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IMPROVED I_S – LIMITER TECHNIQUE FOR IMPLEMENTING FAULT CURRENT LIMITING REACTORS ON FEEDERS AT NO CONSTANT POWER LOSSES

Akpeh, V.A*, Omini, G.U*.
* TRANSMISION COMPANY OF NIGERIA (TCN)

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ABSTRACT

The principles of operation of I_S – limiters and the deficiency in their use in limiting fault currents is discussed in this paper. The paper also gives the modifications needed in I_S – limiters to be effectively used for short-circuit current limitation in power systems.

KEYWORDS: Current limiting reactor, Short-circuit current, I_S – limiter, Power system, Technique, Triggering logic, Circuit breaker.

INTRODUCTION

The demand for electrical energy is growing rapidly all over the world. The consequence of this is an increased complexity of the power systems due to the use of additional generators and transformers. This can create excessive short-circuit, far higher than the rating of the system [1, 2].

The use of current limiting reactor is adjudged the most practical technique for reducing short-circuit currents to levels within the rating of the equipment on the load side of the reactor but their use is however limited to some critical feeders due to the constant power losses caused by them since they are connected in series with the feeders and such carry the full load currents [3, 4, 5]. This very limitation in the use of current limiting reactors leads to the use of circuit breakers of higher capacity and hence of higher cost than is needed, meaning a huge economic loss [6].

The use of I_S – limiters in my view could be superior to the use of Current Limiting Reactors if not for the associated problem of replacing the fuse and the copper conducting bar each time it operates. The improved I_S – limiter utilizes the advantages of the fault current limiting reactor and the I_S – limiter and averts their shortcomings.

I_S-LIMITER

An I_S-limiter is a fault current limiting device that uses chemical charges and current-limiting fuses to interrupt the fault current within the first quarter to half cycle (i.e. before the first peak). In a typical I_S-limiter design, the device is composed of two current paths connected together in parallel – one path is an element rated for the full load current (which can have high continuous current ratings, e.g. 3000A), and the other path provides the current limiting function via a current-limiting fuse (which typically has a continuous current rating of less than 300A at 15kV) [7].

HOW CURRENT LIMITERS WORK

A current limiter is a parallel combination of a copper bar and a current limiting fuse. During normal operation the load current flows through the copper bar which effectively shorts out the fuse. This is the reason why the current limiter has no effect on the distribution system in normal operation. However, when there is a Short-circuit, it is necessary to interrupt the flow of current through the copper bar and force the current through the current-limiting fuse. This must be done much before the peak short-circuit current value is reached if any limitation is to occur. A fast acting triggering device is therefore required. This, together with an explosive charge as shown in Figure 1 will cause the immediate destruction of the conducting path through the copper bar.

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The fault current will then flow though the current limiting fuse until the first natural current zero is reached. After this current zero the fault current through the current limiter will be zero [8, 9].

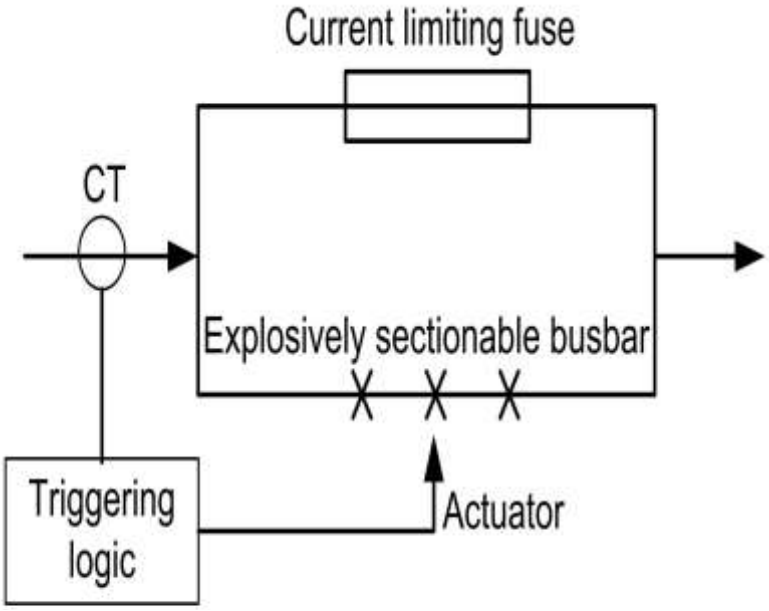

Figure 1: Current Limiting Device.

