# Differential Current Protection of Bus bar Using Micro Control Chip

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Mr.VV Subba Reddy, Mr. Shaik Farook
Department of EEE
Narayana Engineering College,
Nellore, Andhra Pradesh, India

Mr. Shaik Salik, Mr. Shaik Masthan
Mr.E.Mohana Sai, Department of EEE
Narayana Engineering College,
Nellore, Andhra Pradesh, India

Dr.Akhib Khan Bahamani,
Professor, Department of EEE
Narayana Engineering College,
Nellore, Andhra Pradesh, India

*Abstract*—**This work proposes a Differential current busbar protection scheme based on phase changes in positive sequence current of incoming and outgoing line current transformers (CTs). The angle differences of during fault and prefault current signals of incoming and outgoing CTs are the indicators of external or internal faults for bus bar protection. The advantage of the method is that it does not use magnitude information of the current and thus overcomes the CT saturation. This work also proposes with the design, implementation and testing of High voltage busbar relaying scheme using ATMEL processor which is Digital Signal Processor (DSP). Current differential algorithm is proposed to designed based on the DSP platform which can reduce large amounts of calculation, expedite the protection's trip and reduces the hardware requirements. This scheme provides stability against external faults, sensitivity towards high internal faults and better reliability in discriminating in-zone and out of zone faults.**

***Keywords—current Transformer, Digital signal processing***

## I. Introduction

Busbars are very critical elements in a power system, since they are the points of coupling of many circuits, transmission, generation, or loads. A single bus fault can cause damage equivalent to many simultaneous faults and such faults usually draw large currents. So a high-speed bus protection is often required to limit the damage on equipment and system stability or to maintain service to as much load as possible. The term "bus protection" refers to protection at the bus location, independent of equipment at remote locations

Most of faults incurred on buses are one phase to ground, but faults may be caused from different sources and a significant number are inter-phase clear of earth. In fact, a large proportion of busbar faults result from human error rather than the failure of switchgear components. Nowadays, with the advent of fully phase-segregated metal-clad gear, only earth faults are possible, therefore we only worry about earth fault sensitivity. Otherwise, the ability to detect phase faults clear of earth is an advantage, although the phase fault sensitivity need not be very high.

Differential protection is the most sensitive and reliable method for protecting a station bus. The phasor summation of all the measured current entering and leaving the bus must be zero unless there is a fault within the protective zone. For a fault not in the protective zone, the instantaneous direction of at least one current is opposite to the others, and the sum of the currents in is identical to the sum out. A fault on the bus provides a path for current flow that is not included in these summations. This is called the differential current. Detection of a difference exceeding the predictable errors in the comparison is one important basis for bus relaying. In dealing with high-voltage power systems, the relay is dependent on the current transformers in the individual circuits to provide information to it regarding the high-voltage currents. The following figures show typical examples of the location of current transformers that are used for this purpose. The arrowheads indicate the reference direction of the currents. Single bus bar arrangement and multiple bus section with bus Tie arrangement is shown in figures 1.1 and 1.2 respectively.

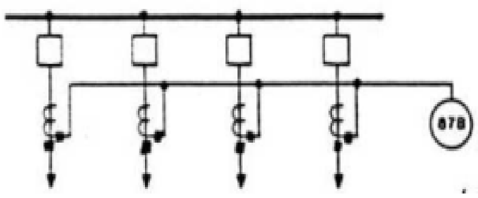



**Fig 1.1 Single bus arrangement**

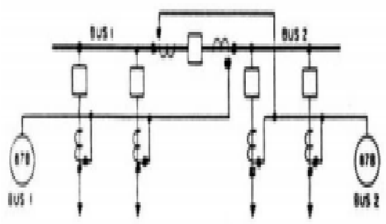



**Fig 1.2 Multiple bus sections with bus Tie arrangement**

## II. Problem Definition

One of the challenges faced in protection of busbars is the CT saturation. Faults in busbars are different in the way that during an external fault, all of the other circuits connected to the bus contribute to that fault. Therefore the current through the breaker of the faulty circuit will be significantly higher than that for any of the other circuits. When this large current flows through CT, there is a very high likelihood that some degree of saturation will occur. A saturated CT will not deliver its appropriate current to the relay. As the current in other circuits are considerably lower, the degree of saturation is expected to be considerably lower. This may cause the relay to misinterpret the external fault for an internal fault. The relay must not misunderstand this current.

