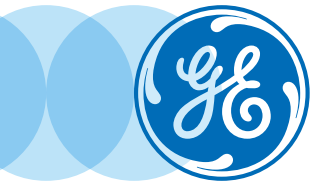


Advanced Arc
Flash Mitigation
With GE ArcWatch*
Frequently Asked Questions





General

What new building infrastructure trends are driving arc event mitigation requirements?

While scheduled outages for maintenance have been and continue to be the best protection from arc flash, they are increasingly difficult to conduct in our constantly connected, 24/7/365 world. Yet unplanned outages can have catastrophic consequences. For critical power facilities and other 24-hour operations (hotels, universities, retail, etc.), options to de-energize for maintenance or trouble-shooting can be limited. As a result, working on energized equipment has become increasingly more common, which raises the importance of devising smarter arc flash mitigation solutions. Modern buildings need to satisfy the requirements for 24/7/365 uptime while also increasing safety from dangerous electrical events like arc flash.

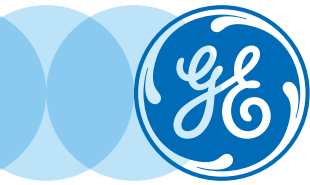
Working on energized equipment has become increasingly more common, which raises the importance of devising smarter arc flash mitigation solutions.

Aren't the safety and uptime of an electrical system inversely related?

Historically, the safety and uptime of electrical systems were sometimes seen as inversely related. Modern designs increasingly call for circuit breakers that are selective. That is, only the breaker closest to the fault responds for strong uptime performance while also inherently addressing arc flash risks that selectively coordinated systems can create. Now it's possible to design systems that allow both improved safety and improved uptime. One of the key elements of these new techniques uses signaling between circuit breakers to improve performance: intelligent circuit breakers automatically coordinate protection between each other. This high level of coordination can improve uptime without sacrificing safety.

What is selectivity and how is it related to uptime?

Uptime and reliability are terms often used interchangeably to refer to the electrical performance resulting from system selectivity. Selectivity, as in "selectively coordinated breakers," is a technique where the circuit breaker closest to the fault trips first, thereby minimizing the affected area of an interruption. If protection isn't selective, short circuits will result in equipment outages affecting much more of the facility than required. Selectivity can be compromised, however, if in an attempt to achieve lower arc flash incident energy, circuit breaker trip points are set too sensitively. Thus, the traditional safety vs. uptime dilemma can be, and often is, referred to as safety vs. selectivity.



What options do I have to provide both selectivity and safety in my arc event mitigation solutions?

Modern electrical systems can now communicate and coordinate to optimize their responses to electrical events. For example, Zone Selective Interlocking (ZSI) systems allow a set of breakers to coordinate protection between upstream and downstream breakers. They can change response time to different events, like a short-time event or a ground fault, thus reducing the arc flash energy potential from the lower settings used on the upstream circuit breaker and allowing the main circuit breaker to respond faster to arcing faults. When instantaneous response is added to traditional ZSI (I-ZSI), breakers communicate fully to adapt and coordinate their response to small overloads or large faults, only operating when needed. I-ZSI provides arc flash protection, since clearing arcing current at instantaneous speed results in lower arc flash incident energy.

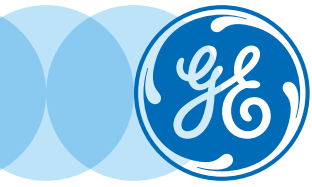
ArcWatch* provides more modern, flexible options for both uptime and safety regardless of the age of the facility.

GE I-ZSI and waveform recognition (WFR) intelligent protection systems use the same simple voltage signal and coordination capabilities to deliver both mandated selectivity and improved safety simultaneously. GE ArcWatch* is the innovative circuit breaker communications technology enabled by I-ZSI and WFR to create a truly intelligent electrical system. The ability to deploy ArcWatch in new installations as well as to retrofit to existing equipment can also provide more modern, flexible options for both uptime and safety regardless of the age of the facility. ArcWatch is described in more detail in the following section.

ArcWatch

What is ArcWatch?

ArcWatch is the technology embedded in specific low-voltage GE trip units and circuit breakers that allows the circuit breakers to be set for better arc flash protection without sacrificing selective coordination. Setting the instantaneous pick-up value on a circuit breaker sufficiently below the predicted arcing current permits the circuit breaker to clear arcing faults using the circuit breaker's fastest speed. Traditionally, lower pick-up settings lead to reduced selective coordination. ArcWatch solves this dilemma by maintaining selective operation in the *instantaneous* region *even* when the time current curves overlap.