The use of fuses for short circuit current limitation is limited to 40kV [10]. The meaning of this is that no matter how good the I_S – limiter technique is, it can only serve for systems up to 40kV only. Again, when the current limiter operates, the copper bar and fuse in the phases that are triggered are destroyed. They must be replaced before the current limiter can be energized again.

The replacement of these components is another shortcoming of the I_S – limiter. For instance, even when used in systems of below 40kV, the time wasted and the cost for replacing the destroyed copper bars and the fuses in event of a transient fault is of serious concern when considering the system down time.

REPLACING THE FUSE WITH CURRENT LIMITING REACTOR AND THE EXPLOSIVE CHARGE WITH ISOLATOR IN THE I_S – LIMITER.

Replacing the fuse in the I_S – limiter with current limiting reactor and the explosive charge in the I_S – limiter with a fast opening isolator results in an improved I_S – limiter as shown in figure 2.

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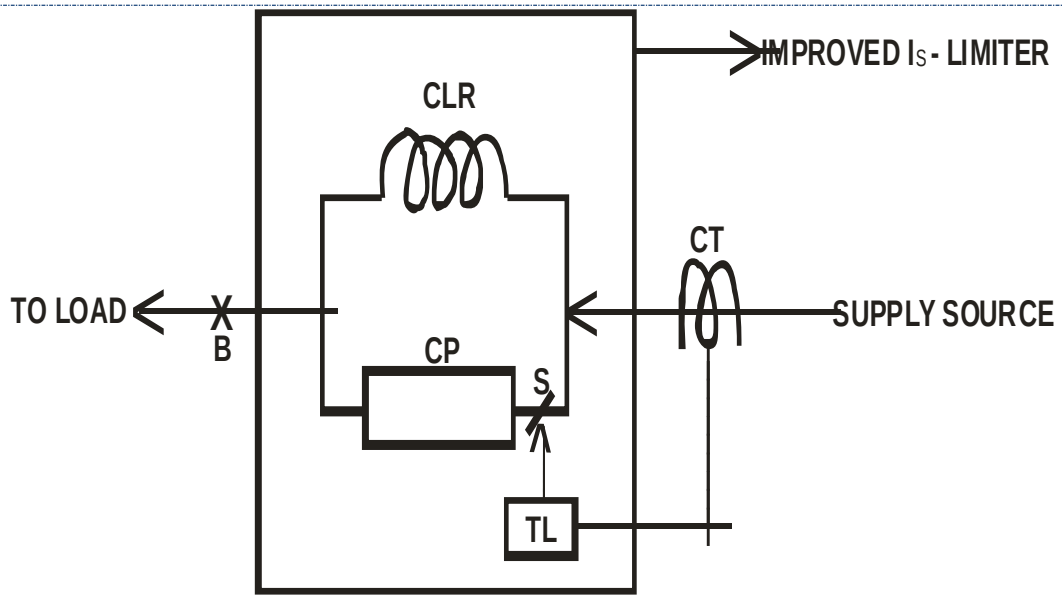

Figure 2: an improved I_S – Limiter

The improved I_S – limiter guarantees no destruction of any part of its components at fault time and as such no system down time for transient faults and no cost arising from replacing the destroyed components.

HOW THE IMPROVED I_S – LIMITER WORKS.

The improved I_S – limiter as shown in figure 2 is simply a parallel arrangement of a Current Limiting Reactor (CLR) and a Copper conducting path (CP) with a fast operating isolator, S. At normal system condition, the current limiting reactor is shorted out by the copper conducting path. When short-circuit occurs, isolation of the copper conducting path is triggered by the Triggering Logic system (TL). This must be done before the first half cycle is reached.

It should be noted that the isolator, S, is motor operated. It is also important to note that the copper conducting path, CP, should not be completely isolated before the current is diverted through the current limiting reactor, CLR. At the very instant the isolation of the conducting path is triggered, a high resistance is caused at the isolating point. This high resistance continues to grow higher and higher and move towards infinite resistance as the isolation process continues, such that by current reversal [6], the current is diverted through current limiting reactor before the circuit breaker, B, clears the fault.

As soon as the circuit breaker, B, opens, the triggering logic again sends a closing signal to the isolator, S, which then closes back the copper conducting path, CP, far before the restoration of the circuit breaker, B.

CONCLUSION

The improved - I_S – limiter can be used on all voltage levels unlike the I_S – limiter which use is limited to 40kV. It does not require replacement of any of its components after its operation like the I_S – limiter and as such removes unnecessary outage periods during transient faults. It is good for short-circuit current limitation on all voltage levels. It is superior to the I_S – limiter.

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