Corso di Elettronica Industriale

A.A. 2015/2016

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Orario di ricevimento: Martedi 9-11

c/o Dipartimento Ingegneria dell'Informazione, stanza 536

Course of Industrial Electronics

Academic Year 2015/2016

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Day for student meeting: Tuesday from 9 to 11

At Dipartimento Ingegneria dell’Informazione, room 536

Industry where Industrial Electronics background is needed.

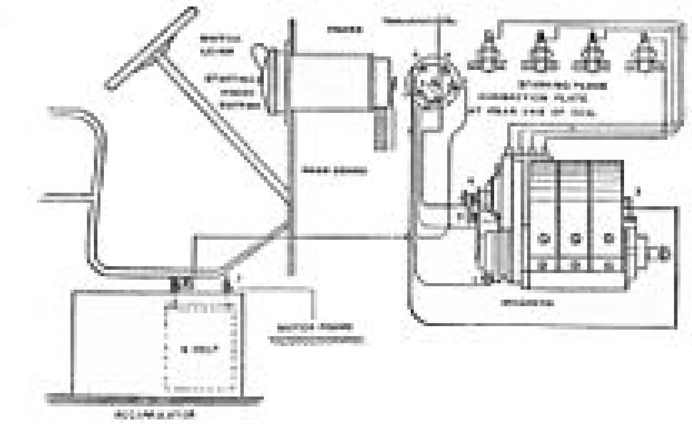
- **Consumer**
- **Medical**
- **Automotive**
- **Renwable energy / Energy Harvesting**
- **Oil and Gas Industry / Industrial processes**
- **Robotics**
- **Avionics / Aerospace / Military**

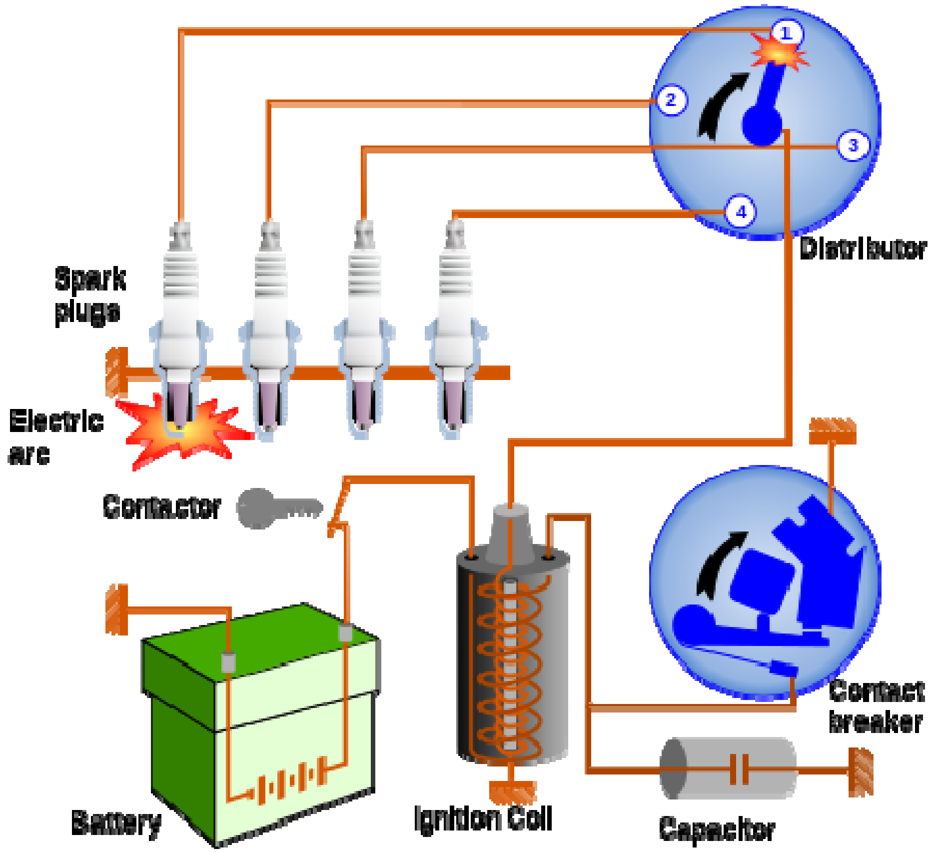
What is Industrial Electronics ?

