

# Siemens Dynamic Arc Flash Reduction System and its application in motor control centers

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The risk of Arc Flash is a growing concern within the electrical equipment community and among both designers and workers. Current research shows that up to 80% of reported electrical injuries are caused by an electrical arc<sup>1</sup>. This fact has spawned new requirements and standards in governing documents, such as in NFPA 70E and the NEC, which address the safety of workers, on and around energized electrical equipment. In response to safety needs and to fulfill these standards, Siemens has developed new technologies to address the issue of arc flash, and help mitigate its risk. This paper will explore the capabilities of the Dynamic Arc Flash Sentry (DAS), investigate an example case, and show the benefits of this technology in motor control centers.

Siemens strongly recommends that all systems be de-energized when personnel are working on electrical equipment. However, in some circumstances qualified professionals may need to access and work near energized equipment. For example, many troubleshooting operations, or work on critical applications, require that power remain on to complete the task. This is where many accidents occur and the risks and effects of an arc flash are the greatest. The Dynamic Arc Flash Sentry system is designed to greatly reduce the risk of arc flash while maintaining efficiency of the loads on the motor control center. These loads could include motor inrush currents, and normal variance in motor operating amperage.

Siemens Dynamic Arc Flash Sentry Technology uses a dual function setting of the ETU776 electronic trip unit when housed in the Siemens WL power circuit breaker. The trip unit has two parameters (A and B), that allow the operator to switch back and forth from a normal operating mode to a maintenance mode. The maintenance mode (Parameter B) reduces the instantaneous trip setting of the WL main breaker. By reducing the instantaneous region, the trip timing of the system is controlled, and can be reduced to clear a fault much sooner than the original operating time. This decreases the amount of energy available in an arc flash, making the area surrounding the motor control center less susceptible to an arc flash event.

Let's look at an example of how the DAS can function to increase safety and help mitigate the risks associated with arc flash. We will use a sample system that is based on an actual application in the field. This example was set up with aid from ESA and their EasyPower software<sup>2</sup> tool to help create the

motor control center layout and calculate the associated arc flash energies. Figure 1 shows a typical motor control center with a Siemens WL as a main breaker and numerous feeder breakers controlling different functions including motors, panels and other loads.

