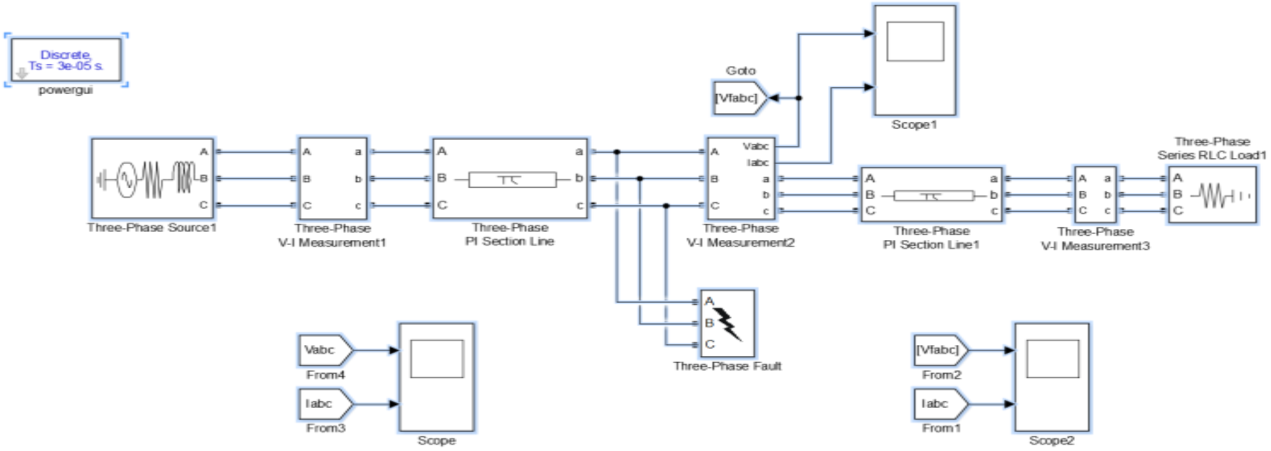

Figure 4: System schematic created in MATLAB/SIMULINK for the intended application.

4.1 Existing Results

Figure 5 illustrates the process by which an ANN controller feeds the fault detection and classification module with voltage and current values acquired before and after the incident. Waveforms of current and voltage, as well as the ANN detecting signal, are shown in figures 6 and 7, respectively, for a single line to ground fault in phase-A and ground.

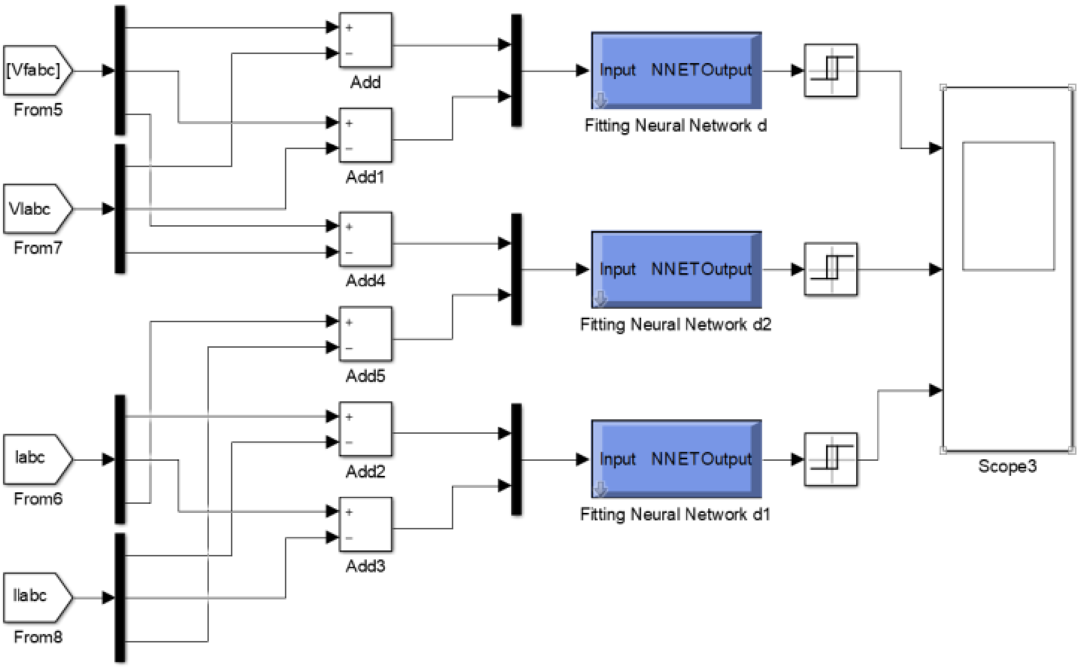

Figure 5: Fault detection simulation circuit using an ANN controller.