Industrial Electronics encompasses the applications of electronics, controls and communications, instrumentation and computational intelligence for the enhancement of industrial and manufacturing systems and processes.

Included are <u>power electronics</u> and drive control techniques, system control and signal processing, fault detection and diagnosis, <u>power systems</u>, instrumentation, measurement and testing, modeling and simulation, <u>motion control, robotics, sensors and actuators</u>, implementation of neural nets, fuzzy logic, and artificial intelligence in industrial systems, factory automation, communication, and computer networks.

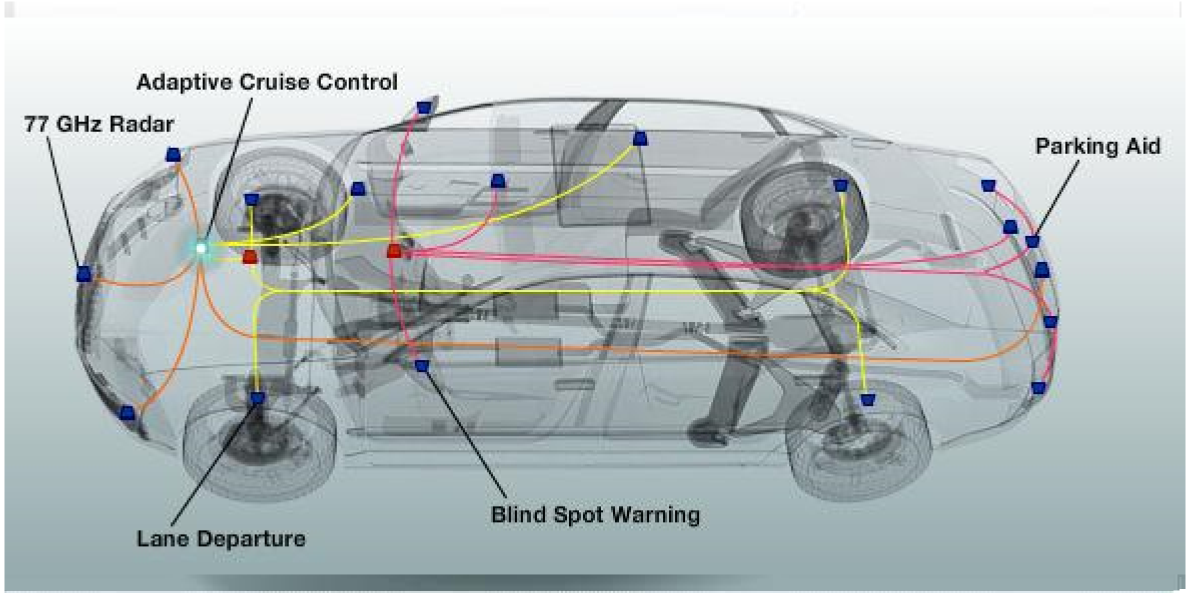
Evolution of Electronics in the automotive industry