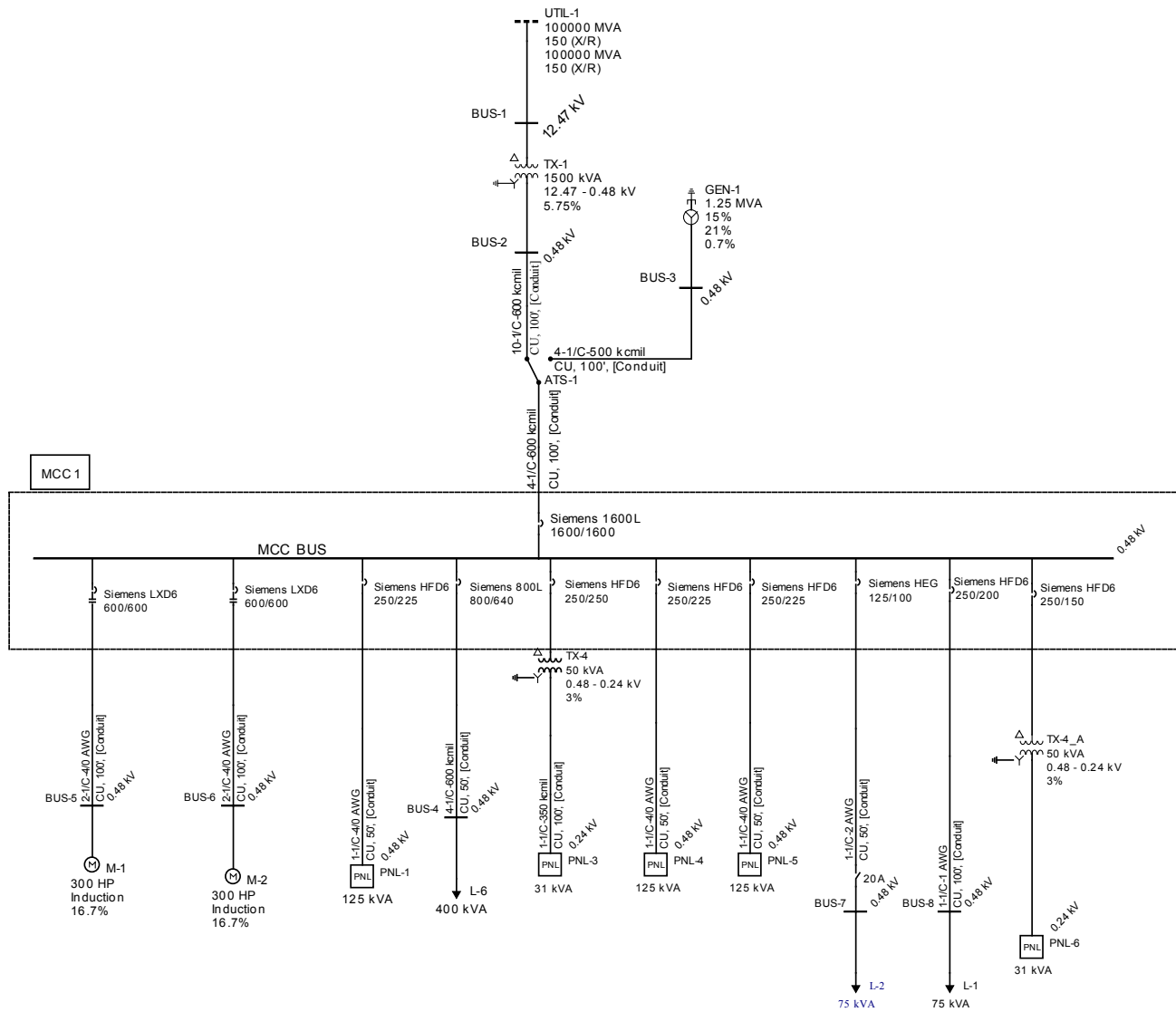


Figure 1 – MCC Example One-line Diagram

This MCC configuration will serve as the basis for this example. To properly coordinate the breakers controlled in the MCC with the main breaker upstream, it is appropriate to analyze the time current curve (TCC) to see the trip parameters for long time, short time, and instantaneous trips. Typically in a motor control center, as with MCC1 in Figure 1, there are numerous operating devices present. The resulting TCC for this motor control center would be cluttered and

virtually unreadable. For this example, we selected the three most relevant devices to display, that will affect the coordination of the upstream breaker. Figure 2 shows the TCCs of 4 devices: a 600A Siemens combination motor starter with a 600A Siemens LX6 circuit breaker, a 250A Siemens HFD6 circuit breaker, an 800A Siemens WL800L, and the main device a 1600A Siemens WL1600

