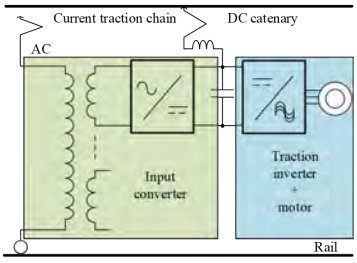
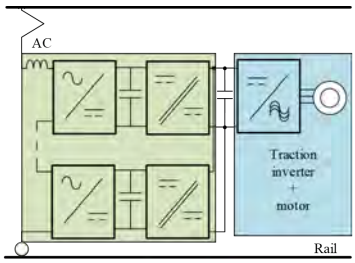
MVDC ready power electronic traction transformer

CONTEXT

Medium Voltage DC (MVDC) system is considered to replace the 1,5kV DC and 3kV DC electrification systems which are approaching end-of-life. The switch to MVDC would blend the advantage of the existing electrification systems, including power sharing between substations, three-phase power supplies from the public grid, a simple onboard power converter on the locomotive, and light overhead line with no inductive voltage drop. Power electronics technology has reached a state of maturity where 9kV DC is a viable option for rail electrification. Availability of power converters, DC circuit breakers, drives for industrial motors and Silicon Carbide semi-conductors all support a shift to MVDC.
On the other hand the power electronics traction transformer (PETT) is considered to replace the bulky on-board low frequency transformer in the 15kV AC and 25kV AC electrification systems. PETT allows to reduce on-board equipment size and weight. It also allows to improve efficiency.
The proposed innovation would make the compatibility with a MVDC catenary thanks to minor amendments of PETT architecture.





TECHNOLOGY DESCRIPTION

The PETT topology is composed of n cells connected in input in series and in output in parallel. The input is supplied by an AC catenary and the output supplies a traction inverter. Each cell consists in :
- An AC-DC converter (H-bridge). The n front end converters are called AFEC (Active Front End Converter) ;
- An intermediate DC bus ;
- An isolated DC-DC converter with a medium frequency transformer.

This PETT topology can be used with a MVDC catenary, configuring the AFEC switches in the right state. However, this may result in rather high losses. The idea proposed here consists in adding some switchgear on the intermediate buses to supply it with a MVDC catenary, reducing the losses.
In the improved PETT topology, the switchgear is added between the intermediate DC buses, between the pantograph and the intermediate bus of the first cell and between the earth and the intermediate bus of the last cell. To connect PETT to a MVDC catenary, the switches are configured after having turned off the power. Thus, the intermediate buses are connected in series/parallel and the pantograph supplies directly the intermediate buses.

APPLICATION DOMAIN

Railway

ADVANTAGES

Reduction in on board size and weight
Increase in efficiency

TRL SCALE

1 2 3 4 5 6 7 8 9

Pure concept

DELIVERABLES

Patent FR3078029A1, WO2019162608A1

SCIENTIFIC REFERENCE

A. Verdicchio, P. Ladoux, H. Caron and C. Courtois, "New Medium-Voltage DC Railway Electrification System," in IEEE Transactions on Transportation Electrification, vol. 4, no. 2, pp. 591-604, June 2018
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Shift 2 rail EU project "Future Unified DC Railway Electrification System" https://cordis.europa.eu/project/id/881772