Due to this the protection of the busbar becomes malfunction and this type of protection cannot differentiate between internal and external faults so to overcome this problem we used microcontroller based busbar protection.

## III. Objectives

The main objectives of this work deals with the real time implementation of differential relaying algorithm using DSP for high voltage busbar. The prototype implementation of differential relying scheme has been carried out. The proposed scheme is capable to discriminate between internal fault and external fault on busbar. The proposed scheme has the ability to detect all types of internal faults and remains stable during external/out of bus zone faults. An average tripping time of the order of 1.2 seconds for all kind of internal faults is achieved

## IV. Electrical Bus Bar

List of the electrical fact that take into account to select any bus bar arrangement in a substation are

A. The pattern of bus bar should be general and not hard for over hauling.
B. It should have the flexible design for adding the extra load to the bus bar.
C. The pattern of the bus bar should not be extravagant with quality service.
D. The spare parts should be available for putting the bus bar in to the operation from the outage.

Different types of busbar have described below

### *A. Single Busbar arrangement*

The bus bar arrangement for the single set for total length of the switch board. This kind of busbar can able to give opportunity to connect all generators, transformer and feeders. The bus bar arrangement has shown in the figure 1.3. This kind of bus bar arrangement has low initial cost, less cost for maintenance and very simple for operation.

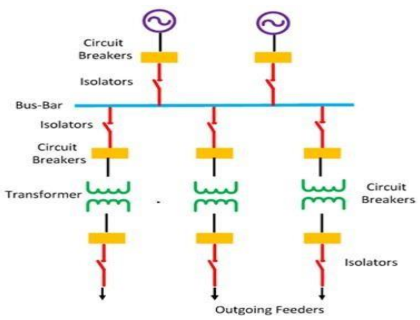



**Fig 1.4 Single Bus Bar Arrangement diagram**

### *B. Bus sectionalized Pattern with Single Busbar*

The bus-bar is divided into a circuit breaker and an isolating switches. The fault on one portion does not causes a whole blackout. In a sectionalized bus bar pattern only one extra circuit breaker is required. This does not charge greatly in association to the whole cost of the bus bar system. During the maintenance of one section does not affect the other part of the bus bar. The bus bar arrangement with bus sectionalized source is shown in the figure 1.5

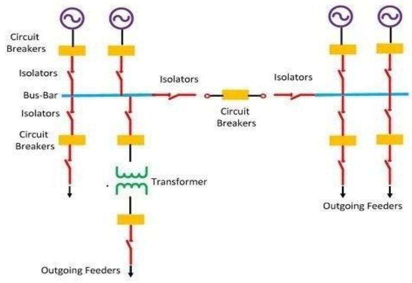



**Figure 1.5 Single Bus bar arrangement with bus sectionalized**

### *C. Main and Transfer busbar arrangement*

This type of pattern has used dual bus bars. One bus-bar is called main bus bar and second one is called supporting bus-bar. The generators and feeders are connected to one of the bus bar using coupler. The coupler is involved with both circuit breaker, isolating switch. The bus coupler is responsible for shifting from main bus-bar to supporting bus bar or vice versa. This operation has done during the load has connected. During the fault time it could also possible to shift from one bus to another bus. This arrangement has worked if the bus is not under fault.

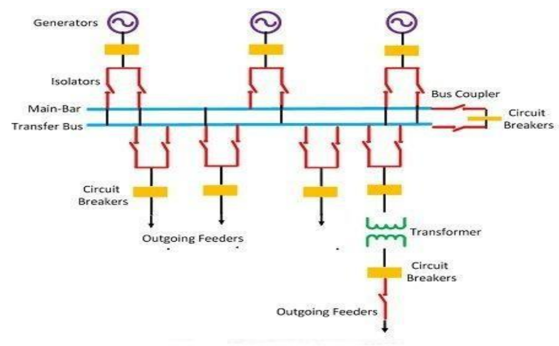



**Figure 1.6 shows the main and transfer bus arrangement**

### *D. Dual Bus and Breaker System*

This kind of arrangement dual bus bars and double circuit breakers are used. This system does not ask for bus coupler. The arrangement is consistent and easier for avoiding the fault disturbance to the reduce rate. It has endurance in power supply. The load could be transfer to alternate circuit breaker in the course of the main circuit breaker goes under repair situation. For the dual buses and circuit breakers it rises the budget of pattern. The double bus double breaker arrangement does not use so much in the substation bus-bar establishment design. The figure 1.5 shows the dual bus and twofold breaker arrangement

