

HPC* Switches

New Generation

Instantaneous Protection Guide



imagination at work



The New Generation GE HPC Switch; a REAL Arc Flash Hazard Mitigation Solution

The arc flash hazard is an acknowledged danger in electrical systems. Minimizing exposure to this hazard is the role of distribution systems designers. The new generation GE HPC switch with ArcWatch* inside is a tool for systems designers to help minimize exposure to the arc flash hazard and to the severity of a potential arc flash incident. There are two improvements in the switch that provide these capabilities:

1. Fully remote operation for close and open with internal operating motor.
2. Two modes of "switch (mechanical)" instantaneous protection to supplement the protection provided by the fuses.

Internal Motor Operator and Remote Operation

An arc flash event can generate tremendous heat, pressure, vaporized materials, shrapnel and noise, presenting a dangerous and possibly fatal situation. The most effective way to prevent exposure is to ensure that the equipment is de-energized before it is approached. This can be accomplished through the use of switching devices that are remotely operable for both open and close functions. GE's new generation HPC switch is listed to UL 977, and provides full remote operation for both open and close functions with no need to manually recharge the springs prior to operation.

Two Types of Supplemental Instantaneous Protection

Current limiting fuses are recognized as effective overcurrent protectors when fault currents exceed the fuse's current limiting threshold.

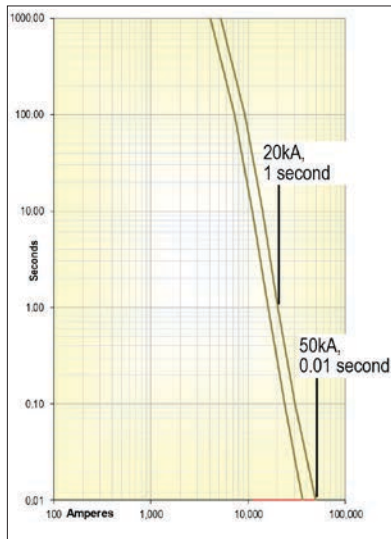


Fig. 1 - 2000A Class fuse, time delay type

When fault currents exceed the fuse's current limiting threshold. When this occurs, the fuse will interrupt the fault current before it even reaches its first half cycle peak, to significantly reduce the fault energy. These fuses are less effective protectors however, under lower levels of fault current.

For example, a typical class L time-delay fuse rated at 2000A (Fig. 1), takes at least 40-50kA of fault current to obtain a 0.01 clearing time at the test power factor for a single phase event. Power factors that are closer to 1,

typical of arcing faults, and three phase events can cause a fuse to operate at a slower rate to completely clear a fault. At 20kA arcing current, a typical arcing fault current value, the fuse may take a full second to operate, without taking into account the power factor and three phase phenomena that may make actual fault interruption even slower.

Fig. 2 shows calculated arcing fault currents, per IEEE 1584 for a 25mm arcing gap at 480V. This is a typical gap used for arc flash calculations in switchboards and motor control centers. At 208V, the arcing current may be approximately half of what it is at 480V. At 600V, it can be approximately 20% higher than at 480V.

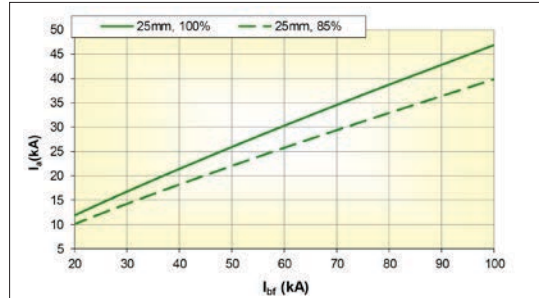


Fig. 2 - 100% and 85% arcing current for a 25mm gap, at 480V. IEEE 1584-2002

To obtain the best possible arc flash event protection, the protection should be active for 85% or below of the expected arcing fault current. Even for a 100kA system at 480V, some 2000A fuses may be too large to provide their fastest protection at actual arcing current levels. As available bolted fault currents become lower, the ability of the fuse to provide optimal protection is further decreased. It should also be considered that a fuse or circuit breaker is a circuit protector for both ends of the circuit. Even in systems where the service entrance equipment has sufficiently high short-circuit current available to operate the fuse in its current limiting range, a fault at the far end of a feeder cable run may have enough impedance to prevent the fuse from operating in its range. See Fig. 3 for an illustration.

