Less shocking vehicles with active protective measure

A questionable idea to reduce the risk of high voltage exposure

A popular science summary of the master's thesis project *Chassis Potential Detection and Limitation with Conductive Electric Supply*. It was conducted at the Department of Industrial Electrical Engineering and Automation at the Faculty of Engineering, Lund University, in 2015.

An electric current that leak from grid to vehicle during battery recharging can be forced back before being a risk to humans. This is a new concept to ensure a low electric potential in the vehicle chassis. It differs greatly from conventional passive protective measures and may open up new possibilites for tomorrows charging technologies.

Electric vehicles are becoming increasingly popular as more and more people start to question the use of fossil fuels as a reliable source of energy. As a natural response, the automotive industry brings forth new and improved technologies. Research includes extended drive ranges, better batteries and more convenient battery charging. In this summary, the latter is more important.

The charging method of interest involves recharging a car's battery during propulsion. It is done much like how a tram or a train is powered, though there is a significant difference: whilst trams and trains are powered with overhead lines, the cars draw current from rail sections on the road. Another difference is how protective systems are implemented. Trams and trains are electrically grounded in the rails they run on, but the cars, being significantly lighter and on rubber tyres, do not have this possibility.

An alternative to a ground, or a protective earth connection as it is also called, is insulation. Lots of it, to be more precise. Trolleybus technology, i.e. another concept of electrified transportation with a similar grounding problem, must fulfill very strict insulation criteria. This is called double or triple insulation. Although not a significant problem for larger vehicles such as buses, smaller cars may suffer from the increased weight and volume that comes from considerable usage of insulation material.

With this in mind, and no more standarised solutions to look into, the project began. The result was an on-board system (Figure 1) that uses sensors, mounted on the vehicle underbody, to collect an electric ground potential reference from the rail. Measuring the difference between it and the electric potential of the chassis gives an idea of the amount of leakage current that comes from the grid. This information is then used to control a compensation current that is sent back to the grid. By doing so, the electric potential of the chassis is kept at a desired level.

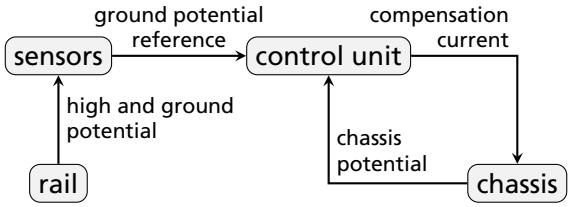

Figure 1: *System schematic.*

This solution does not come without complications. The most overwhelming problem is the inconsistency with today's standards and regulations. They strictly say that sufficient insulation is imperative for grid-connected electric systems without a protective earth connection. Apart from this, there may be technical problems as well. What is the best way to generate a compensation current without violating standards on insulation too much? How does sudden voltage spikes propagate to the electric chassis of the vehicle? Is the failure rate of active components low enough to be used as a protective measure in something so widely used as an ordinary car?

In the end, complying with the criteria on insulation may be unavoidable. This would certainly not solve the problem at hand, though. It is the author's sincerely hope that this idea will not stop here, since this, if I may say so myself, is a very interesting topic.

Gustav Hagelin