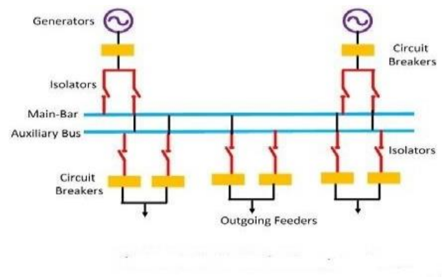



**Figure 1.7 Dual Bus and Breaker System**

*E. One and a Half Breaker Pattern*

The pattern proposed that three circuit breakers are necessary for two circuits. This arrangement bus bar could be use in high power capacity substation where large amount of power has handled per circuit. Figure 1.6 has showed the one and a half breaker pattern. It offers great safety contrary to loss of supply as a fault in a bus will not interfere the supply. The supplementary circuits are easily additional to the bus bar. The bus Voltage can be used as a source for relay.

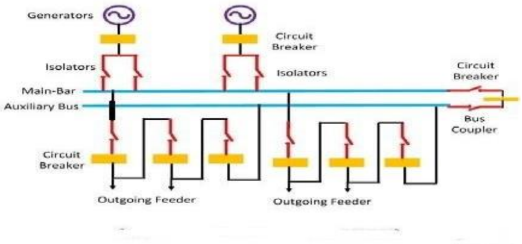



**Figure 1.8 one and a half breaker pattern**

## V. Results and Discussion

When the feeder is in off position no current flows through the busbar and the current through the each bus bar is zero and the display shows thee currents as F1 and F2 is shown below figure 5.1 and 5.2.

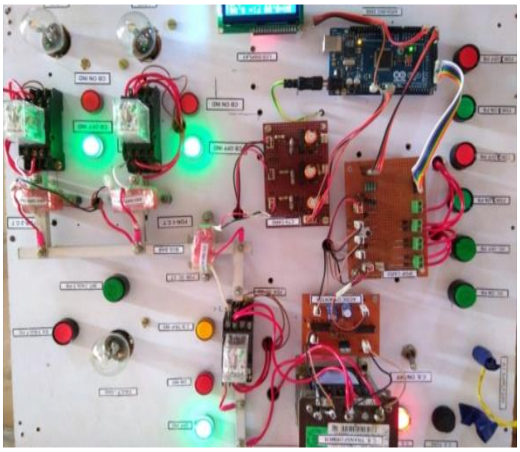


**Fig 5.1 When the feeder is in off position**

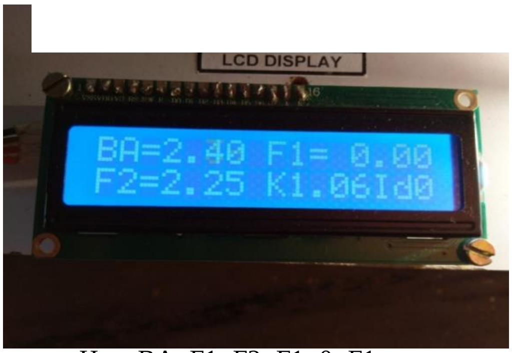

**Fig 5.2 Readings when the both feeders in OFF position**


**Fig 5.3 when bus bar supply is given**

When the feeder push button is switched on then the supply to the busbar is given and then we switch on the feeders from the busbar and it is shown above figure 5.3.

