

T e c h n i c a l

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Extended Instantaneous Protection

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The electronic trip units designed for use with the WL low voltage power circuit breaker by Siemens provide a feature called "Extended Instantaneous Protection" (Patent Pending). This feature allows the WL breaker, across the entire range of ampacities to be applied at the withstand rating of the breaker with minus 0% tolerance; that means no instantaneous override whatsoever. EIP further enables the circuit breaker to be applied up to the full interrupting rating of the breaker on systems where the available fault current exceeds the withstand rating, even with LS-only trip units. Why is this feature important? The answer is reliable power.

Reliable electrical power is more critical than ever today. Multiple utility feeds, back-up generators, and UPS systems are some of the choices available to the power system designer to provide 24/7/365 availability of power. Of course, the power source can only be effective when the distribution system is properly designed to deliver that power to critical loads. An important part of that design is the coordination of the overcurrent protective devices, or more correctly, the selective trip coordination of those devices.

The coordination of the main breaker and the first level of feeder breakers is especially important because of the wide spread outage that will occur if one of these breakers trips unnecessarily. Conventional practice is to specify electronic trip breakers with "LS" type trip units in critical power systems on mains and feeders. These trip units have no 'Instantaneous' overcurrent trip function, only 'Long Time' and 'Short Time' functions. Why forgo the fast tripping times given by an instantaneous function? Why deliberately delay the tripping of the breaker? The justification for this delay is the benefit of allowing the best opportunity for a downstream breaker to open first to clear a high magnitude fault. The main or feeder stays closed to keep the remainder of the system operating.

In order for a circuit breaker to remain closed during a high magnitude fault it must have a high 'Withstand Rating'. A withstand ratings can be defined as:
The assigned RMS current a device can carry for the specified period of time without damage to itself. In the case of overcurrent protective devices interruption does not take place. The rating is expressed in amperes and time.

The time period specified is typically 30 electrical cycles. The circuit breaker must not interrupt during that period, instead it must stay closed and 'withstand' the tremendous forces of a high magnitude short circuit. A downstream branch should trip to clear a fault well within 30 cycles. To achieve reasonable withstand ratings for this trip coordination a heavy duty circuit breaker, generally a Low Voltage Power Circuit Breaker (LVPCB), such as the WL, is required.

The benefits of high withstand ratings and LS-only equipped circuit breakers are clear. However, a breaker with an LS-only trip unit may never be applied on a system capable of delivering higher fault current than the breaker's withstand rating. Damage or even complete destruction of the circuit breaker will occur if it is exposed to currents beyond that rating. Generally these ratings are less than 100kA, however, more and more we see systems where more than 100kA is available. These extremely high fault current systems are a continuing trend as utility companies use lower impedance feeds and higher capacity grids. How does the system designer address these applications to provide reliable power?

To properly apply a circuit breaker within its ratings and retain as much trip coordination as possible, the only practical answer is to apply a breaker with a high level instantaneous trip function, usually called an instantaneous override. This override function trips the breaker instantly, overriding the short time delay, when the fault current reaches a pre-determined level. This tripping affects selective trip coordination because, for faults occurring that exceed the withstand value, the main or feeder will probably trip at the same time as a downstream branch breaker.

At what level does the instantaneous override take over the short time delay? The override level can be difficult to determine for a given circuit breaker. The override value is not required to be a part of the rating label that appears on the circuit breaker so it probably will not be shown there. The breaker technical literature or time current trip curve will usually list the override value, sometimes as a footnote. But be careful to read all of the fine print. The override value will change from one frame size to another, even within the same breaker type, or vary with the type of trip unit used. So don't assume that the same value will apply across the range of ampacities. Check all of the exceptions and exclusions for the different frames and trip units available for that particular circuit breaker. In some cases the instantaneous override value can be as low as half of the withstand rating. This would seriously compromise the selective trip

coordination of the breakers in a system.

Also be careful to note the tolerance of the override value. In most cases the tolerance is around minus 20% of the stated value. To be safe it should always be assumed that the breaker will trip at the lower tolerance value, which means that the breaker can trip at current levels substantially below the withstand level. Why must circuit breakers allow for possible tripping at the lower values? It's typically due to the difficulty in reliably measuring the very high current flowing during a maximum level short circuit in the very short time that it occurs. The trip unit must err on the lower side to be sure and trip fast enough to protect the breaker itself. Again, be aware that this tolerance value means a potentially serious compromise of the ability of the main breaker to coordinate and therefore affects the reliability of the system as a whole.

This is where the Extended Instantaneous Protection feature of the WL can offer a higher level of protection and coordination functionality. Unlike the traditional instantaneous override, Extended Instantaneous Protection (EIP) allows the WL to stay closed through the full withstand value - no minus tolerance whatsoever. How is this done?

One key factor is the current sensors used in the WL. The traditional method of current sensing is to use an iron core CT, however, the WL uses Rogowski coil technology for current

sensing. The Rogowski coil allows current sensing accuracy of better than 1% and unlike the traditional CT, does not saturate at the high current levels that are present during a short circuit. This high speed sensing and accuracy, coupled with advanced predictive tripping techniques is the technology behind the Extended Instantaneous Protection function. It allows 100% of the full withstand rating of the frame and still provides the ability of the breaker to be applied at up to 150kA in a non-fused breaker. This unique combination enables the system designer to achieve the highest level of coordination possible in the industry and also allows application of the WL on modern power systems with extremely high levels of available fault current.

Of course not all systems have these extremely high fault current levels. In those systems the system designer can achieve the theoretical best system design by matching the available fault current to the withstand rating of the circuit breaker. But even in these systems EIP can provide a unique benefit over a standard LS-only trip unit. It is quite likely that over the course of the life of a facility changes will be made that will increase the available fault current, potentially beyond the withstand rating of the breaker. One example might be a utility change to a lower impedance transformer as mentioned earlier. Another change that could increase the available fault current might occur within the facility itself. The addition of generators or large motors would also

contribute fault current. A traditional LS-only breaker would have to be replaced with a higher rated breaker when changes are made that significantly raise available fault current. The EIP equipped breaker would probably

not need replacement, since it provides an extra measure of protection to extend into the instantaneous capability of the circuit breaker - up to 100ka or even 150kA.

Extended Instantaneous Protection is just one of the features of the WL circuit breaker that helps provide the utmost in reliable power for demanding applications.