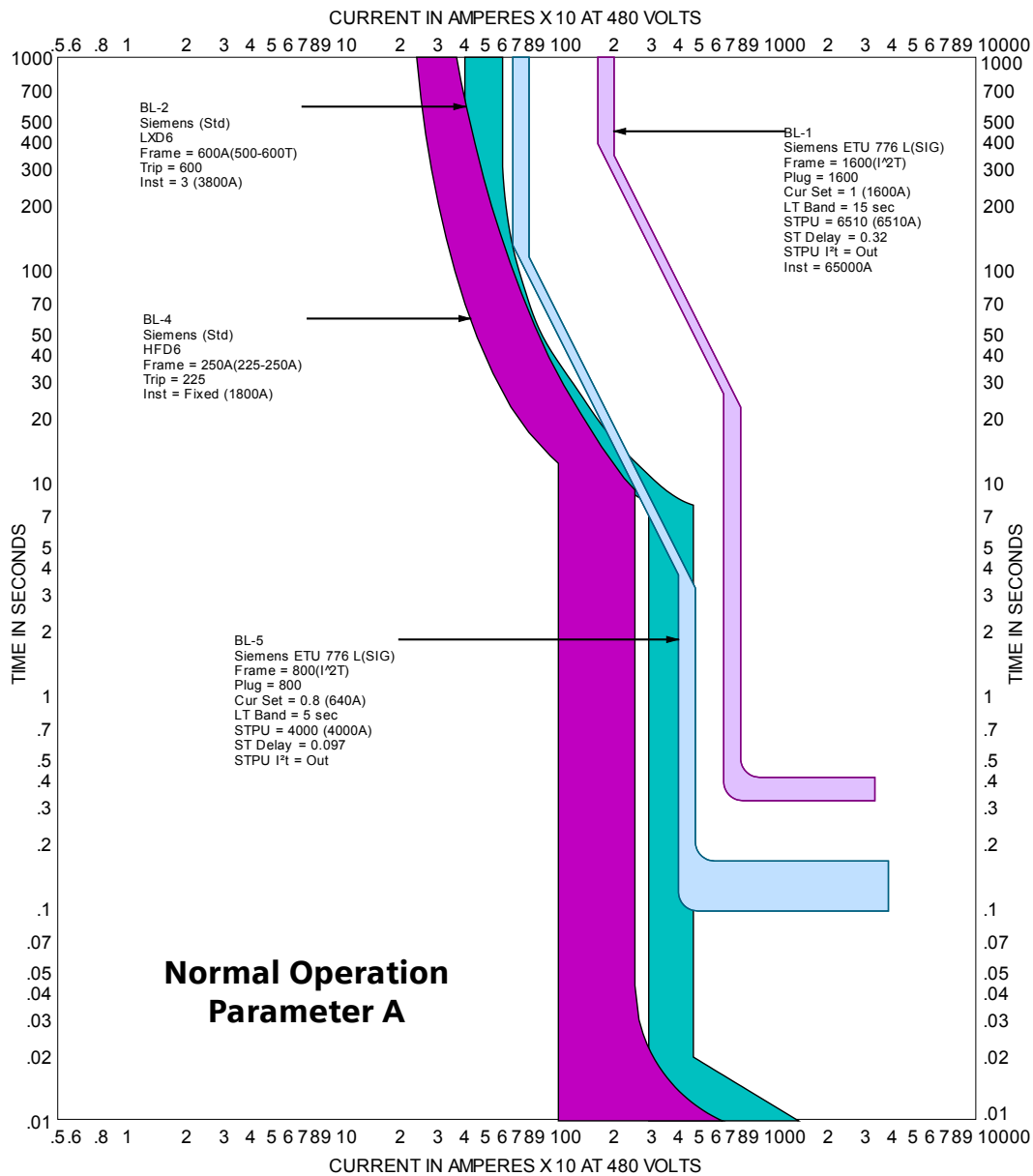


Figure 2 – TCC of Parameter A – Normal Operating Mode

As you can see in Figure 2, the WL breaker is selectively coordinated with the devices downstream from it. The WL main has a typical instantaneous trip time of 0.32 seconds at 65kA. The next step is to run an arc flash hazard analysis

across the system to determine the calculated risk of working on this MCC. By inducing a fault, the arc flash boundary, the incident energy, and proper personal protective equipment (PPE) can be calculated based on IEEE 1584 and NFPA 70E standards.