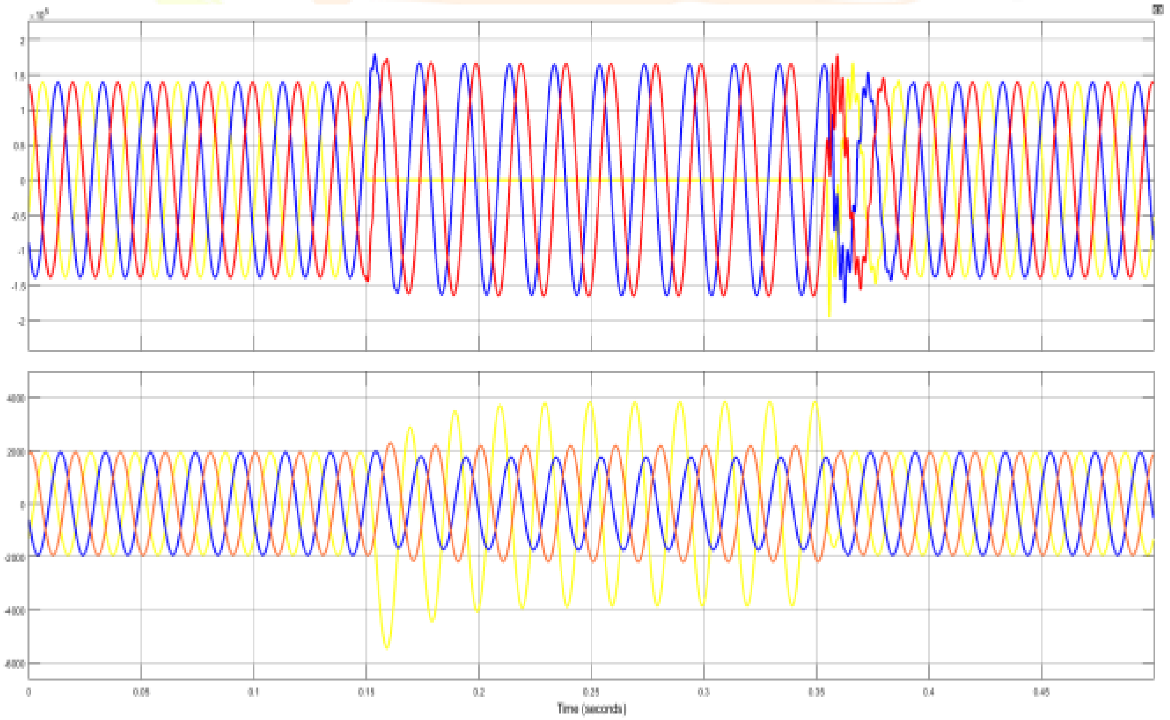

Figure 6: Ground voltage and phase-A voltage waveforms for a single line-to-ground accident the ground fault current waveform and the combined phase-A waveform on a single line.

