

Data Bulletin

Zone Selective Interlocking (ZSI) Systems and Alternate Maintenance Setting (AMS) Switches in Electrical Distribution Systems

Class Number 0100

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Introduction

This bulletin describes the basic principles of how Zone Selective Interlocking (ZSI) systems and Alternate Maintenance Setting (AMS) switches can be used with selective coordination to enable an efficient, safe, and effective electrical distribution system. The selective coordination of circuit breakers and electronic trip units with AMS switches and ZSI capabilities localize system outages and reduce fault stress in electrical distribution systems.

Selective Coordination

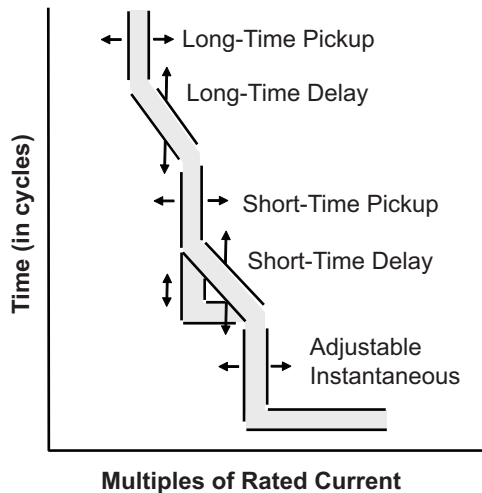
Overcurrent Protection Devices (OCPDs) are used in electrical distribution systems to protect electrical conductors and equipment against the effects of short circuits, ground faults, and/or overloads. The OCPDs in an electrical distribution system are often selectivity coordinated so that the nearest device upstream of a detected fault will open and clear the detected fault before another farther upstream device opens. Selective coordination of OCPDs limits the number of distribution circuits that are de-energized by the operation of a device in response to a detected fault.

The OCPDs in an electrical distribution system can be circuit breakers having programmable electronic trip units for controlling the OCPD's trip settings. The circuit breakers employing these electronic trip units are known as **electronic trip circuit breakers** (see Figure 1).

Figure 1: Masterpact® Circuit Breakers with Electronic Trip Units



Figure 2: Trip Settings



Automatic Reduction in Incident Energy—Zone Selective Interlocking (ZSI)

An electronic trip unit can include one or more of the following settings:

- long-time current pickup setting,
- long-time delay setting,
- short-time current pickup setting,
- short-time delay setting, and
- instantaneous current pickup setting (normally disabled).

Selective coordination among electronic trip breakers is achieved by appropriately adjusting the trip settings of the electronic trip units (see Figure 2).

Engineering studies for selective coordination and arc flash hazards are completed to ensure minimum disruption to available power through the electrical distribution system and, if a detected fault were to happen, to minimize the available incident energy.

These studies often guide decisions to maintain electrical coordination and availability of electrical power through the addition of time-delay settings to the electronic trip unit. The most common is the short time-delay setting, which is used to ensure selective coordination that allows an increased incident energy level in the event of an arcing fault. Methods can be incorporated into any electrical system design to minimize the available incident energy while maintaining coordination (either automatically or manually, as described below).