**Fig 5.4 single feeder switched ON**

When the first feeder is on then the current in the bus bar and the feeder one will be same




Here BA=F1+F2=F1+0=F1

**Fig 5.5 readings when one feeder turned ON**

Similarly when the second feeder is switched on the supply to the load attached to feeder 2 gets supply

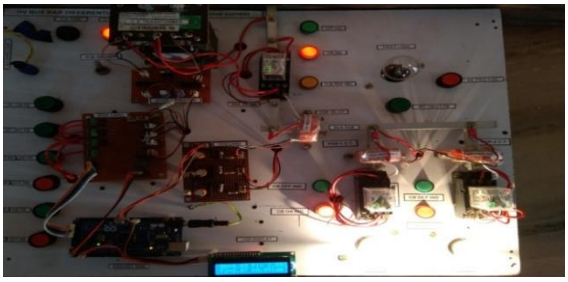


**fig 5.6 when both feeders are turned ON**

When both the feeders are given supply then the sum of the currents in both the feeders is equal to the busbar current and it is shown in the fig 5.7

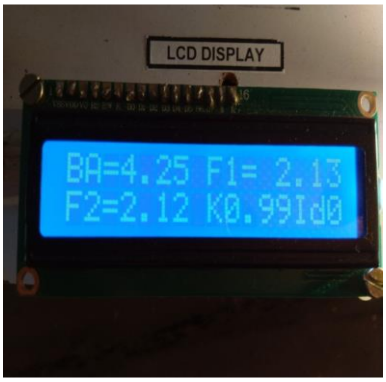



**Fig 5.7 readings when both feeders turned ON**

In this display Id is the differential current and k is the ratio of the differential and the set or threshold current which is already fixed to certain value. When the external fault occurs the value of k doesn't change as the difference currents will be constant when external fault occurs.

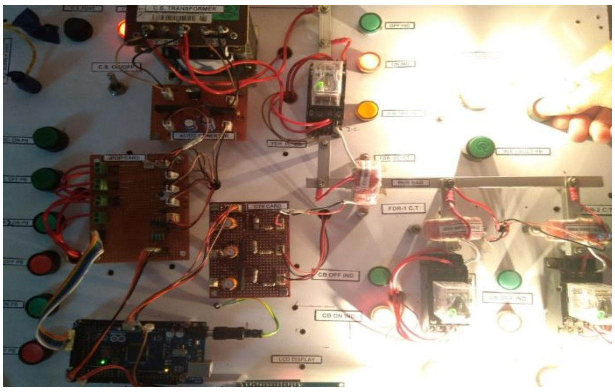


**Fig 5.8 When the external fault applied**

So when the external fault occurs then the circuit doesn't trip off. When the Internal fault occurs then the differential current through the busbars changes and the k radio changes and the circuit trips off. And this makes the current in entire circuit is zero

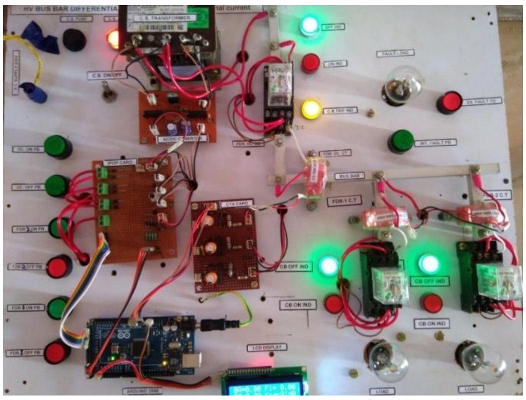


**Fig 5.9When the Internal fault applied**


**Fig 5.10 readings when the internal fault occurs**

Table 5.1 Table Normal Internal and External faults with feeders 1, 2 and 3

| REGION | FEEDER -1 | FEEDER-2 | K RATIO |
|---|---|---|---|
| Normal | 2.13 | 2.12 | 0.99 |
| External fault | 2.02 | 2.32 | 0.93 |
| Internal fault | 0.00 | 0.00 | 9 |

## CONCLUSION

This work proposes a digital relaying technique for Differential current busbar protection using phase change in sequence current of incoming CT currents (CT1 group currents) and outgoing CT currents (CT2 group currents). The angle differences of above said current signals are the indicator of external fault and internal fault. The phasor concept is used to overcome the current transformer (CT) saturation. The proposed technique is not using voltage signal for discriminating the internal and external faults. The proposed technique also overcomes the CT saturation and CT ratio mismatch problem.

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