Hazard/Risk category	Clothing description	Required minimum arc rating of PPE [cal/cm <sup>2</sup> ]
0	Nonmelting, flammable materials (i.e., untreated cotton, wool, rayon, or silk, or blends of these materials) with a fabric weight at least 4.5 oz/yd <sup>2</sup>	N/A
1	Arc-rated FR shirt and FR pants or FR coverall	4
2	Arc-rated FR shirt and FR pants or FR coverall	8
3	Arc-rated FR shirt and pants or FR coverall, and arc flash suit selected so that the system arc rating meets the required minimum	25
4	Arc-rated FR shirt and pants or FR coverall, and arc flash suit selected so that the system arc rating meets the required minimum	40

Table 1 – Protective Clothing Characteristics from Table 130.7(C)(11), NFPA 70E, 2009

Figure 3 shows the conditions that appear at the MCC when a fault is sent to the bus in MCC1. The incident energy is calculated to be 24.4 cal/cm<sup>2</sup> and a PPE level #3. This level of PPE would require the qualified personnel to wear flame resistant clothing and equipment, as well as an arc flash suit, all with a minimum arc rating of 25. As the PPE level increases,

the material can become increasingly bulky and hot, leading to uncomfortable work conditions for any personnel. This figure also shows that the arc flash boundary is 112.7 inches away from the MCC in every direction. To have personnel working on or around this electrical equipment can be extremely hazardous.

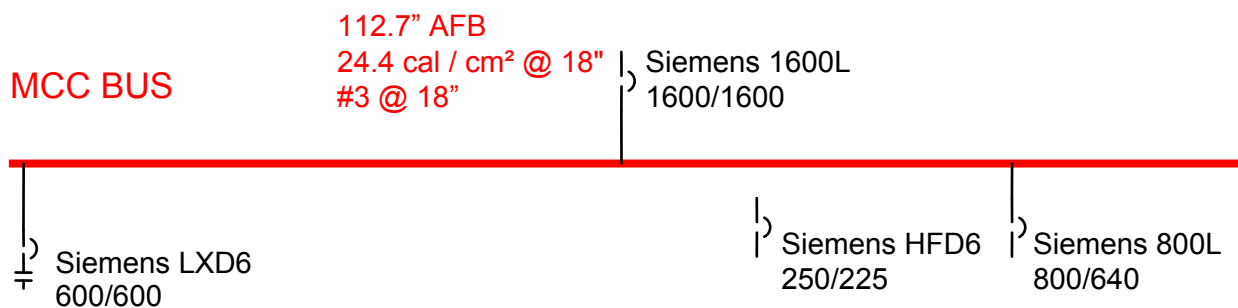


Figure 3 – Arc Flash in Parameter A

So how can we resolve this problem? The goal would be to reduce the arc flash risk by lowering the amount of incident energy of the system. This is done by reducing the clearing

time of the fault, which then makes a safer environment. This solution lies in Dynamic Arc Flash Sentry Technology.

Instead of working under these conditions, the DAS allows the flexibility for the worker to switch from the normal operating settings of Parameter A, to the lower arc flash energy settings of Parameter B. The goal is that when any person is working on or near this equipment, the system will be set to Parameter B. This is made possible by the dual protection capability of

the ETU776 trip unit previously mentioned. So, lowering the instantaneous trip settings of the WL breaker ensures that the time it takes for an electric fault to clear will be decreased, providing a safer working environment. Let's look at the second part of the example.