Which GE products include ArcWatch?

All EntelliGuard* trip units are ArcWatch enabled. This is the standard trip unit on every currently manufactured PowerBreak* II or EntelliGuard G insulated case circuit breaker and every WavePro* or EntelliGuard G low voltage power circuit breaker. EntelliGuard E low-voltage power circuit breakers used only in Entellisys* switchgear also have ArcWatch technology by design.

Additionally, all *micro*EntelliGuard* trip units have ArcWatch. This is an optional trip unit on the larger frames of the Spectra* series of molded case circuit breakers (MCCBs). Current-limiting circuit breakers used downstream to any of the following upstream combinations are also part of the ArcWatch family:

- Circuit breakers with the EntelliGuard trip unit
- A selective Spectra K-frame circuit breaker
- The EntelliGuard E circuit breaker

Can ArcWatch capabilities be retrofit into existing equipment?

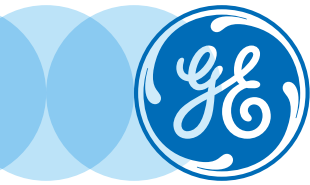
Yes. Anywhere the EntelliGuard trip unit can be retrofit or a selective Spectra K-frame circuit breaker with the *micro*EntelliGuard trip unit, the standard capability of ArcWatch is included. The EntelliGuard R retrofit circuit breaker includes the EntelliGuard trip unit and, therefore, also includes the standard ArcWatch capability.

What is standard and what is optional in ArcWatch?

The standard capability is a feature called waveform recognition (WFR). WFR is included in every EntelliGuard trip unit, EntelliGuard E circuit breaker in Entellisys 5.0, and the *micro*EntelliGuard installed on a selective Spectra K frame. For the standard feature to be used there *must* be downstream current-limiting circuit breakers. (See the FAQ section on WFR for more details.)

The optional capability is instantaneous zone selective interlocking (I-ZSI). I-ZSI can be included on EntelliGuard and *micro*EntelliGuard trip units as well as EntelliGuard E circuit breakers in Entellisys 5.0. I-ZSI *must* be used with downstream circuit breakers that have an EntelliGuard or *micro*EntelliGuard trip unit. (See the FAQ section on I-ZSI for more details.)

An EntelliGuard G main circuit breaker can use WFR with any current limiting feeder circuit breaker, and use I-ZSI with other feeder circuit breakers



Can a circuit breaker with ArcWatch use both WFR and I-ZSI at the same time?

Yes. They are not mutually exclusive. For example, an EntelliGuard G main circuit breaker can use WFR with any current limiting feeder circuit breaker, and use I-ZSI with other feeder circuit breakers.

How do you set circuit breakers with ArcWatch?

The following documentation explains setting ArcWatch enabled circuit breakers:

DET-760 Guide to Instantaneous Selectivity lists the coordination capability of various circuit breaker pairs. This guide documents to what short circuit current level ArcWatch provides instantaneous coordination, and the minimum instantaneous pick-up value that must be used to take advantage of WFR.

DET-654 Guide to Low Voltage System Design and Selectivity provides additional background on designing for instantaneous selectivity, as well as time current curve layouts (templates) for general purpose dry transformers protected using ArcWatch capabilities where appropriate.

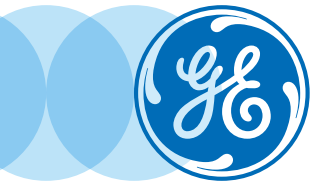
What is instantaneous coordination?

A circuit breaker's response to fault current may be thought of as having a non-instantaneous component and an instantaneous component (also known as the overload region and the short circuit region, respectively, per NEMA APB 1-2010). Coordination in the non-instantaneous region can be obtained by arranging the upstream and downstream circuit breaker settings so that "white" space is visible between the upstream and downstream circuit breaker curves. In the instantaneous region, upstream and downstream circuit breaker time current curves typically overlap. Using the ArcWatch technology, the overlap in the instantaneous region can still coordinate.

Waveform Recognition (WFR)

What is waveform recognition?

Waveform recognition (WFR) is a standard feature in every EntelliGuard trip unit (regardless of the circuit breaker it is installed on) and in the *micro*EntelliGuard trip unit when installed on a selective Spectra K-frame circuit breaker. The upstream circuit breaker must have a trip unit that has the WFR feature, and the downstream circuit breaker(s) must be current-limiting. When a fault is below the downstream circuit breaker and within the current limiting range of the downstream circuit breaker, the upstream circuit breaker with WFR senses the fault current signature caused by the downstream current-limiting circuit breaker responding to the fault. This can prevent a trip—even where overlap exists—in the instantaneous parts of the time current curves.