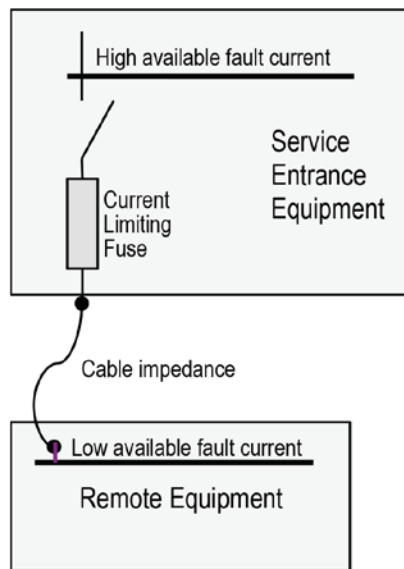


Fig. 3 - Cable impedance can reduce available fault current below fuse's current limiting range even in systems with high available short circuit current at the service entrance equipment.

GE designed the new generation HPC switch with two modes of instantaneous protection to complement, at a lower arcing fault current, the excellent protection the fuse provides at higher bolted fault currents.

The new generation GE HPC switch offers two modes of instantaneous protection, similar to that provided by a circuit breaker of equivalent size.

1. Adjustable Selective Instantaneous protection with waveform recognition (WFR)¹ capability.
2. Reduced Energy Let-Through Instantaneous (RELT)²

The Adjustable Selective Instantaneous with WFR capability function may be selected and set via the switch relay HMI for 24/7, sensitive instantaneous protection. The settings range includes a minimum pickup up of 2X the switch rating and a maximum pickup of 10X for switches up to 3000A, 9X for the 4000A switch.

The RELT instantaneous function may be adjusted via the switch relay HMI from a minimum of 1.5X to the same maximums as the WFR instantaneous. The RELT protection is enabled or disabled via a 24 Volt signal applied at specific switch control unit inputs.

The switch control unit also provides positive feedback when the RELT ON command has been received and processed. See Fig. 4 for a simplified schematic of how the RELT control may be wired.

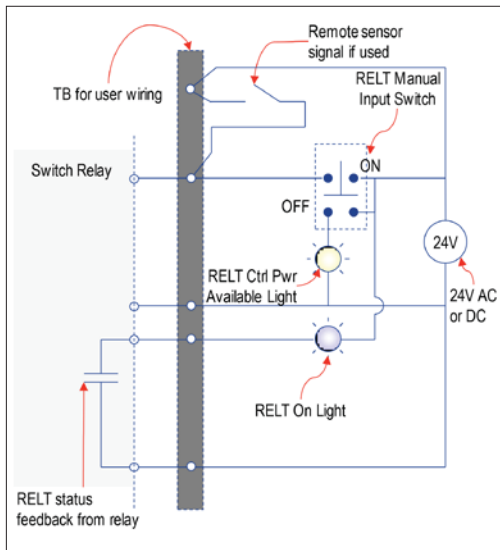


Fig. 4 – RELT control schematic

¹ A unique GE instantaneous algorithm that allows sensitive set instantaneous pickup to be selective when properly set above current limiting circuit breakers or fuses. See GE DET-760, **Guide to Instantaneous Selectivity**, for additional details on how to use WFR to obtain selectivity and protection simultaneously.

² See footnote 1 and GE publication “RELT” on www.geindustrial.com/publibrary.

Adjustable Selective Instantaneous with WFR capability may be used whenever improved protection is desired, such as when fault currents fall below the level where the fuse or the permanently selected adjustable selective Instantaneous would protect quickly on a continuous basis. The RELT instantaneous protection may be used as part of maintenance practices to improve arc flash protection. This is effective when the fuse does not provide sufficient protection at the possible arcing fault current of the circuit where the work is being performed.