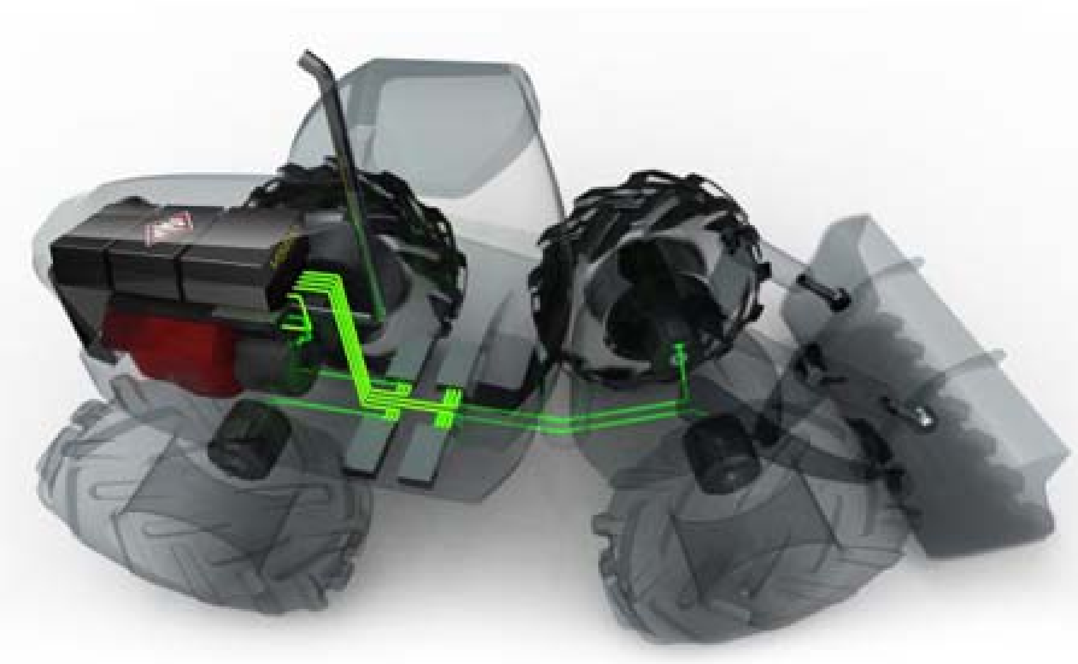


Car engine with switchable ignition and battery (year 1910)

Automotive Electronics (2010)