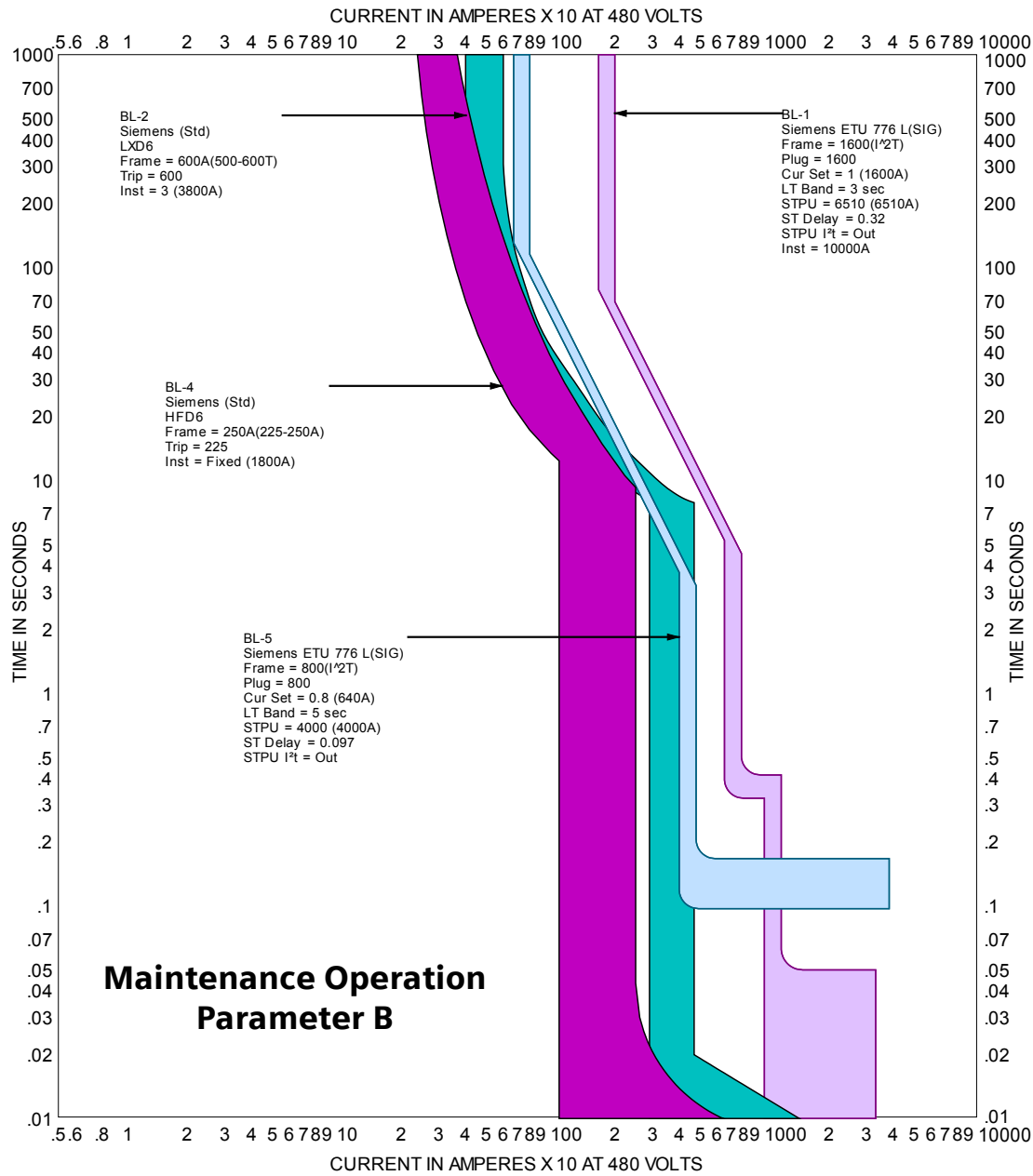


Figure 4 – TCC of Parameter B – Enhanced Safety Mode

When switching from Parameter A to Parameter B, each of the settings is kept the same in the motor control center, except the instantaneous trip setting of the WL main breaker. The TCC for Parameter B is displayed in Figure 4. As can be seen, the WL main overlaps the WL feeder breaker in the instantaneous region, which was lowered to 10kA, while the other regions remain coordinated appropriately. This provides another example of the flexibility of the ETU 776 trip unit in the Dynamic Arc Flash system.

This system allows the user to alter the trip delay settings, as well as long time, short time, and instantaneous pickup of the ETU 776 trip unit. However, these changes are not required and can be kept the same for simplicity reasons. In this example, only the instantaneous pickup was reduced between Parameter A and B, keeping all other trip unit and main breaker settings the same. When an electrical fault is applied to the MCC1 bus in Parameter B, the difference can be seen.