Figs. 5 and 6 are examples of a 4000A Class L fuse, and the instantaneous protection available in the 4000A switch. **Fig. 5** demonstrates how the instantaneous protection provided by the switch results in a lower level of incident energy than the fuse, for systems that deliver up to 75kA bolted fault current. In a 75kA system the switch will maintain incident energy at 8 calories or less at an 18” working distance. This is based on a 25mm gap, solidly grounded system and arc-in-a-box per IEEE 1584-2002³. **Fig. 6** shows the same situation but with the RELT instantaneous protection function enabled.

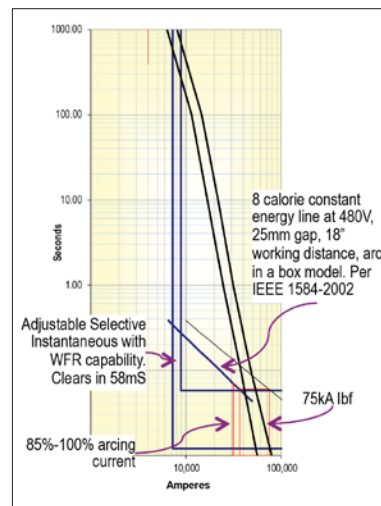


Fig. 5 – 4000A Class fuse, time delay type. Adjustable Selective Instantaneous set at 2X. This instantaneous offers better protection than the fuse for arcing fault currents on systems able to deliver up to 80kA bolted fault current (25mm Gap @ 480V), and has unique selective capabilities outlined in GE DET-760.

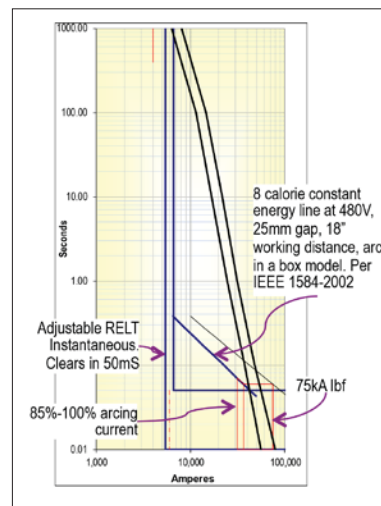


Fig. 6 – 4000A Class fuse, time delay type. Adjustable Selective Switch RELT Instantaneous set at 1.5X. The RELT instantaneous offers better protection than the fuse for arcing fault currents on systems able to deliver up to 90kA bolted fault current. (25mm Gap @ 480V).

³ IEEE 1584-2002, Guide for Performing Arc-Flash Hazard Calculations, section 5, page 10, model for incident energy calculations.

The combination of fuse and instantaneous protection provides a compound protection curve as shown in **Fig. 7** for a 2000A fuse.

Fig. 8 shows the 2000A fuse and switch instantaneous drawn as a compound curve, and the 4000A switch instantaneous and fuse drawn as two separate curves. This example demonstrates how a fuse-switch combination provides both 0.1 second selectivity⁴ and arc flash protection, simultaneously.

In summary, the new generation GE HPC switch combines the capabilities of a circuit breaker with a highly selective instantaneous algorithm, a circuit breaker with a remotely selectable maintenance

switch instantaneous and current limiting fuses. This results in optimum protection, regardless of fault-current magnitude, inclusive of zone-selective-interlocking operation with other switches or circuit breakers.

Figs. 9 and 10 demonstrate how the instantaneous zone selective interlocking capability of the switch can achieve up to 100kA of selectivity with a 4000A circuit breaker upstream, while both devices maintain sensitive instantaneous protection against lower magnitude arcing current faults. Fuses and circuit breakers “can” be selective while simultaneously protecting instantaneously . . . **“if” you use the New Generation GE HPC Switch!**

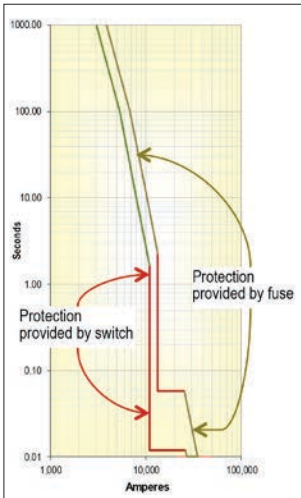


Fig. 7 – 2000A Class L fuse, time delay type. Adjustable Selective Switch Instantaneous set at 6X.

