Cold plates easy design software tool for industrial electronic applications

UNIVERSITÀ DI PARMA
POSEICO POWER ELECTRONICS

N. Delmonte [1], D. Chiozzi [1], P. Cova [1], M. Portesine [2], F. Vaccaro [2], E. Mantegazza [2]

[1] Department of Engineering and Architecture - University of Parma, [2] POSEICO S.p.A Power Electronics - Genova

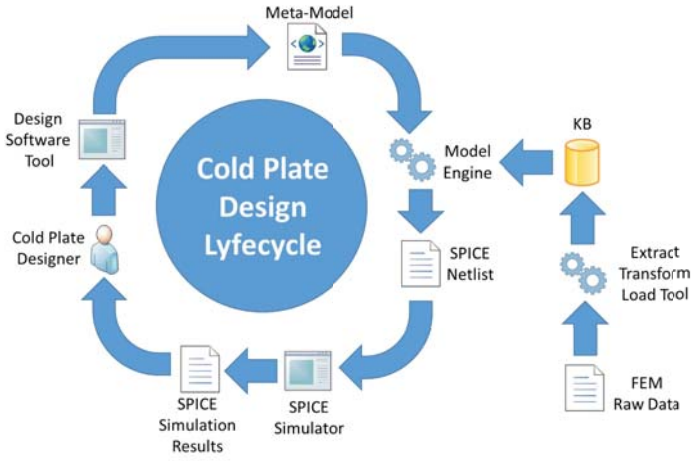
1 Introduction

Cold plates are an important topic in the field of power electronics, in order to develop reliable applications. Typically the design of custom cold plates is a manual process that forces to build many prototypes in order to find the best solution. Otherwise, Finite Element Method (FEM) analysis is an useful methodology, able to reduce the number of prototypes, but it requires skilled technicians and long simulation studies. Here is suggested a methodology able to assist the design of cold plates with negligible simulation cost, and limited use of FEM simulations and prototypes. POSEICO has developed a new ICP - Integrated Cold Plate (patent pending), that use the proposed methodology during the product design phase.

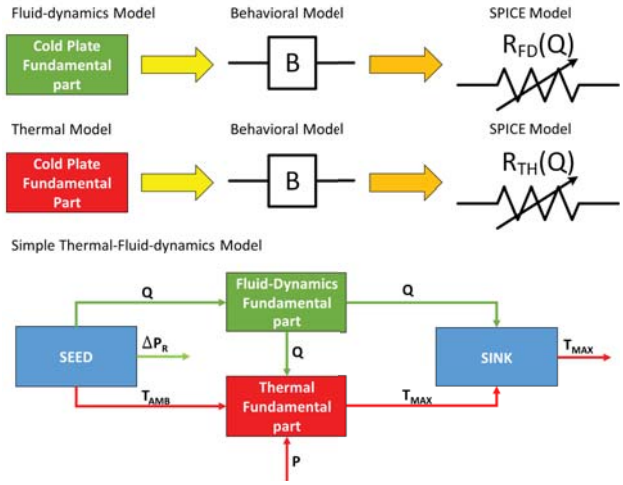
2 The methodology

A cold plate can be decomposed in fundamental parts, each of them with some properties and linked between through relationships. This decomposition is analogue to the Object Oriented Programming (OOP), where a class could be composed by further classes and between classes subsists a relationship. Only selected fundamental parts are simulated through FEM and a Knowledge Base (KB) is built. The final model is based on SPICE syntax.

2.1 Software architecture



2.2 SPICE model



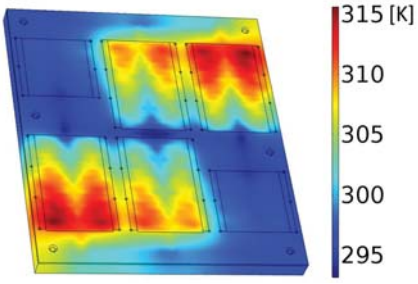
3 Results

In order to validate the approach, the ICP AWCH-L640W420T24 developed by POSEICO (patent pending) is simulated through FEM study. FEM and SPICE results are compared in order to evaluate the agreement between the two simulation methodologies. The used case study presents different fundamental parts (i.e. coil, coupling straight, elbow nipple, etc.).

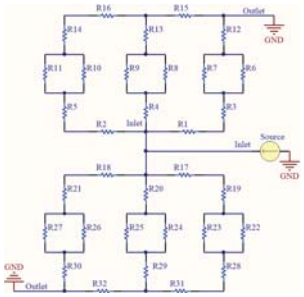
3.1 Simulation conditions

The input power sources of 2000 W represent 4 IGBT modules mounted on the cold plate. The inlet flow rate is 12 l/min. Ambient and water temperature are both 293.15 K. Boundary conditions used are similar to [1].

3.2 FEM study



3.3 SPICE Study



3.4 FEM vs SPICE

Parameter	FEM	SPICE
ΔP_R [mbar]	20	33
T_{MAX} [K]	308	311

4 Conclusions

Results show a good agreement between a cold plate thermal-fluid-dynamics FEM simulation and the SPICE based methodology. The proposed **CAE** method allows to design the best cold plate solution, to save simulation resources, and to extract necessary data for the datasheet: i) pressure drop [mbar]; ii) thermal resistance [K/kW].

References

[1] M. Lazzaroni, et al. “Metrological characterization of cold plates for power converters”, IEEE Trans. Instrum. Meas., vol. 65, no. 1, pp. 37-45, 2016.

Acknowledge

P.O.R. FESR LIGURIA 2014-2020 – Asse 1 "Ricerca e Innovazione (OT1)" Azione 1.1.3