SALTEK®

Overvoltage controlled. ANYWHERE.

WHITEPAPER

VLD SALTEK class 2 with external activation

Voltage Limiting Devices

VLD SALTEK class 2 with external activation

The BVL-100-020-R02-ET is another new product in SALTEK's portfolio of voltage limiters. Concerning its design it is based on the BVL family of limiters, but is supplemented with the possibility of external blocking or activation (triggering) of its autonomous touch voltage limiter function. It has been primarily developed for the specific installation of the Prague underground (metro) train wash system, however, it will certainly find application in other applications where there are problems with the burn-up of train wheels at locations where the train passes between different traction systems.

The basic problem that needed to be solved was the intense arcing between the wheels of the trainset and the track when crossing from a track with an isolated (ungrounded) track and a directly grounded train wash track. The frequent occurrence of the relatively high voltage potential of the service track against the ground, as well as the ability of the system to generate high currents between the insulated and grounded sections of the track are the reason for this arcing.

When the insulated track is connected or disconnected from the grounded infrastructure (in this case the train wash track) through the conductive structure of the trainset, then the first and last train axles are exposed to danger situation.

In the case of the first axle passes through the isolated joint, the sparking is not intense, since the connection of the two systems occurs at the moment of contact between the first axle and the track of the second traction system. Due to the relatively small voltage difference, there is no electrical breakdown through the air when the wheel approaches the rail, so the contact point sparks only at the moment of direct contact. Due to the large mass of the trainset and the consequent rapid increase in pressure between the wheel and the rail, good conductive contact between the two railway systems is achieved instantaneously and only a slight brief sparking occurs, which is of such low energy that it does not cause mechanical damage to the wheel or rail.

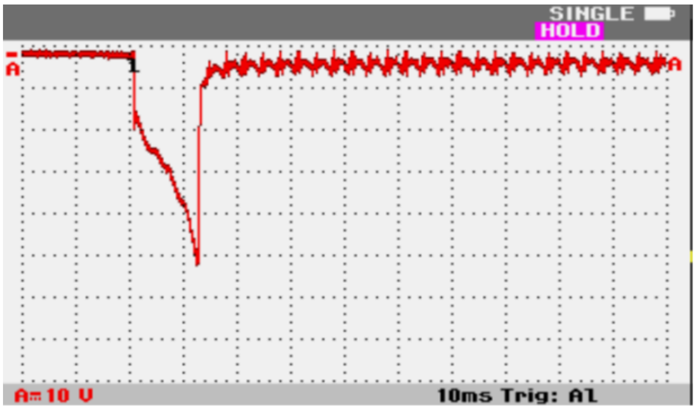
However, the situation is quite different when the trainset leaves the isolating joint between the track systems. If this happens in a situation where the power supply system is generating relatively high currents through an electrical short caused by the trainset (often in excess of hundreds of amperes), the moment when the mechanical pressure between the wheel and the abandoned track begins to drop, the electrical resistance at the point of contact starts to increase causing the area to be heated rapidly by the current passing through the rapidly increasing impedance at the contact area.

As the wheel begins to physically leave the rail, electrical arc is created in this area which, due to the hard power source of the passing current, has sufficient energy to locally melt the metal of both the wheel and rail and cause a "weld wart" or "dimple" in either of the steel parts (wheel or rail). Such a damaged axle not only causes subsequent vibrations of the train during its ride, but also periodically (with every wheel turn) damages the railway line by the action of the added welded material.

For this reason, the damaged trainset must be taken out of service and the affected axle must be repaired, which means significant operating losses and service costs. The damage is proportional to the instantaneous situation on the track (the magnitude of the instantaneous current passing through) and also inversely to the speed of movement of the axle through the isolation point (the slower the circuit disconnection occurs, the longer the arc burning duration and thus the extent of the axle damage).

The following oscillogram shows the evolution of the voltage on the electric arc characterising the physical length and the time duration of the arc during a relatively fast passage of the trainset. In this case the duration of the arc is about 13 milliseconds, but it can be significantly longer during slow train passage. The increasing voltage on the arc corresponds to increase of the arc physical length (with the electrical current passing through amounting to about 300 A).

Towards the end of the arc duration, the arc voltage increases up to 50 Volts, so the thermal energy is large enough to be capable of melting even a massive part of material such as a train axle wheel.



The basic idea of the minimization of damage to the axle consisted in detecting the arc as quickly as possible and immediately responding by creating a parallel current path, thus eliminating the conditions for further arc burning.

The originally intended solution of establishing manually a mechanical short-circuit before the train arrival had several disadvantages. Apart from the financial cost of the power DC contactor and its limited lifetime, there was also the risk of premature switching on and a too late switching off of the short-circuiter, followed with the risk of passing a large amount of stray currents. A solid-state solution appeared to be much cheaper, more reliable and operationally more efficient. For this purpose we used a specially modified thyristor-based voltage limiter (VLD class 2.2) supplemented by electronic circuits for external blocking or triggering. The first requirement was that a VLD connected in between the railways should automatically switch on as quickly as possible at low arc voltages (i.e. around 20V).