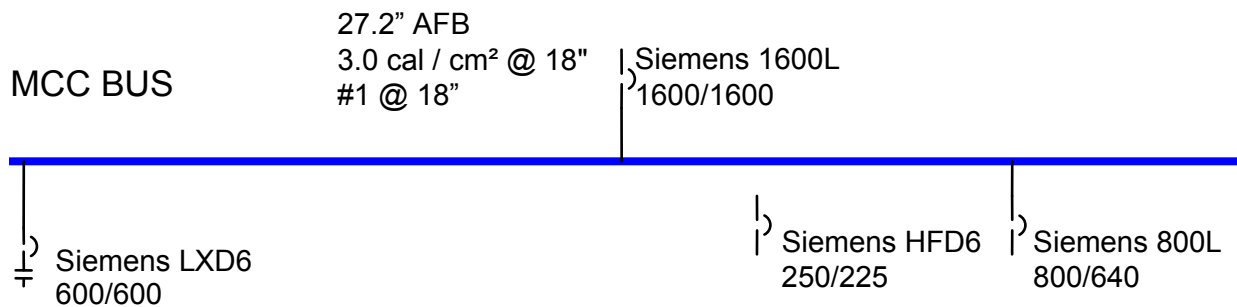


Figure 5 – Arc Flash in Parameter B

The results of the arc flash hazard analysis show that the incident energy has been reduced to 3.0 cal/ cm<sup>2</sup>, which is over an 8 times reduction in energy.

It also shows a reduction in the required PPE level to #1. The arc flash boundary is reduced to 27.2 inches away from the MCC.

Now let's compare the TCCs from Parameter A and B when they are side by side, as shown in Figure 6. This clearly shows that the only parameter that is changed is the main WL

breaker, with the instantaneous pickup being reduced. This greatly reduces the incident energy of a potential arc flash and creates a safer environment.