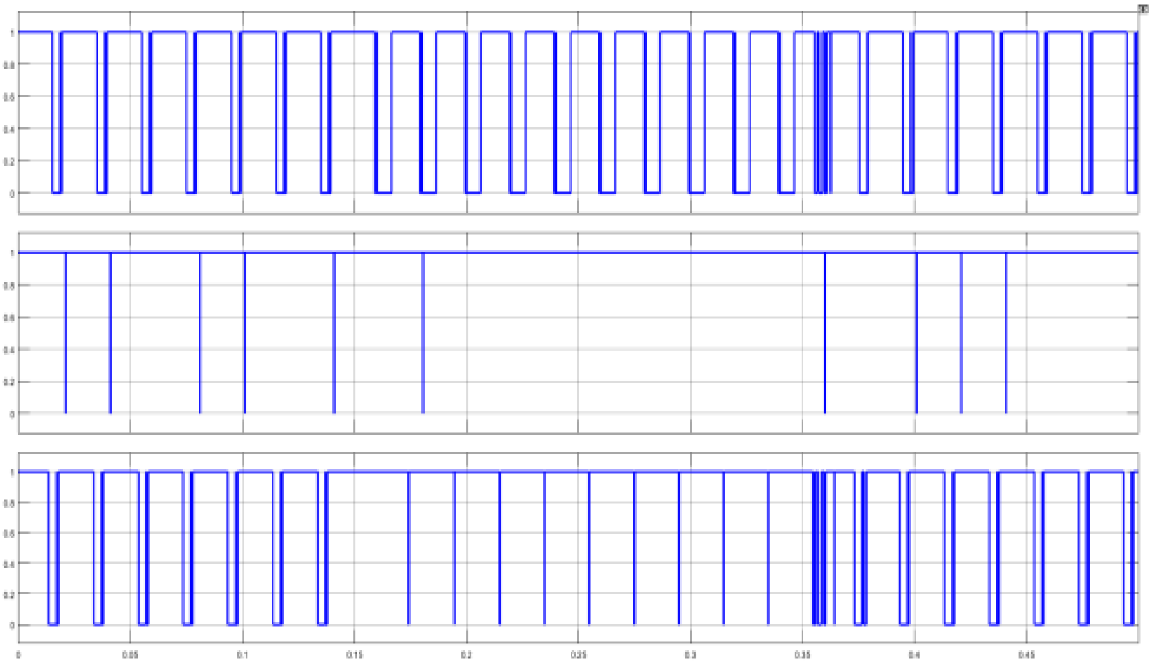

Figure 7: ANN detecting signal

4.2 Extension Results

The results of running the suggested transmission line model in the MATLAB/Simulink environment are shown in Figure 4. The transmission system receives its power and frequency from a triphasic voltage source. Utilizing three phase V-I measurement blocks, one may ascertain input and output voltages and currents. There are two inputs to the relational operator: the current values and a constant representing the currents when there is no defect. Under no-fault conditions, the relational operator's circuit breaker will open if the current value differs from the current value. A three-phase fault block causes the problem to occur inside the first tenth of a second of the simulation. The problem is fixed by turning on the circuit breaker. The results were recorded after careful observation. During the time interval of 0.15 to 0.35 seconds, a simulation fault is produced between Ph-A and Gnd. There are very large oscillations in the phase current (I_{ph} A), yet there is no phase voltage (V_{ph} A). Figure 9 shows the voltage and current waveforms at the location of the breakdown. We did the same thing for all of the simulated fault conditions, recording the fault currents and voltages. The signal for PR detection is shown in Figure 10.

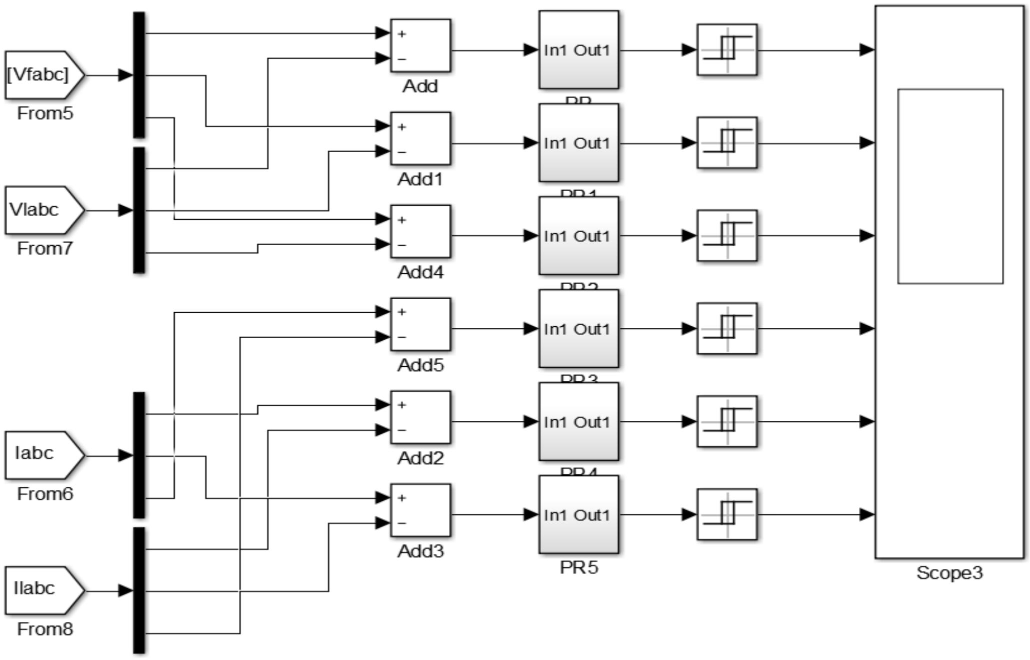

Figure 8: Using a PR controller to simulate a fault detection circuit.

