

TIEG: Basic information of the research group

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Abstract—This paper presents a summary of the main activities of research group TIEG (Terrassa Industrial Electronics Group). The group objectives are basically focused on four main areas, i.e. Electromagnetic Compatibility (EMC) in Power Systems ; EMC in integrated circuits ; Power Electronics for Energy Management ; Power Electronics for Motion Control.

Keywords—Electromagnetic Compatibility (EMC), Power Converters , Energy Management , Renewable Energy , Motion Control.

1. INTRODUCTION

The term “Industrial Electronics” in the group name defines its main field of activity. Industrial Electronics covers a wide and diverse range of technical matters devoted to the application of electronics and electrical sciences for the enhancement of industrial and manufacturing processes. It covers from integrated circuits, sensors, all kind of electronic devices to complex systems including small signal circuits and power devices and power blocks. The technical activities of the group address to the latest developments in intelligent and computer control systems, robotics, factory communications and automation, flexible manufacturing, data acquisition and signal processing, vision systems, and power electronics.

On the other side Electromagnetic Compatibility (EMC) is the area of science and technology dealing with the techniques for reducing electromagnetic interference between low signal circuits and devices and power devices and systems. The subjects of interest cover the following items: measurement techniques and test procedures, instrumentation, equipment and systems characteristics, interference control techniques, components, education, computational analysis, and spectrum management, along with scientific, technical, industrial, professional or other activities that contribute to this field.

TIEG is a group which covers all the aspects of Industrial Electronics, but also focusing on EMC aspects related with industrial equipment, covering from small signal and high frequency devices and circuits to complex and powerful systems dedicated to energy transformation, energy management and motion control. The cohabitation of such small signal circuits and power systems generates a set of specific problems which are the core of the research of TIEG group.

2. MAIN ACTIVITIES OF THE GROUP

The main research topics of the group are:

A. *Electromagnetic Compatibility (EMC)*

The main goals in this area are:

- Analysis and simulation of small signal devices and circuits
- EMI modeling of switched power converters.
- EMI modeling of components and printed circuit boards (PCB).
- EMI over the life cycle and environmental conditions.
- RFI reduction by means of metamaterials
- Control of power converters to efficiency improve and reduce electromagnetic interferences (EMI).
- EMI diagnostic techniques.
- EMC in industrial plants and boarded systems (vessels, airplanes, train and automotive).
- Measurement and compensation of disturbances in power systems.
- Active, passive and hybrid filtering.
- Processing techniques applied to the measurement of electrical disturbances.
- Design and development of measurement instruments.

B. *Power Electronics*

The main goals in this area are:

- Design and control of power converters.

- Advanced topologies in power converters: multilevel, matrix, etc.
- Design and control of power converters for renewable energy systems.
- Network integration of distributed generation systems.
- Power quality in electrical systems.
- Development of power systems for industry and vehicles.
- Development of drives using advanced structures for application to aeronautical and automotive field.
- Smart grids
- Grid control: SVC, Real time reactive energy compensation, etc



Fig. 1.- TIEG research areas

3. SCIENTIFIC PRODUCTION

The scientific production of the group in the last 5 years can be seen in <https://tieg.upc.edu/publications>.

The main figures are:

- 63 articles in journals indexed in JCR
- 183 publications in relevant Conference Proceedings
- 16 PhD Thesis
- 2 books and 5 book chapters
- 5 Projects with public funding + 8 Projects with private funding
- 3 Patents

4. SINGULAR EQUIPMENT AND FACILITIES

Both fields, EMC and power electronics, require singular equipment to perform the experimental tests required. The labs of the Group are equipped with the following singular equipment:

A. Equipment for EMI tests and simulation

- TEM cell WAVECELL allowing emission and susceptibility tests. Including calibration equipment
- RF generator + amplifier. Allows tests of conducted emitted EMI according to EN-61000-4-6 and immunity tests up to 30V/m for equipment which dimensions do not exceed 300x300x300mm
- We can provide tests on semi anechoic chamber (Dept in BCN campus)
- EMI standard receivers: Rohde Schwartz tipo R&S ESPI3. According to CISPR 11 ; TEKTRONIX 2712 Analyzer from 9 kHz-1,8 GHz. Includes tracking facilities and pre filter for EMI measurement.
- HAMEG HM5014 Spectrum Analyzer 0,15 MHz-1050 MHz
- ELECTROMETRICS LISN (Line Impedance Stabilization Network)
- KEYTEK CEMASTER to perform susceptibility tests, including “burst” and HV pulses
- Antennas for radiated tests
- Capacitive coupling clamp to measure cable emission KEMZ 801
- HF signal generator ROHDE & SCHWARTZ SML01 ; 9 kHz-1,1 GHz
- Arbitrary waveform generator SONY-TEKTRONIX AWG2021
- Vector network analyzer ROHDE & SCHWARTZ ZVRE ; 9 kHz-4GHz
- HF current clamp ROHDE SCHWARTZ
- Pulses generator WAVETEK 802 , up to 50 MHz
- Keithley 2636 Source-Measurement Unit
- Everbeing Probe Station.
- Handhelp Agilent N9923A Vector network analyzer. 9kHz-14GHz

- Oven
- Advanced Design Systems, ADS software from Agilent. Allows finite elements and circuit simulation of HF circuits

B. Power Network Analyzers

- CIRCUTOR AR5 . Can perform analysis of (Harmonics , Flicker, high dV/dt disturbances, etc.) Includes monitoring software and current clamps up to 2000A (open clamps) and Rogowski clamps (flexible core)
- AGILENT MSO 7104A, Power analyzer

C. Power converters and power supply and loads

- Matrix converter designed in cooperation with NOTTINGHAM University, controlled by DSP TMS320C6711
- Several power converters . Single phase, three phase 3 wires and three phase 4 wires with controllers based on DSP TMS320C335 (floating point). Isolated JTAG connection for debugging with “Code Composer Studio”
- Resistive and nonlinear power loads up to 10kW
- Pacific Power Source. Three phase linear source up to 3,3 kW allowing simulation of all types of power line disturbances.

D. Controllers

- TI PC/C32M with DSP TMS320C32 to insert in PC ISA motherboard
- 2 DSPACE DS1103 hybrid PCB RISC/DSP (TMS320F240) to insert in PC ISA motherboard
- DSP software for DSP development of Texas families 2000 and 6000, Isolated JTAG interface with “Code Composer Studio”
- National Instruments (NI) PXI, general purpose real time controller. Equipped with FPGA module allowing fast controllers implemented on silicon.
- National Instruments (NI) Compact Rio controller. Equipped with FPGA module allowing fast controllers implemented on silicon.
- National Instruments LAB VIEW software to program all the NI controllers

