Summary of the PhD Thesis

This works moves its steps within the European Union's Horizon 2020 research and innovation programme named ASSURED.

Launched in October 2017, the project has the aim of developing innovative heavy-duty (buses) and medium-duty (trucks) vehicles together with interoperable charging infrastructure concepts, enhancing performances, comfort and safety. At the same time, it wants to contribute to creating competitive and sustainable mobility.

Within this background context, this research has its basis and starting point represented by the electrical and mechanical constraints given by the European Project Partners.

In particular, the aim of the Pillar, to which this work case belongs, within the European Project is to provide a sustainable and a user safe charging system for light-duty Electric Vehicles like delivery vans in a city public transport HUB.

Therefore, in this case, the project aims to employ the public transport DC power grid as the DC voltage supply for the Electric charger solution.

Furthermore, to improve the safeness of the users and simplify the charging operations the suitable technology for the charge structure utilized is the Inductive Power Transfer (IPT), more commonly called Wireless Power Transfer (WPT).

The target power to charge the Electric Van is then set to be 100 kW as a requirement of the European Project as well as the supply voltage that is set from the public transportation power line to be ≈580 Vdc.

Thus, the goal of the research results to be the feasibility study, the design and eventually the experimental validation of a DC/DC galvanic insulated system using the technology of the WPT at a rated working frequency of 85 kHz as required by the standards.

In particular, one of the main aspects that this work would focus on is represented by the leakage flux of a generic IPT structure and the way to minimize it while at the same time maximising the power transferred.

Therefore, this work starts from the already well know structures featured in literature and move in the direction of employing multi-phase structures to improve the user's safeness mitigating the flux leakage.

Thereby, a numerical feasibility study of the problem is introduced to obtain an optimization algorithm that would define the geometric dimensions of the structure to match the purpose of transferring the rated power, at the higher efficiency admitted by the structure topology, translated into mutual inductance problem.

Afterwards, a 3D Finite-Element-Analysis is performed as a first verification step of the analytical study, proving the effectiveness of this in terms of computation saving time.

Furthermore, a first approach solution is proposed in terms of thermal analysis as well as a detailed circuital modelling investigation to define the device's dimensions later used in the design of the multi-phase converter used to drive the IPT structure.

Thus, a detailed overview of the realization process of the different actors, that play a main role in the final solution structure, is provided together with a first validation of the electromagnetic components, as the second step of verification for the numerical feasibility study.

Finally, the experimental validation is carried out at different supply voltages and levels of power transferred as the last step of verification of the proposed numerical pre-design for the WPT structure.

Furthermore, a detailed dissertation is addressed from an efficiency point of view, which turns out to be ≈94.5% for the supply rate of 580 Vdc with power transferred more than 100 kW.

Thus, a brief investigation regarding the leakage of flux compared to the guidelines of the standards is proposed to verify the user's safety of the prototype.

In the conclusions, together with a summary of the work results, also the problems and the issues of the research are faced turning them into possible future works and improvements.