Catenary Flashover Localisation

Background

Catenary flashovers are high-energy electrical discharges caused by short circuits in the overhead catenary systems of electrified railways. There are various causes for these short circuits, such as wildlife, soiling or weather influences, but in many cases the root cause of individual short circuits cannot be determined. Catenary systems are designed to withstand certain short-circuit, nevertheless, short-circuit events can cause damages to components of the catenary line. To avoid unscheduled operational downtimes, operators need to carry out manual localisation and inspection processes, which are time-consuming and inefficient. To address these challenges, Sensonic has developed an advanced solution using fiber optic vibration sensing technology.

Current technologies can only approximately locate short circuit locations, potentially leaving maintainers with several kilometres of catenary to manually inspect, which is challenging on several levels:

- **Manual Inspections**: Historically, identifying catenary flashovers has relied on manual inspections by maintenance teams. This method is time-consuming and labour-intensive, often requiring extensive track walking or the use of inspection vehicles. Given the vast length of railway networks, this process creates workload and might lead to interruption of train operation.
- **Equipment and Personnel**: The manual inspection process demands substantial resources, including specialized equipment and trained personnel. This increases the overall cost of maintenance and impacts the budget allocated for railway operations.
- **Operational Disruptions**: During manual inspections, sections of the railway may need to be closed, leading to disruptions in service. These closures affect the punctuality and reliability of train schedules, causing inconveniences to passengers and freight operations.
- **Safety Risks**: Maintenance crews working on the tracks are exposed to potential hazards, including high-voltage electrical systems, and moving trains. Ensuring the safety of personnel during inspections is a critical concern, necessitating strict safety protocols and procedures.
- **Detection Inaccuracy**: Manual inspections may not be successful in determining the location of a flashover. This can result in repeated inspections and unnecessary repair efforts, further increasing costs and time.

To overcome these challenges, Sensonic Catenary Flashover Localisation application provides user with the ability to determine the precise location of a catenary flashover event with a known timestamp.

Methodology

Short circuits generate acoustic signals, similar to lightning and thunder. An electric arc heats up the surrounding air, creating a shockwave that travels above speed of sound. Breaking the sound barrier creates an acoustic bang. A pressure wave propagates into the ground and excites the optical fibre cable, which can be detected by the Sensonic system as distinct acoustic and vibrational signatures. The Sensonic Dashboard interface displays these events as graphical plots, known as waterfalls, which clearly show the unique shapes of flashover signatures as shown in Figure 1. Users can review these plots to determine the flashover

location by checking vibration data at the time of a short circuit event. This precise localisation enables maintenance teams to quickly inspect and repair the affected areas.

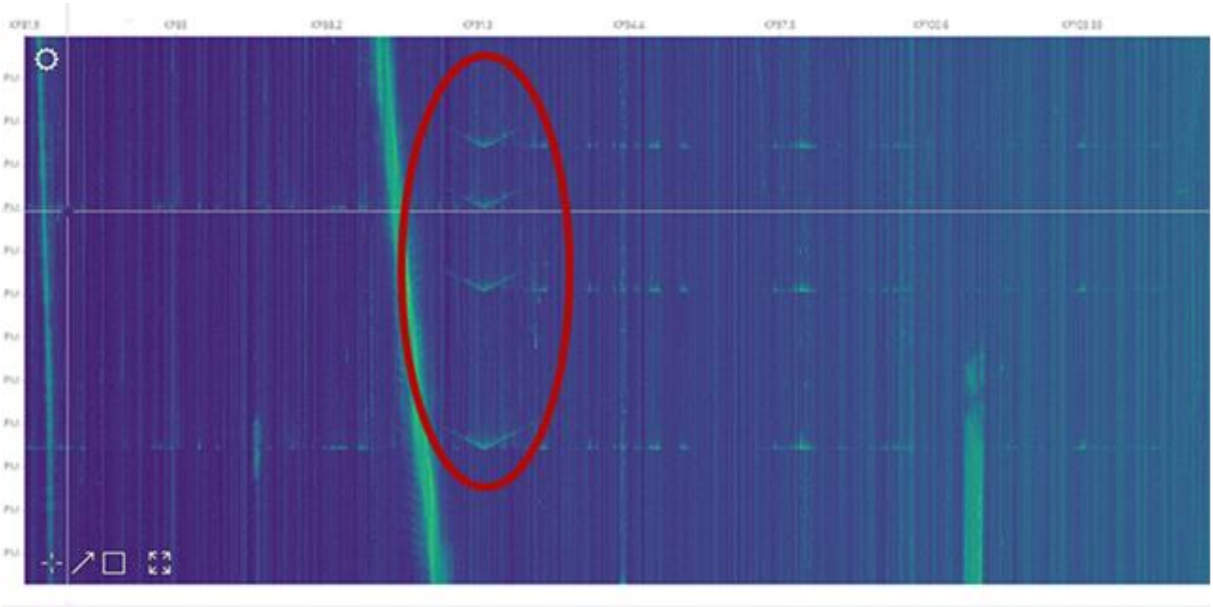

Figure 1. The distinct vibration signature generated by flashovers from the waterfall.

Benefits

- **Targeted Inspection:** By determining the exact location of the catenary flashover, the Sensonic solution significantly reduces inspection efforts. Maintenance teams can respond quickly and efficiently, minimizing the impact on railway operations.
- **Enhanced Safety:** The accurate localisation of flashovers reduces the time maintenance crews spend on the tracks, enhancing their safety. By knowing the exact location of the fault, workers can focus their efforts and limit their exposure to potentially hazardous environments.
- **Increased Reliability:** The ability to accurately detect and quickly address catenary flashovers helps prevent future issues, enhancing the overall reliability of the railway system. Timely repairs reduce the likelihood of recurrent faults, extending the lifespan of catenary components.
- **Resource Efficiency:** Sensonic's system reduces the need for extensive manual inspections, saving time and resources. Maintenance efforts can be concentrated on precise locations, optimising the use of manpower and materials. This efficiency leads to cost savings and improved operational performance.

Application and Boundary Conditions

The user must consider the following application and boundary conditions regarding the implementation, function, and operation of the Sensonic system:

- The railway operator shall maintain the availability and reliability of the fiber optic cable being utilised for the Sensonic system to preserve the system’s functionality and performance.
- The Sensonic system can register flashover-induced vibrations that occur near the optical fiber cable. It cannot determine the cause or the track on which the event occurred. It can only provide information regarding the event location longitudinally along the rail track.

- The Sensonic system cannot provide a reliable estimate of the size or severity of the flashover event.
- The Sensonic system cannot predict imminent flashovers.
- The acoustic coupling of the fiber cable with the catenary poles determines the ability of the fiber to detect the flashover event.
- The Sensonic system cannot provide automated notification for a flashover event. The determination of flashover location is required to be done by manual review of Sensonic data.