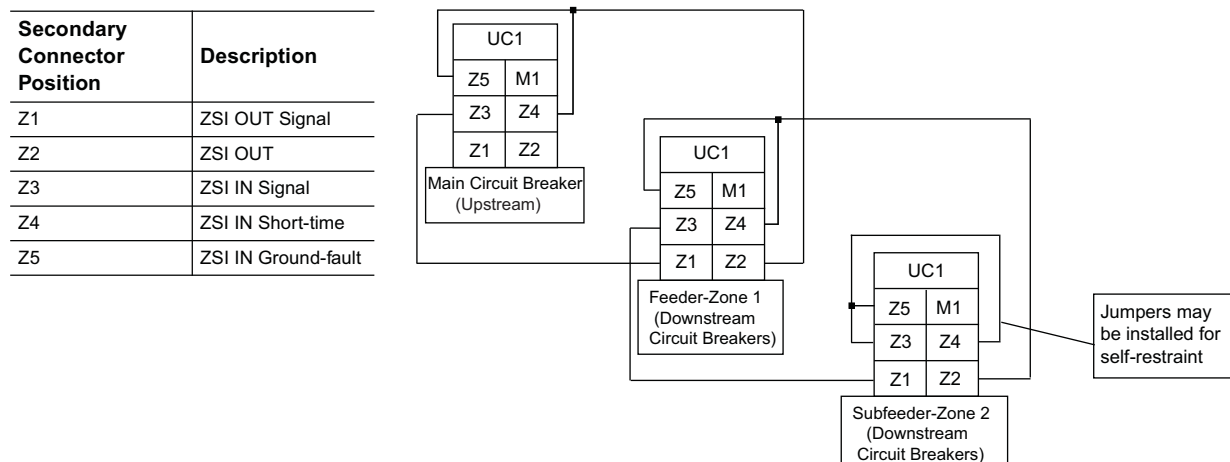
Micrologic electronic trip circuit breakers (see Figure 3) can accommodate ZSI. In a ZSI system, the ZSI terminals from all downstream Micrologic circuit breakers are connected to the ZSI terminals of the upstream Micrologic circuit breaker, creating a protection zone that is formed from the load side of the upstream circuit breaker extending to the line side of the downstream circuit breakers.

Figure 3: PowerPact® P- and R-Frame Circuit Breakers with Micrologic Electronic Trip Units



In a typical ZSI connection, wiring is run from the downstream ZSI OUT Signal terminal to the upstream ZSI IN Signal terminal and from the downstream ZSI OUT terminal to the upstream ZSI IN Short-time and/or ZSI IN ground-fault terminal. See Figure 4 for details.

Figure 4: Typical ZSI Connections



When a device equipped with ZSI senses a short circuit or ground fault, it sends a restraint signal (via the restraint wire) to the ZSI device just upstream from it. This activates the preset time delay on the upstream device.

When a device equipped with ZSI senses a short circuit or ground fault and **does not** receive a restraint signal, its preset time delay will not be activated and it will trip with no intentional delay.

Without ZSI, a coordinated system results in the circuit breaker closest to the fault clearing the fault, but usually with an intentional delay. With ZSI, the device closest to the fault will ignore its preset short-time and/or ground-fault delays and clear the fault with no intentional delay.

Manual Reduction in Incident Energy—Alternate Maintenance Setting (AMS) Switch

Figure 5: Local AMS Switch



The AMS switch temporarily eliminates the short-time delay setting of the circuit breaker and provides a circuit protection system with two modes: a normal mode and a maintenance mode (in which potential arc flash energy is reduced).

In normal mode, the upstream circuit breaker acts in accordance with the settings provided in the electronic trip unit that provides selective coordination of the electrical distribution system.

In maintenance mode, the upstream circuit breaker disregards the preset time-delay and operates to clear the fault condition with no intentional short-time delay. In this mode, the upstream circuit breaker responds as a ZSI circuit breaker that fails to receive a restraint signal, as described previously. By responding quickly to an arcing fault, incident energy is reduced. However, selective coordination is **not** preserved when the AMS is in maintenance mode.

For an AMS-controlled breaker to be effective for arc-flash reduction, the breaker's short-time current pickup setting (considering the positive tolerance) must be set below 85% of the minimum arcing current at the system location where it is expected to provide "fast" interruption (considering all fault current scenarios in an arc flash study).

Summary

The use of electronic trip circuit breakers as protective devices in electrical distribution systems provides the advanced ability to selectively coordinate and enhance safety. The ZSI system provides the ability to maintain electrical coordination and decrease the incident energy hazards. The AMS switch provides a manual means that may be incorporated into a facility's Lock Out/Tag Out procedure, per NFPA 70E, reducing the level of Personal Protection Equipment required for the personnel working on or near the energized equipment.

To ensure the chosen settings allow for proper operation of the ZSI system or AMS switch, an engineering analysis is required.

Related Documents

- Reducing Fault Stress with Zone-Selective Interlocking (Document No. 0600DB0001)
- Guide to Power System Selective Coordination 600 V and Below (Document No. 0100DB0603)
- Alternate Maintenance Setting (AMS) Switch Handout (Document No. 8998HO1001)
- Arc Flash Reduction Systems—Are They Always a Good Idea? (Document No. 0600DB0901)

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