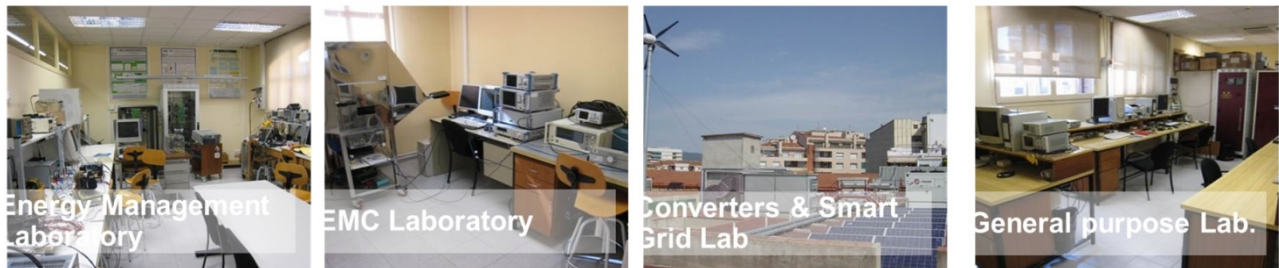


Fig. 2.-TIEG research facilities

5. ON GOING PROJECTS

- Caracterización y mejora de la Compatibilidad Electromagnética entre Convertidores conmutados y sistemas de comunicación PLC. Project area: National MICIN , Ref. TEC2011-25076; Start date: 01/01/2012 , 3 years
- Estrategias de control de generadores offshore y convertidores multinivel conectados a la red eléctrica en sistemas de transmisión de HVDC (CONNECT-DC). Código ENE2012-36871-C02-1. Inicio 2013 final 2016
- Study of Low-Voltage Energy Converters for Cost Reduction and Reliability Improvement in Wind Energy Systems
- Advanced Wide Band Gap Semiconductor Devices for Rational Use of Energy ACRONYM: RUE , CONSOLIDER project with 8 Universities and 2 Technological Centers involved.
- SGR 2009 1425 Compatibilitat electromagnètica en Circuits integrats
- TEC2010-18550 Reliability and robustness characterization and modeling of the radiofrequency electromagnetic interference on integrated circuits
- EFINDPRO Energy efficiency in industrial parks, CODE: Q-00009. Project area: KIC Innoenergy, European Union , Head researcher: Josep Balcells. SUBJECT: Optimization of global energy usage in industrial parks through the energy exchange flows between the industries located on them.
- Estudi de viabilitat d'implentació d'energies renovables a través de microxarxes en els pobles del Pirineu (RURALGRID). 01/01/2012. 31/12/2013. Codi d'entitat finançadora: 2011 CTP 00028. Àmbit: Autonòmic. Entitat finançadora: AGAUR. Agència de Gestió d'Ajuts Universitaris i de Recerca.

- PROYECTO COORDINADO: Topologías y control de convertidores electrónicos de potencia para la transmisión offshore de energía en corriente continua en alta tensión; SUBPROYECTO: Estrategias de control de generadores offshore y convertidores multinivel conectados a la red eléctrica en sistemas de transmisión de HVDC. MCYT, (ENE2012-36871-C02-01).

6. RELEVANT PROJECTS IN THE LAST 5 YEARS

- Análisis y Técnicas de Reducción de EMI En Convertidores Matriciales y Sistemas Multiconvertidor: Interacción con los Sistemas de Comunicaciones por Línea (PLC) (TEC2007-615827/MIC). Funding body or bodies: MCYT ; Start date: 01/10/2007 , 3 years
- Nuevas técnicas de control de convertidores de potencia orientadas a la mejora de prestaciones de los accionamientos eléctricos y a la reducción de perturbaciones en el sistema de alimentación y en el entorno.
- PROYECTO COORDINADO: Topologías avanzadas de convertidores de energía para la mejora del rendimiento y calidad de potencia en la integración de la energía eólica en la red eléctrica; SUBPROYECTO: Control de topologías avanzadas para la mejora del rendimiento y calidad de potencia de convertidores estáticos en generadores eólicos asíncronos doblemente alimentados
- CRISALIDA (Convergencia de Redes Inteligentes y Seguras en Aplicaciones Eléctricas Innovando en Diseño Ambiental) Project area: National; Funding body or bodies: CENIT Start date: 01/07/2007
- Electromagnetic Enhancement robustness TEC2009-09994 Impact of RFI on Circuit under New Default Mechanisms and Increasing Immunity by Means of Metamaterials
- EOLO. Consecuencias de la Integración de Turbinas Eólicas en la Red de Distribución y de Transporte Eléctricos. Generalitat de Catalunya – AGUR, Comunidad de Trabajo de los Pirineos (CTP).
- CITY-ELEC: Sistema de Tracción/Propulsión Eléctrica en Vehículo. Ministerio de Ciencia e Innovación.
- CITY-ELEC: Almacenamiento, Adaptación y Distribución de Energía Eléctrica en Vehículo. Ministerio de Ciencia e Innovación.

7. REFERENCES

- [1] <https://tiieg.upc.edu/>