To use WFR, the instantaneous pick-up value of the upstream circuit breaker with WFR is set in accordance with DET-760. When set per DET-760, the overlap in the instantaneous region between the upstream and downstream circuit breakers will be coordinated.

As an example, a PowerBreak II insulated case circuit breaker with an EntelliGuard trip unit (which has WFR as standard) will coordinate with a downstream Record Plus* 250AF FE circuit breaker up to the short circuit rating of the Powerbreak II or Record Plus FE circuit breaker (whichever is lower) when the instantaneous pick-up on the PowerBreak II is set no lower than 9610 amps. The WFR feature allows instantaneous pick-ups to be selected for better arc flash protection while still providing selective coordination.

An upstream circuit breaker with WFR senses the fault current signature caused by the downstream current limiting circuit breaker responding to the fault.

Does WFR require communications wiring to the downstream circuit breaker?

No. WFR works using the current sensing done by the upstream circuit breaker's integral current transformers (CTs) and trip unit. No extra wiring is used and there is no communication or signaling between the upstream and downstream circuit breaker.

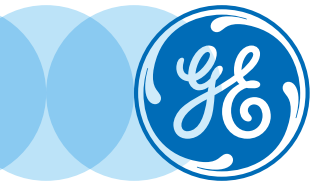
How do I know if my trip unit has WFR?

Your trip unit has WFR as standard if it is an EntelliGuard trip unit (installed on *any* circuit breaker, even including retrofits to non-GE circuit breakers!) or a *micro*EntelliGuard trip unit that is installed on a selective Spectra K-frame. Entellisys switchgear does not use trip units, but EntelliGuard E circuit breakers used in Entellisys 5.0 also have WFR.

Instantaneous Zone Selective Interlocking (I-ZSI)

Can you tell me more about Zone Selective Interlocking?

Zone selective interlocking (ZSI) is available as an optional feature on selected electronic trip units in specific circuit breakers. For arc flash safety, the two forms of low-voltage ZSI of primary interest are 1) short-time ZSI and 2) instantaneous ZSI (I-ZSI). Each form may be used individually, or concurrently with each other. Both short-time ZSI and I-ZSI are a specialized protection scheme between two circuit breakers in series, such as a main and a feeder. Multiple feeders may be in a ZSI scheme with one main. The ZSI scheme may also be extended to main-tie-main configurations.



The safety benefit of a ZSI scheme is its potential to reduce arc flash energy on the system between the upstream and downstream circuit breakers in the scheme. ZSI is intended to be active continuously and will allow lower pick-ups (and delays in the case of short-time ZSI) to be set on the upstream circuit breaker without the loss of selectivity. If a downstream circuit breaker senses a fault within the pick-up range of the ZSI scheme, a signal informs the

I-ZSI allows the instantaneous pick-up setting on the upstream circuit breaker to be set for superior arc flash protection by lowering arc flash incident energy.

upstream circuit breaker and it will adjust its protection response, allowing the downstream circuit breaker to clear the fault *first* and preserve selective coordination in the range of fault current where the ZSI is employed. The arc flash energy reduction potential of ZSI is derived from the lower settings (relative to traditional nesting techniques) that can be used on the upstream circuit breaker. Consequently, these lower settings help the main circuit breaker respond faster to arcing faults.

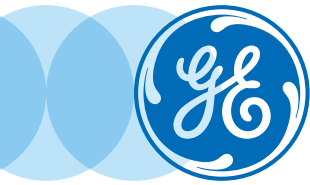
What makes I-ZSI different from short-time ZSI?

I-ZSI is an ArcWatch feature that has important advantages over using only short-time ZSI. I-ZSI allows the instantaneous pick-up setting on the upstream circuit breaker to be set for superior arc flash protection. The instantaneous clearing speed of the EntelliGuard trip unit is 37% faster than the clearing time of its fastest short-time delay band (band 1 on the EntelliGuard trip unit). For the same set of conditions, clearing arcing current at instantaneous speed results in lower arc flash incident energy compared to clearing arcing current at even the fastest short-time speed.

Selective coordination in the instantaneous region also benefits by using I-ZSI. Where overlap exists in the instantaneous region between the upstream and downstream circuit breakers' time-current curves, I-ZSI helps to ensure they remain selectively coordinated.