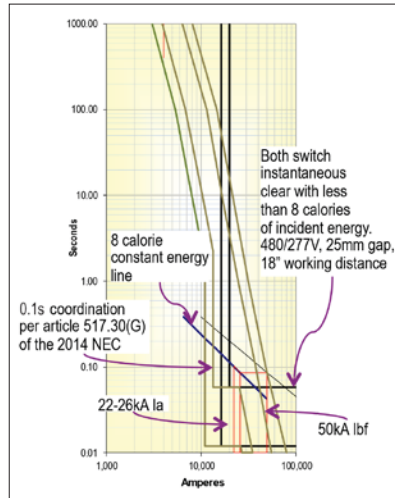


Fig. 8 – 4000A & 2000A Class L fuse, time delay type. Adjustable Selective 2000A Switch Instantaneous set at 6X (12kA). 4000A Switch at 4.5X (18kA)

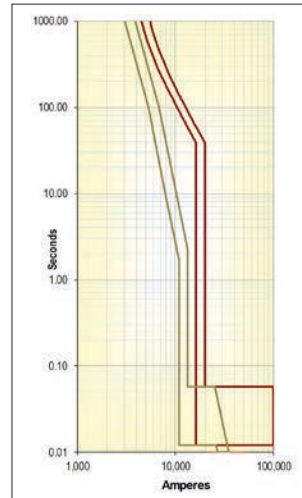


Fig. 9 – Composite curve: 2000A Class L fuse, time delay type. Adjustable Selective Switch Instantaneous set at 6X. With 4000A LI circuit breaker upstream set at 4.5X instantaneous. Both providing instantaneous protection at currents below 22kA.

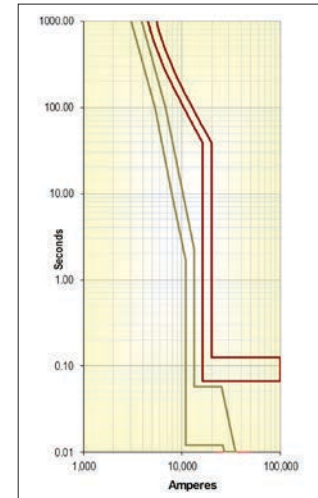


Fig.10 – Same devices as in Fig. 9 but the 4000A instantaneous has been restrained by the 2000A switch to maintain selectivity and back up protection

⁴ Article 517.30 (G), 2014 NEC, page 470. **“Coordination. Overcurrent protective devices serving the essential electrical system shall be coordinated for the period of time that a fault’s duration extends beyond 0.1 second.”**

Related Reading and References:

DET-760 - Guide to Instantaneous Selectivity, Circuit Breaker Engineering Reference

DET-654 - Guide to Low Voltage System Design and Selectivity

NEMA ABP 1-2010 NEMA Guide to Selectivity Coordination Available from the NEMA website: <http://www.nema.org/Standards/Pages/Selective-Coordination.aspx>

M. Valdes et al; Optimized Instantaneous Protection Settings: Improving Selectivity and Arc-Flash Protection, IEEE Industrial Applications Magazine, May-June 2012, Vol. 18, Issue 3, Pgs. 63-73.

M. Valdes et al; Advances in Protective Device Interlocking for Improved Protection and Selectivity, IEEE Petroleum & Chemical Industry Conference Record, September 2013.

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Online BuyLog: <http://energy.gecatalogs.com/>

Online product information: geindustrial.com

DEA-584 – HPC Switches, New Generation Brochure

DEC-139 – HPC Switches Catalog Numbers Cross-Reference Table

DEH-41689 – HPC Switches, New Generation, User’s Manual

DEH-41700 – HPC Switches, New Generation, Retrofit Kits (Switchboards)

DES-121 – Time Current Curve - Fusible Switches, HPC New Generation, Ground Fault Protection

DES-122 – Time Current Curve - Fusible Switches, HPC New Generation, Instantaneous

Contact your local GE sales representative or Specification Engineer for more information and specific application assistance. Or call **1-800-431-7867**.



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