

EPE'2021 – Call for Tutorials

## Integrated Drives: power electronics and electrical machine challenges

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### Scope and Benefits:

With a power converter inside the machine, the Electrical Integrated Drives are already attractive solutions for mass-market applications where simple packaging is of high importance. The disappearance of the AC cables between the Voltage Source Inverter (VSI) and the machine simplifies the implementation without external problems of Electromagnetic Compatibility. Moreover, integrated fault tolerant drives are able to address industrial domains where high compacity, high power/mass ratio and high reliability are expected.

### Contents:

This tutorial addresses the numerous questions raised to achieve an integrated smart drive. Its objective is to highlight the different constraints induced by the integration of the power converter close to the electrical machines, on the points of view of SiC & GaN transistor characteristics and modelling, EMI, dielectric behaviour, thermal limitation, inverter and machine control, inverter and machine topologies. Another objective is also to show how these constraints are highly interdependent, which actually narrows the possibilities for the design of an Electrical Integrated Drive. In addition, the industrial example of the ENGINEUS™ smart machines dedicated to the field of aeronautic will be explained by the CTO from Safran Electrical and Power division. the tutorial will be split into 5 parts, accounting to the following outline:

- Introduction: (Estimated time: 10 minutes)
- Overview on Electrical Integrated Drives: (Estimated time: 25 minutes)
- ENGINEUS™ smart machines by Safran Electrical and Power (-Estimated time: 30 minutes)
- Theme 1: “Why multiphase machines are adapted to integrated drives?” (Estimated time: 30 minutes)
- Theme 2: WBG power converter (Estimated time: 50 minutes)
- Theme 3: thermal considerations (Estimated time: 25 minutes)

-Conclusions (Estimated time: 10 minutes)

### **Schedule:**

Schedule is as follows

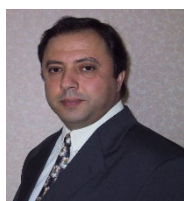
#### **Monday, 6 September 2021 - Tutorial day (Virtual)**

09:30 - 11:00	Introduction, Overview, ENGINEUS™ example, Multiphase -machines
11:00 - 11:30	Coffee break
11.30 - 13:00	WBG converters, thermal consideration, conclusion

### **Who should attend:**

This tutorial is dedicated to scientists with a advanced background on the modelling and control of classical three phase electrical machines and/or on 3-legs power electronics inverters.

### **About the Lecturers:**



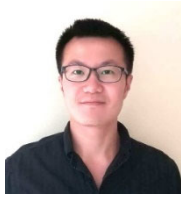
**Nadir Idir** received Ph.D. degree in electrical engineering from the University of Lille, Sciences and Technologies, France, in 1993. He is a Full Professor with IUT A of University of Lille. Since 1994, he joined the Power Electronics Group of the Laboratory of Electrical Engineering and Power Electronics (L2EP) of the University of Lille. His research interests include, design methodologies for high frequency switching power converters using wide band gap semiconductor devices (SiC and GaN), electromagnetic interferences (EMI) of static converters, HF modelling of the passive components and EMI filter design methodologies.



**Betty Lemaire-Semail** received the Ph.D. degree in Electrical Engineering from the University of Paris XI, Orsay, France, in 1990. From 1990 to 1998, she was an Assistant Professor with the Ecole Centrale of Lille. In 1997, she received the “ability to supervise research” and since 1998, she is a Professor at University of Lille, North of France. In 2013 she was the general chair of the IEEE EPE ECCE Europe conference and since, associate editor for IEEE transactions on Power Electronics. She is the head of the L2EP of Lille and the coordinator of a research project (2015-2022) about smart integrated drives which gathered 7 high education institutions in the North of France



**Eric Semail** is graduated in 1986 from the Ecole Normale Supérieure, in France. He received Ph.D. degree in 2000 on « Tools and studying method of polyphase electrical systems, Generalization of the space vector theory ». He became Associate Professor at Engineering school of ARTS et METIERS PARISTECH in 2001 and full Professor in 2010. In Laboratory of Electrical Engineering of Lille (L2EP) in France, his fields of interest include design, modeling and control of multi-phase electrical drives (converters and AC Drives). More generally, he studies, as member of the Control team of L2EP, Multi-machine and Multi-converter systems. Fault Tolerance for electromechanical conversion at variable speed is one of the application of the research with industrial partners in fields such as automotive, marine, aerospace.



**Ke Li** received the Ph.D degree in electrical engineering from University of Lille, France, in 2014. From 2015 to 2019, he was Research Fellow at the University of Nottingham, UK. In 2019, he was appointed as Assistant Professor in power electronics, machines and drives, Coventry University, UK. His research interests include wide-bandgap (SiC/GaN) power semiconductor devices integration to high power-density power converters, power converters electrothermal and electromagnetic modelling and power converters electromagnetic interference mitigation.



**Souad Harmand** is Professor at the Polytechnic University Hauts de France and researcher at the LAMIH-UMR CNRS 8202-Valenciennes France. She graduated as an Engineer in Industrial Energetic Processes from Ecole des Mines-Douai, and obtained her PhD at Valenciennes University.

Her research area is focused on heat and mass transfer and interfacial phenomena: convective heat transfer, evaporation, condensation, melting, heat pipes... The applications of her research are mainly in the fields of electrical machines and power electronics. She has published more than 270 papers in journals and conferences.



**Florent NIERLICH** is graduated in 1997 from ENSEM, the Ecole Normale Supérieure d'Electricité et de Mécanique de Nancy, in France. He worked for several major aerospace companies in the field of More Electric Aircraft covering mainly electric actuation EHA & EMA for Flight Control systems, Landing Gear Systems and for the whole development of Boeing 787 Electric Brake System.

His background is now complemented with intensive activities in the new electric propulsion domain, developing technologies and products for the Urban Air Mobility, General and Commercial Aviation.

He is currently CTO of Safran Electrical & Power, a subsidiary of SAFRAN group.