Does I-ZSI require wiring between the circuit breaker pair?

Yes. For a typical application between a main circuit breaker and its feeders within the same line-up, all the wiring is done at the factory. For applications where the upstream and downstream circuit breakers are in different enclosures, some field wiring will be needed to complete the connections. Twisted pairs of non-shielded American wire gauge (AWG) #18-22 are used to make the ZSI connections.



How far apart can the interlocked upstream and downstream circuit breaker pair be?

The maximum recommended line length between the circuit breaker and the ZSI module is 1000 feet. The upstream and downstream circuit breakers can be connected using a maximum total line length of 2000 feet (each side not to exceed 1000 feet).

How can you tell if I-ZSI is actually working? Can you test the feature?

In cases where both the upstream and downstream circuit breakers use the EntelliGuard trip unit, the test capability built into the trip unit may be used to test the downstream trip unit's ability to send a ZSI signal, the ZSI wiring between the circuit breakers, and the upstream trip unit's ability to receive a ZSI signal. This test does not cause a circuit breaker to trip. In all cases, direct high-current injection can also be applied across phases below the downstream circuit breaker in the ZSI scheme to demonstrate that the downstream circuit breaker trips and the upstream circuit breaker does not.

What if the ZSI wiring is compromised?

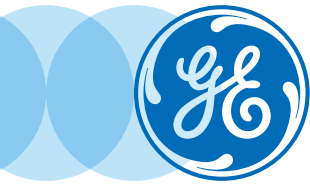
The standard test capability built into the EntelliGuard trip unit would identify wiring failures. The test functions on the ZSI module include the ability to detect reverse polarity connections and shorted wiring. The ZSI module test function can also be used to isolate which connection has the problem. See publication, [GEK-64467A](#), for additional ZSI module test functionality. If the ZSI signal is not received at the upstream circuit breaker, it will use its normal (unrestrained) settings to respond to a fault.

What is a ZSI module?

The ZSI module is an intermediate control device that is always used between the upstream and downstream circuit breakers when any form of ZSI (instantaneous, short-time, or GF) is installed. It is the *same device* that has been used for many years with short-time and ground fault ZSI, before instantaneous ZSI became available. The ZSI module performs several important functions.

First, it simplifies the wiring. In a typical single source application (one upstream circuit breaker in a ZSI scheme with multiple downstream circuit breakers), all of the downstream circuit breakers (up to 30) are connected to the downstream side of the ZSI module, and one wire pair is connected from the upstream side of the ZSI module to the upstream circuit breaker.

Next, the ZSI module permits continuity of the interlocking function in the event that control power is lost during a fault. To help maintain the integrity of the signal transmitted to upstream circuit breakers and to help ensure that coordination is not lost, the ZSI module has an energy storage feature that permits follow-through of the interlocking function in the event that control power is lost. Last, the ZSI module has test functions to check its own functionality as well as checking for problems in the upstream or downstream wiring.



How do I know if my trip unit has I-ZSI?

The trip unit product number has a position to indicate what ZSI options are present. A trip unit with ZSI will also have options in the settings windows for enabling or disabling the ZSI functionality as well as settings for the restrained bands used with short-time and ground fault ZSI. The restrained position for I-ZSI is fixed and not adjustable by the user.

Additional Resources

Are there any technical papers that describe the details of WFR and I-ZSI?

These technical papers are available at www.geindustrial.com/whitepapers :

- [*Zone Selective Interlocking On Instantaneous \(I-ZSI\) & Waveform Recognition \(WFR\)*](#)
- [*Improved Selectivity & Arc-Flash Protection Through Optimized Instantaneous Protection Settings*](#)

What additional application information is available?

These references provide additional details:

- [*EntelliGuard G Circuit Breaker Application Guide*](#)
- [*EntelliGuard Trip Unit Installation, Operation, and Maintenance Manual*](#)
- [*Spectra RMS Circuit Breakers with microEntelliGuard Trip Units*](#)
- [*EntelliGuard R Retrofill*](#)—describes capabilities for retrofill of existing metal frame circuit breaker cubicles with EntelliGuard G circuit breakers
- [*EntelliGuard TU Conversion/Upgrade Kits*](#)—describes capabilities for retrofitting the EntelliGuard trip unit on to existing GE and non-GE circuit breakers
- [*Entellisys 5.0 and EntelliGuard E Circuit Breaker Fact Sheet*](#)