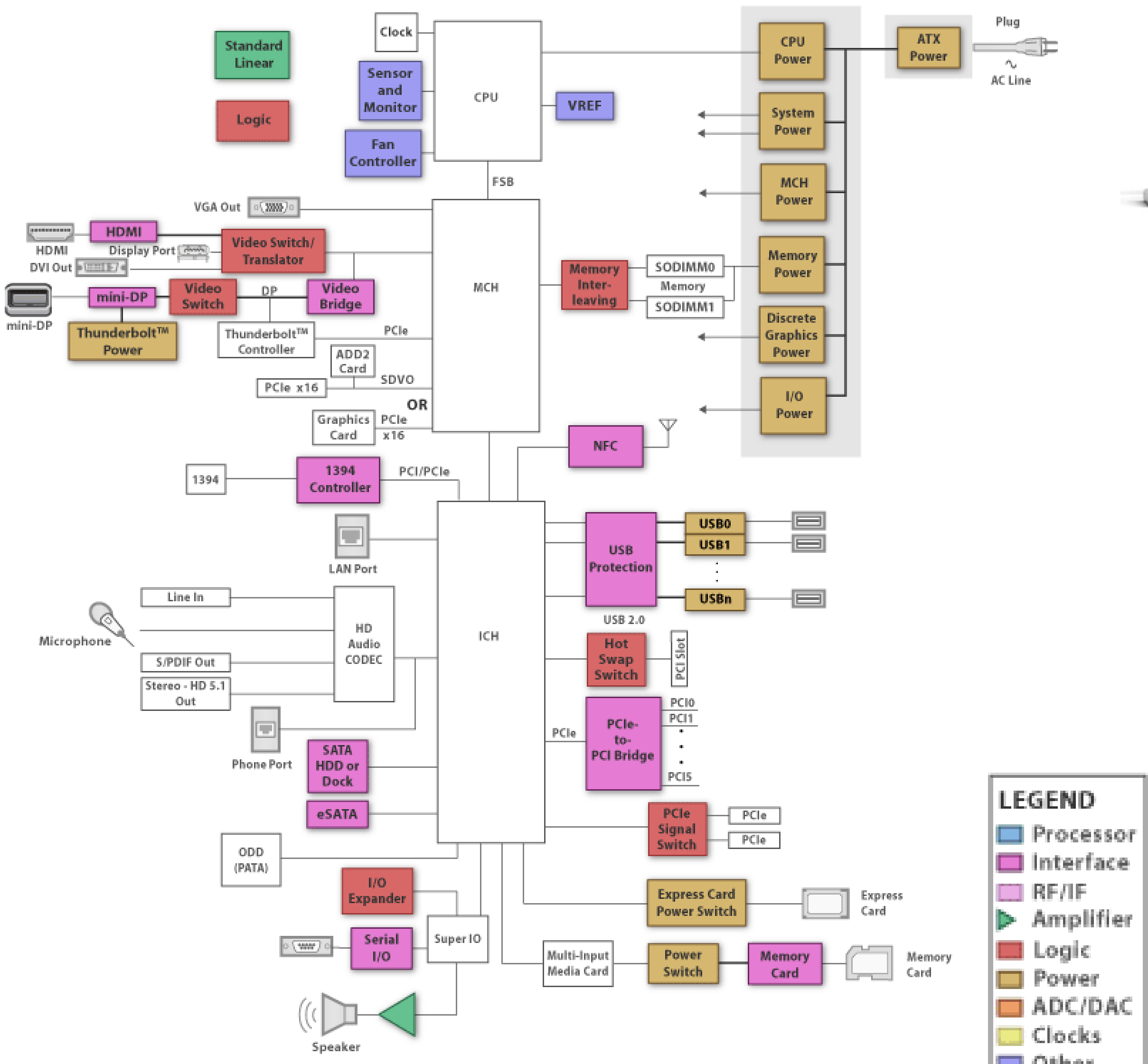


Hybrid vehicles : diesel power generator– electric traction



Courtesy by VISEDO http://www.visedo.com/it/prodotti/motopropulsori-elettrici