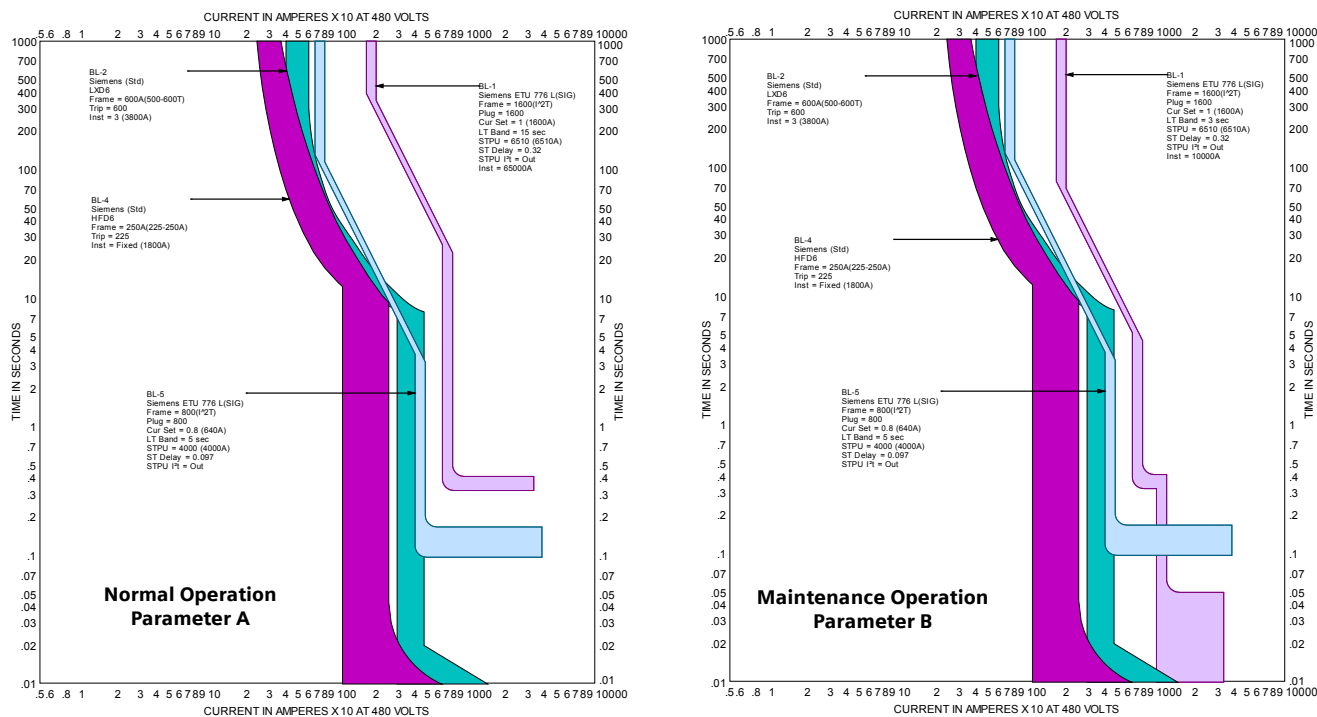


Figure 6 – Parameter A and Parameter B comparison

By switching from Parameter A to B, the DAS allows a temporary overlapping of the main breaker with a feeder breaker. However, to fully understand this situation, there are two main points to consider. First, to maintain a reliable system and avoid nuisance tripping due to normal operating currents in Parameter B, inrush currents must be taken into account. In this example, a 1500kVA transformer with a 480V secondary side and 5.75% impedance has a typical full load current of around 1.8kA. For the 300 HP motor running in our example, the full load amperage is 361 amps, which gives a typical inrush current of around 4700 amps.<sup>3</sup> With a peak inrush current lasting less than 1 second, this value is still well below the instantaneous pickup of the main circuit breaker at 10kA. Even with multiple devices and other loads running, a very high current spike would need to exist in order to trip the main. The reality is: if the system is designed correctly, compromising of the

coordination which causes issues such as nuisance tripping should be extremely limited. In addition, the trade off that is being made with a worker standing in front of an energized motor control center should be worth this concession.

This leads to the second and more realistic point of understanding the temporary overlap of the main breaker with a feeder. Parameter B does present an overlap of coordination; however the intent of this system is to create a significantly safer environment when the equipment is energized. Safety should be the primary concern in the unique and unusual situation in which the equipment can not be de-energized. To address this issue, the DAS provides the flexibility of the full range of settings to create a safer environment for workers. In this way, the DAS system provides a unique solution for the industry.

The Dynamic Arc Flash Sentry has been available in low voltage switchgear for some time. It has recently become available in Siemens new Arc Sentry Motor Control Centers. This technology can also be employed in Siemens switchboards and busway. Siemens is listening to its customers and meeting the highest industry standards. By offering a system that has the flexibility to actually reduce the amount of arc flash incident energy without forcing customers to choose reliability over safety, the Dynamic Arc Flash System is addressing the difficult challenges related to electrical worker safety.

#### References:

- <sup>1</sup> National Technology Transfer, Inc. NFPA 70E/ Arc Flash: Electrical Safety. Edition 3.1.
- <sup>2</sup> EasyPower Software. ESA.
- <sup>3</sup> "Inrush Current of Standard and High Efficiency Motors." Siemens Industry Automation and Drive Technologies, Service & Support. [www.automation.siemens.com](http://www.automation.siemens.com).
- <sup>4</sup> IEEE Std 1584 -2002.
- <sup>5</sup> NFPA 70E: Standard for Electrical Safety in the Workplace. 2009 Edition.
- <sup>6</sup> "Dynamic Arc-Flash Sentry" by Ray Clark. Siemens Technical Journal.

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