However, due to the frequent occurrence of track potentials above the level of 20V even during normal operation of trains on underground lines, it was necessary to limit this switching to the time period of the immediate occurrence of the trainset at the isolation joint (when the trainset enters/leaves the washing line).

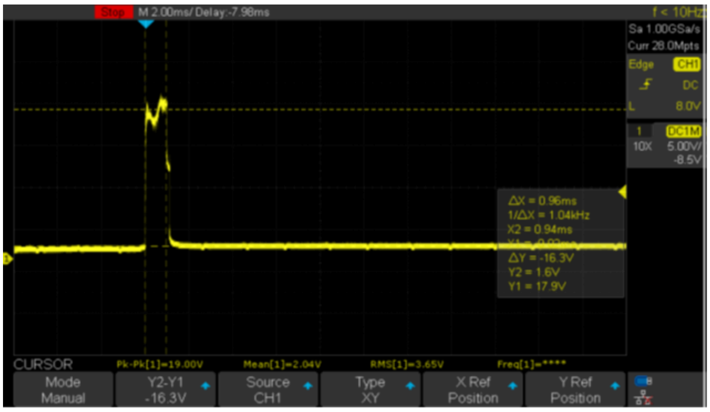
Otherwise, the VLD would often switch unnecessarily on when track potentials exceeding 20V occur at times when the train is not crossing the isolated joint, which would lead to intense stray current leakage and corrosion of the infrastructure around the interface point, which had to be prevented. This function was made possible by the VLD external interlocking circuitry in conjunction with an infrared train presence detector at the isolated joint. The VLD is therefore inactive in normal situations (finding itself in the state of high impedance), however, when a train is detected at the entrance to the carriage wash, the sensor activates the VLD, puts it to standby mode and automatically reacts to a voltage overshoot (approx. ±17V) between the track systems.

A parallel current path (short circuit) between the track systems is created already before the first axle enters the isolation interface point by switching the thyristors in the VLD, thus creating voltage equipotential situation between the railway tracks, and preventing the arcing between them.

The trainset, with a small delay, takes over the current path between both rail sections and, in such a way, simultaneously deactivates the thyristors in the VLD. At the moment the last axle leaves the isolation joint the VLD is ready for the next switching-on and responds to voltages that form between the wheel and the track. Switching-on taking place in less than 1 millisecond cancels the conditions for further burning of the emerging arc, limiting the process to mere a short sparking with energy level inadequate to cause weld spots on the steel parts.

The minimum sparking is documented by the voltage waveform oscillogram, showing a situation when the electrical circuit between the trainset and the track is disconnected by this switching element.

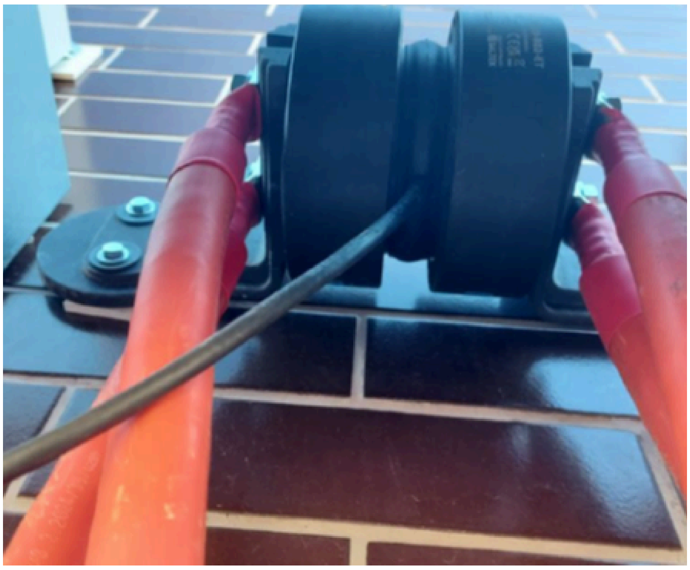
It can be seen that the VLD reacts by switching on in less than 1 millisecond from the start of the arc, responding to a minimum arcing voltage of around 20V, thereby substantially limiting the arcing energy below the disruption level to the metallic structure of the wheel and rail.



The result is a cheap, effective solution with minimal stray current leakage (and infrastructure corrosion). In principle, this patented solution can also be applied to other situations in traction systems where there is an acute need to limit the differences in electric potential and the risk of damage to the axles or rails (e.g. at transition points between DC and AC traction, etc.). The high current carrying capacity of the solid-state switching elements of the SALTEK BVL family is predestined for this. At SALTEK, specific solutions are tailor-made according to customer specifications.

Contact: Jiří Vykydal – SALTEK product manager – **j.vykydal@saltek.cz**

Finally, just a few implementation photos:



SALTEK s.r.o.
Drážďanská 85
400 07 Ústí nad Labem
Czech Republic
Phone: +420 272 942 470
E-mail: trade@saltek.cz
www.saltek.eu/en