

Design elements of static converters



Component
École Nationale
Supérieure
d'Électrotechnique
d'Électronique

In brief

- > **AmetyS Code:** N9EE28B
- > **Open to exchange students:** Yes

Presentation

Objectives

To acquire the knowledge necessary to contribute to the design of the inverter powering an AC machine, integrating aspects such as architecture, control, and semiconductor selection.

- + To be able to justify the power structure of the power converter (three-phase inverter) and identify the main sizing parameters.
- + To identify the degrees of freedom provided by the three-phase inverter structure and understand their variation at different time scales (instantaneous, in the low-frequency range relative to the switching frequency).
- + To know how to use the degrees of freedom to control the currents injected into the machine windings.
- + To understand power reversibilities (at the time scales of the switching period, the machine current period, and steady state).
- + To understand the operating constraints of the inverter's power supply stage, related to the inverter's power reversibilities.
- + To understand the inverter's filtering principle (DC stage) and size the filter components.
- + To understand the instability phenomenon resulting from the "constant power load" behavior of the inverter with its associated regulation
- + Understand the stabilization principle and design a dedicated circuit

- + Identify the losses generated in the semiconductor components of the inverter's switching cell, their nature (conduction or switching), and their location (transistor or diode)
- + Understand the datasheet content of a power transistor and a heat sink
- + Know how to size the number of power modules to use for a given current range
- + Know how to use a transistor and diode loss model in PLECS and analyze the simulation results
- + Understand the sizing of a heat sink and know how to simulate the dynamic thermal behavior of the circuit for several operating points

Description

2 lecture volumes: Architecture and Control (3 x 1.75 hours)

- HP Semiconductor Components (2 x 1.75 hours)

- MC

1 Design Office module (2 x 3.5 hours), based on the use and improvement of a simulation model (PLECS software):

- + Study of the architecture and implementation of the control system for a drive (permanent magnet synchronous machine)
- + Study and dimensioning of the filtering stage (DC side of the inverter)
- + Study of the reversibilities of the current drawn by the inverter from the DC source
- + Identification of the instability phenomenon and dimensioning of a stabilizing solution
- + Study of the losses generated in the semiconductor components constituting the inverter's switching cell
- + Analysis of the datasheet for a SiC MOSFET and Si IGBT power transistor
- + Dimensioning of the number of power modules to be used based on a target operating point
- + Use of PLECS models of transistor and SiC and Si diode losses
- + Dimensioning of the heat sink and thermal simulation of the assembly

Pre-requisites

- + Understanding of switching cells and connection functions; Static and dynamic characteristics of semiconductor components (2A-NRJ course: N7EE02A)

+ concepts of switching and conduction losses in semiconductor components (2A-NRJ course: N7EE02A - Energy approaches to CVS design)