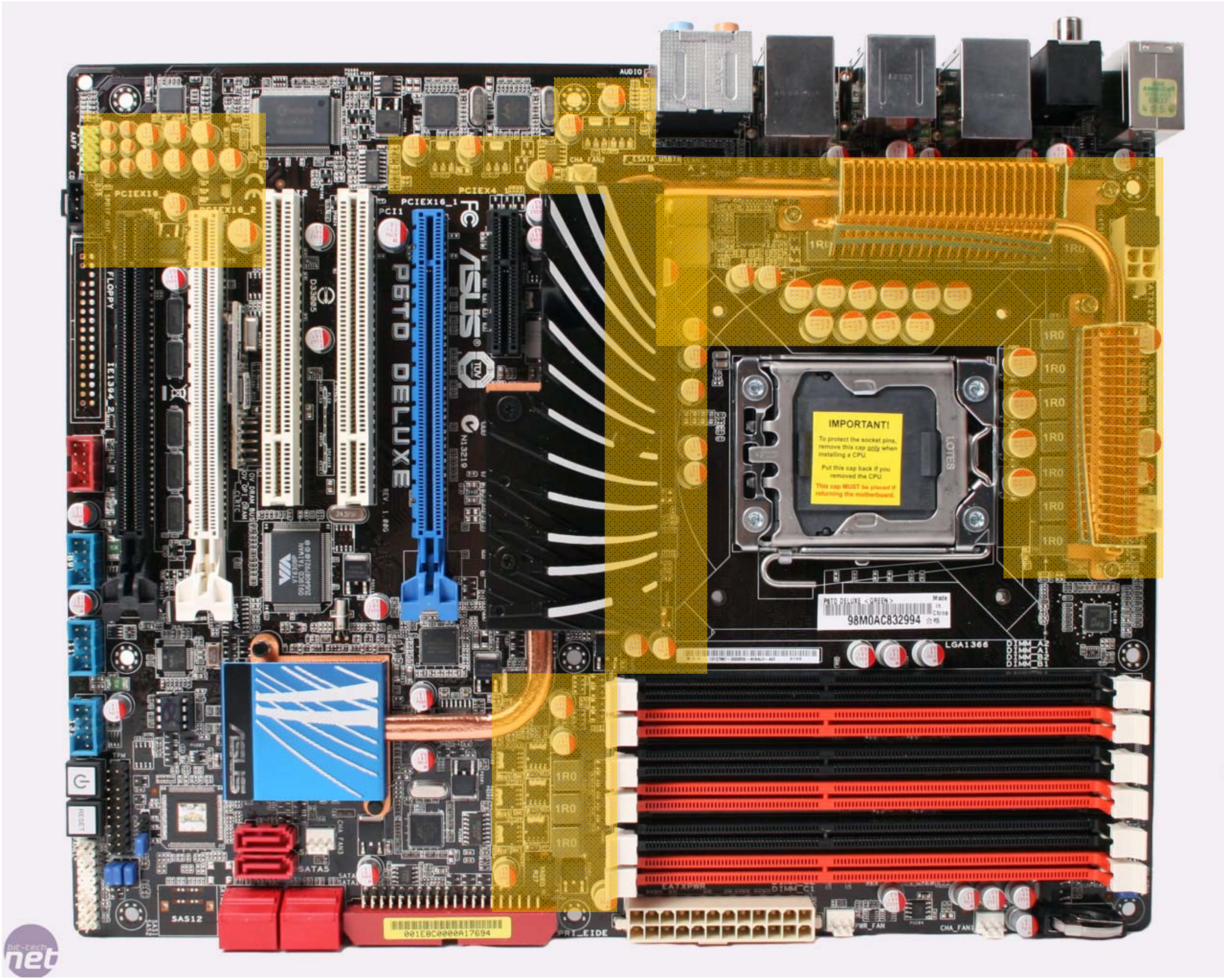
Power management: PC



Thunderbolt and the Thunderbolt logo are trademarks of Intel Corporation in the U.S. and/or other countries.