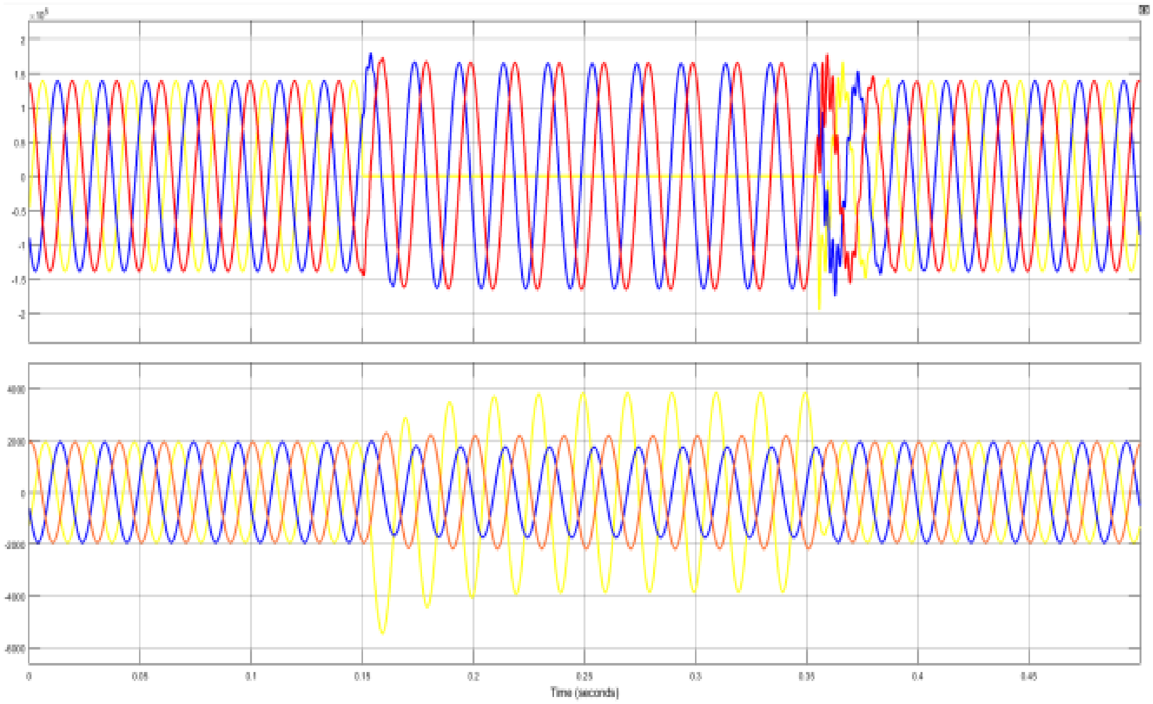

Figure 9: Voltage and current waveforms for a single line-to-ground fault in phases A and ground at ground level.

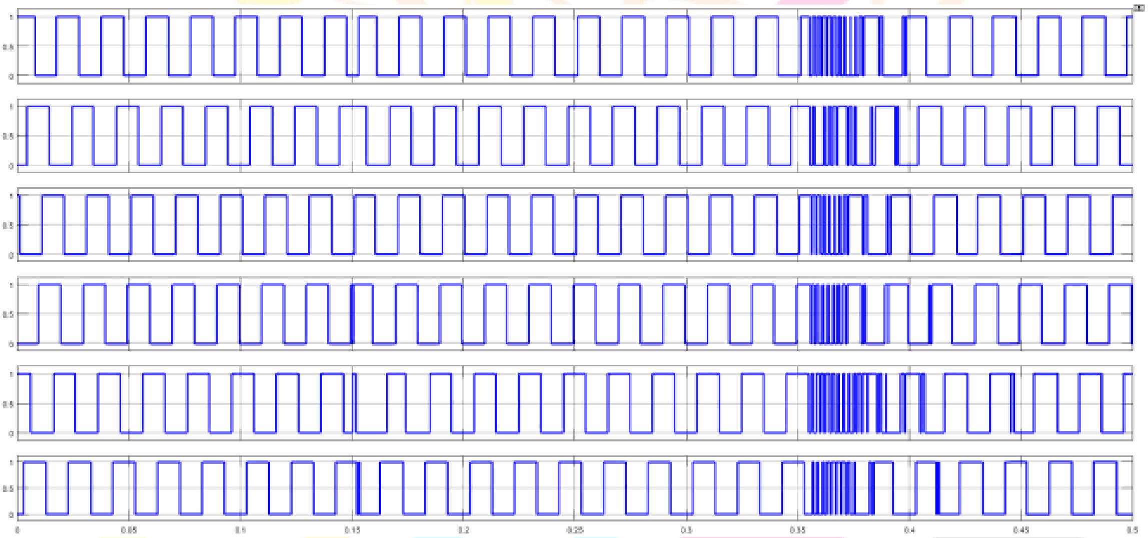

Figure 10: PR detecting signal.

V. CONCLUSION

This research used the MATLAB/Simulink environment to model and transforms a medium power transmission line system with three phases into a Π-model. Neural networks are trained using models of transmission systems. The feed forward PR method allows for the categorization and localization of mistakes. In this post, we show you the results of our performance study of the PR algorithm. In this study, we accounted for the modelled AG and ABG fault values. The suggested controller provides a quicker reaction time during problem identification in comparison to current ANN controllers. Alternatively, a PR model based on improved PSO might do the same thing.

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DECLARATION OF CONFLICTING INTERESTS

The authors declare no potential conflicts of interest with respect to the research and publication of this article.

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