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Dynamic Arc-Flash Sentry*

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A concern with all energized electrical equipment is the issue of arc flash. This issue has received considerable attention in recent years triggered primarily by a change in the 2002 National Electrical Code (Article 110.16) that requires several types of electrical equipment to be field marked to warn qualified persons of potential electric arc flash hazards. This paper will describe a unique feature of the Siemens WL, Low Voltage Power Circuit Breaker, that can help address the issue of arc flash energy.

Two major factors that determine the level of arc flash energy are the available fault current and the time in which the fault is cleared by the overcurrent protective device. Of these two factors, the trip timing of the protective device is more easily controlled. Simply put, lower levels of arc flash energy can be achieved by implementing faster circuit breaker trip times. However, power circuit breakers such as the WL are typically chosen for critical selective trip coordination due to their high current withstand capability. This withstand capability allows delayed tripping to give a downstream device time to open first. In fact, in applications where a power breaker like the WL is used as a service main or switchboard main, generally the instantaneous function is eliminated altogether in order to achieve full selective trip coordination. Since it is the switchboard MAIN breaker operation time that must be used for the arc flash energy calculation, NOT the branch breaker, the deliberately delayed tripping time is the exact opposite of what is desirable for lower arc flash energy. Long trip times mean higher arc flash and bulky Personal Protective Equipment (PPE) that workers must wear. Must the system designer sacrifice selective trip coordination for lower, safer, levels of arc flash? A unique feature of the WL trip unit can help address this question.

This feature is Dynamic Arc-Flash Sentry (DAS). It employs the dual protective setting capability of the 776 trip unit, coupled with the ability to easily switch to a trip parameter set which can be designed to reduce arc flash energy, and a sensor for the presence of anyone crossing the arc flash protection boundary. This boundary is defined in NFPA 70E as the approach limit at a distance from exposed live parts within which a person could receive a second-degree burn if an electric arc flash were to occur. Only “qualified” workers are permitted to be within the flash protection boundary and they are required to wear appropriately rated PPE. DAS allows the system designer to achieve the needed delayed tripping for trip coordination purposes and lower levels of arc flash.

DAS can be implemented on all WL circuit breakers, no special frame is needed. To add DAS the breaker hardware components needed are, 1) ETU776 trip unit, 2) a 24Vdc power supply and 3) the Digital Input Module (part number WLDGNCUB). The final component is an appropriate safety rated sensing/switching device set to the flash protection boundary.

There are a few simple steps to implement the DAS feature. First, a ‘normal operation’ trip parameter set, the usual LSIG trip unit function settings, should be determined to optimize the WL for best selective trip coordination. Of course, the Instantaneous trip function may be turned off if needed. The WL offers a full range of functions to allow the highest levels of trip coordination capability in the industry.
Once the best coordination settings have been determined for a particular system, they should be entered into the trip unit as the ‘A’ parameter set. The trip unit has a dedicated area to display the active parameter set and will show an ‘A’ for this set.

The second step is to determine the settings for the ‘B’ parameter set. This set will be optimized for lower arc flash energy. The goal is to find the lowest possible trip settings that will still allow the WL to carry normal loads, including normal inrush currents, for a particular system.

One critical area for the lowest arc flash energy is the instantaneous trip function. Since trip coordination is not the primary concern here, in most systems the instantaneous trip may be enabled, even set at fairly low levels, and still allow normal operation of the systems loads. Calculations of the arc flash energy can be made based on the available fault current and the operating time of the WL as determined from the instantaneous settings selected. Lower levels of arc energy will allow lighter PPE which allows faster and easier completion of work.

How is selective trip coordination really affected? The good news is that the Long Time and Short Time

settings have little impact on arc flash. This is fortunate because the most common overcurrent trip is an overload, which typically occurs in this range of settings. Therefore good coordination can still be achieved in these sections of the trip curves without increasing arc flash levels. The main area of trip coordination to be affected is the Instantaneous range where only high levels of short circuit currents are a factor. It is in this area that trip coordination must be compromised to achieve appreciable arc flash energy reduction.

This is the reason that DAS can be such a powerful tool for the system designer. With DAS, the breaker is set with an instantaneous trip function only when personnel are within the arc flash boundary. At all other times DAS allows Instantaneous to be turned off to achieve the coordination that power breaker can best provide. There are specialty circuit breakers on the market that are called 'Arc Flash' circuit breakers. These circuit breakers are typically designed to have fast operational times, which is good for lower arc flash energy. However, one consequence of this design is that they also typically have low withstand ratings, which is not good for selective trip coordination. To achieve their best arc flash energy reduction they must also implement instantaneous tripping at all times– which means that coordination in this area is compromised at all times. The system designer should carefully research and consider all the ratings of a circuit breaker to be sure that his overall system needs are met. As outlined above, DAS can help address most system protection and coordination needs.

The next implementation step is the setup of the Digital Input Module. It must be set to the "Parameter Switch" mode which allows a dry contact input to toggle the trip unit between the 'A' and 'B' parameter sets. The dry contact input can come from a wide variety of switching means.

The last step is the selection of an appropriate sensing/switching means and configuring the flash protection boundary limits. Siemens offers a full range of SIGUARD machine safety products that can meet the requirements, and industry standards, to implement a safety control function such as this. All design considerations must follow safety industry standards. For safety purposes, the arc flash boundary distance itself should be calculated based on the higher levels of the 'A' parameter set. The key advantage of DAS is that the PPE used may be based on the lower arc flash energy levels calculated with the clearing times of the 'B' set.
The simplest sensing approach could be as straightforward as a key lock maintained control switch to monitor the equipment room door. Anyone entering the room via that door would trigger the WL to switch to the 'B' parameter, lower arc flash energy settings, and allow the use of minimal PPE appropriate to that level of energy. An important safety practice would be to verify the parameter set via the trip unit display. The operational parameter set is always displayed on the bottom row of information on the trip unit. Again, all safety industry standards and safety procedures should be followed until all personnel have cleared the area and are outside the arc flash boundary.
The limitation of this approach is that the entire room would be considered in the arc flash zone. Access to the room for equipment unrelated to the switchgear would trigger the parameter switch unnecessarily.

A more flexible approach would be to use a sensor such as the SIGUARD LS4 laser scanner. This device employs a low level laser diode and rotating mirror system to continuously scan a 190 degree field of view. The LS4 evaluates the reflected light pulses from any object in the field of view and, using the light propagation time, continually calculates the precise position and distance coordinates of that object. Up to four programmable protective zones can be field configured to react only to people that are crossing the arc flash boundary. In fact two zones could be configured, one distance could be set to warn personnel that they are approaching energized electrical equipment. A second zone, closer to the equipment and conforming to the flash protection boundary, would automatically trigger the switch to the 'B' parameter settings. Once personnel are clear, the trip unit would be allowed to return to normal operation with the 'A' parameter set.

The DAS principle might even be extended to a situation where the layout of the equipment is such that the 'main' device for a switchboard is a WL 'feeder' breaker in an upstream distribution board some distance away. In this case the communications capability of the WL could be used to allow transmission of the necessary 'B' parameter switch signal to the appropriate WL trip unit over considerable distances. A wide variety of safety integrated devices, including those in the SIGUARD line, can be used to implement DAS for maximum flexibility.

OSHA and other industry guidelines must be followed for worker safety. **Siemens always recommends that all power be turned off and lockout procedures observed when working on electrical equipment.** NFPA 70E is also an important resource for information about arc flash and other electrical safety issues.

* Patent pending