Courtesy of TI

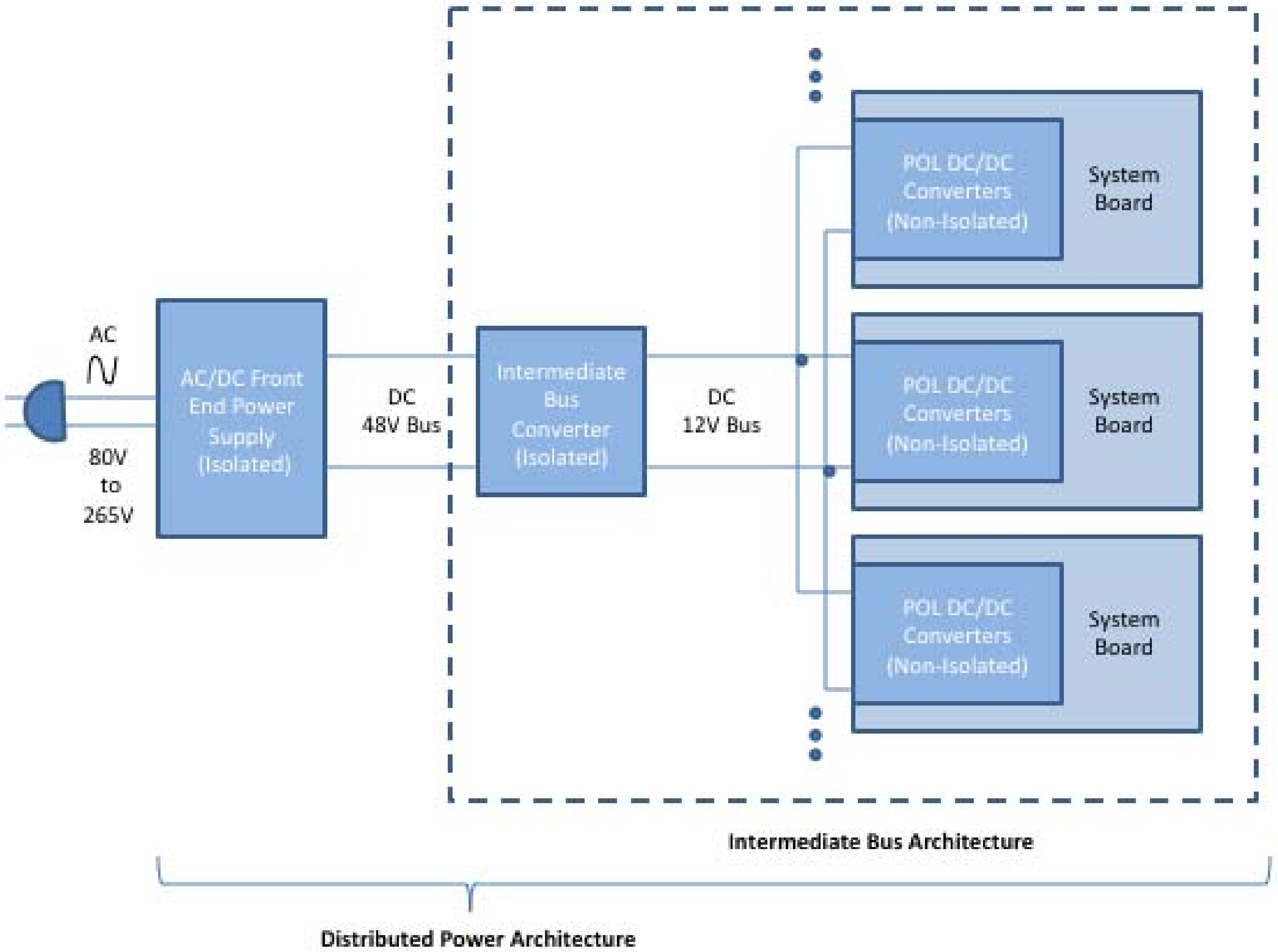
Power management: PC motherboard



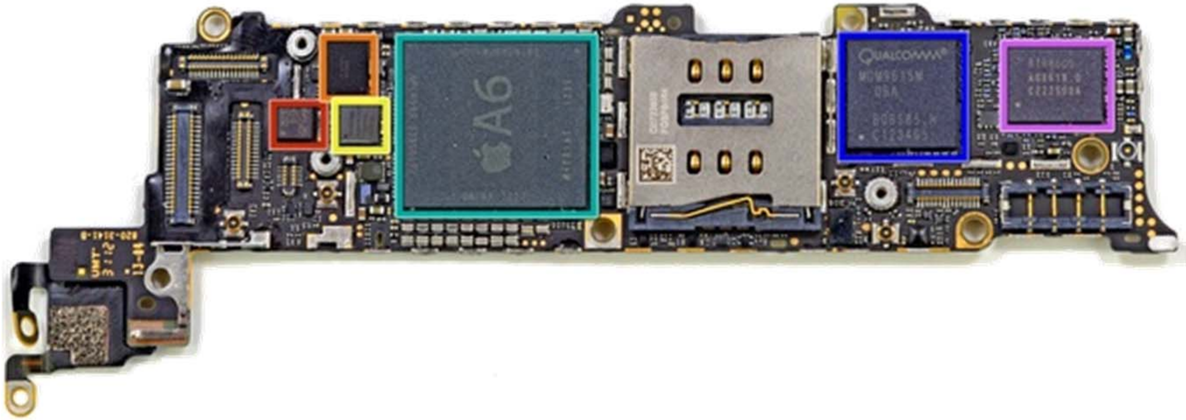
Power management areas

Large areas are used for power management

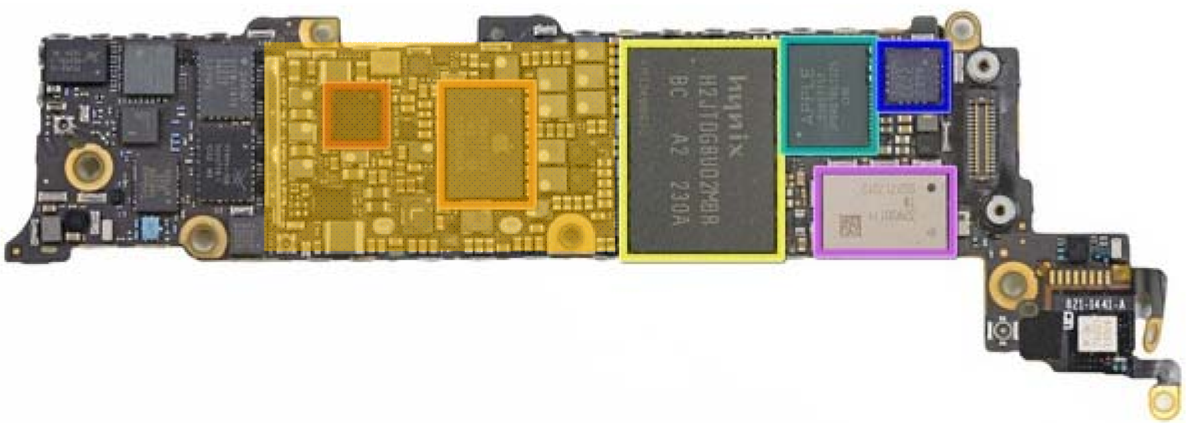
Distributed Power Architecture (DPA)



