Securely detect and clear more high-impedance faults.

- Enhance high-impedance fault (HIF) detection security using SEL-patented technology.
- Improve understanding of HIF events with dedicated high-impedance event reports for detailed analysis.
- Improve HIF detection by applying protective relays and recloser controls with AST on distribution feeders.
- Coordinate with upstream protection devices to minimize the number of customers impacted.
HIF Detection

AST from SEL is an innovative solution that detects many HIFs on a distribution system. Detecting HIFs has challenged utilities and researchers for years. SEL’s patented AST detects and clears faults that might not be detected by conventional overcurrent elements. AST algorithms provide HIF detection, resulting in enhanced security and fewer false trips.

Common Causes and Dangers of HIFs

HIFs have high resistance in the fault path and often produce fault currents that are below conventional ground overcurrent element pickup levels, thus making them hard to detect and allowing them to exist in the distribution system for extended periods of time. Some typical causes of HIFs include trees that come in contact with overhead power lines or conductors that fall onto poorly conductive surfaces.

While the HIFs are unlikely to cause thermal damage to electrical distribution equipment due to the low fault current, they can be a significant threat to humans, livestock, and property. Downed cables can cause electrocution to people or animals that come into accidental contact with them or could initiate a fire that results in significant property damage. AST helps detect more HIFs on the distribution system while maintaining protection security.
Understanding HIF Detection

SEL's patented AST uses the process outlined below for HIF detection.

1. Sum of Difference Current (SDI) accumulates the difference in current from cycle to cycle at 32 samples per cycle. The larger the accumulated value, the more likely there is arcing on the system.

2. Infinite Impulse Response (IIR) limiting averager develops an SDI reference (shown in red) based on the feeder's historical performance.

3. Adaptive tuning learns the normal operation of the feeder and automatically sets the arc-detection margin (shown in green).

4. Trending and memory track how often and how much the SDI departs from the SDI reference and the margin.

5. Decision logic includes alarm and trip counters based on trending and memory. It decides if arcing from an HIF exists and generates an alarm or trip signal.
SEL Products Equipped With AST

SEL-451 Protection, Automation, and Bay Control System
The SEL-451 is a complete standalone protection, automation, and control system. The SEL-451 has speed, power, and the flexibility to combine complete substation bay control with high-speed breaker protection in one economical system.

SEL-751 Feeder Protection Relay
The SEL-751 is ideal for directional overcurrent, fault location, and HIF detection applications. Flexible I/O options, easy mounting, and fast settings make the SEL-751 the right solution for industrial and utility feeder protection.

SEL-651R Advanced Recloser Control
Apply the easy-to-use SEL-651R for Automatic Network Reconfiguration, three-phase and single-phase tripping, and all your distribution automation needs. The SEL-651R is compatible with most manufacturers’ reclosers and includes directional power and directional overcurrent elements for advanced applications.

SEL-651RA Recloser Control
Apply the SEL-651RA Recloser Control for Automatic Network Reconfiguration, three-phase tripping, and all your traditional 14-pin recloser control needs. The SEL-651RA includes directional power and directional overcurrent elements for added protection.
Easy to Set and Test

HIF detection using AST is easy to set. Simply enable the feature to start monitoring HIFs and downed-conductor events. Available Relay Word bits allow additional reporting and trip actions. The test mode eliminates adaptive tuning, making it easy to test the system before, during, or after commissioning.

Comprehensive Diagnostic Tools

Quickly evaluate downed-conductor events and HIFs with oscillographic and digital elements recorded at 30 samples per second. The RMS current, SDI element, statistical element, and digital quantities are all available. AST files in COMTRADE format can be displayed using a COMTRADE file viewer, such as SEL synchroWAVE® Event 2015 Software.
Many factors influence the amount of arcing produced by an HIF or a downed conductor. These factors include surface type, mineral content, moisture, thickness of material, distance to system ground, and others.

In many cases, security is the most important aspect of a protective relaying system. High security means that there will not be any false trips. AST is designed to improve security compared to existing systems while still providing the best possible fault protection.

### Surface Detection

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<tr>
<th>Surface</th>
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<tbody>
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<td>Sand</td>
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AST System Coordination

When AST is present in multiple devices on a single feeder, the relay or control closest to an HIF will detect the stronger signal and isolate the fault to coordinate with other relays or controls on the system. This coordination isolates only the faulted segment of the line and minimizes the number of customers affected by an HIF.

A stronger AST signal is detected closer to the fault.
Automatically Collect AST Event Reports

Special AST event files can automatically be transferred to long-term storage to ensure you never miss a high-impedance event.

1. Select an event report length of 2 to 40 minutes to record arcing throughout the event. Events include 60 seconds of pretrigger information.
2. Use an SEL-3355 Computer running AcSELERATOR TEAM® SEL-5045 Software to automatically transfer event files.
3. Plot and evaluate event reports for proper operation and real-world performance.