Power management: smartphone



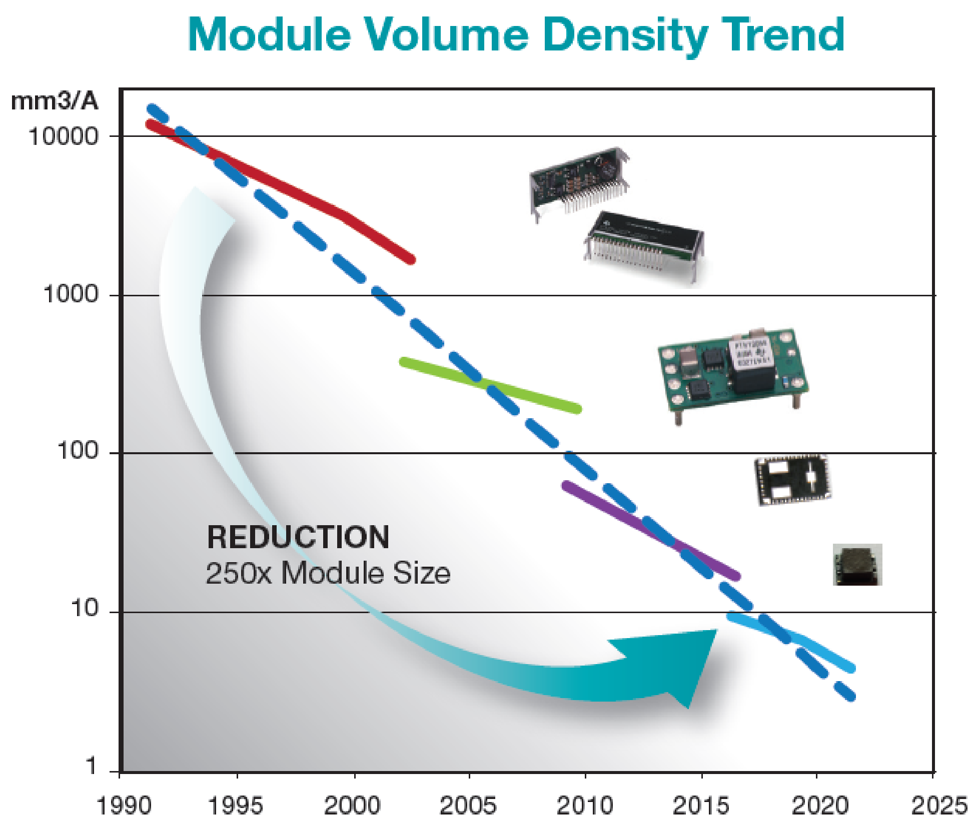
Power management areas



Large areas are used for power management

https://www.ifixit.com/Teardown/iPhone+5+Teardown/10525

Trend of power modules

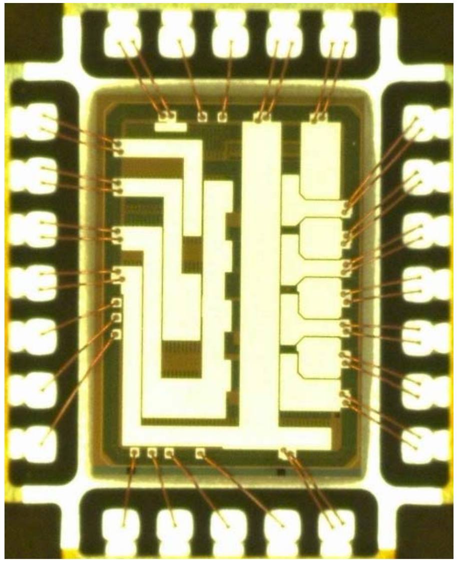


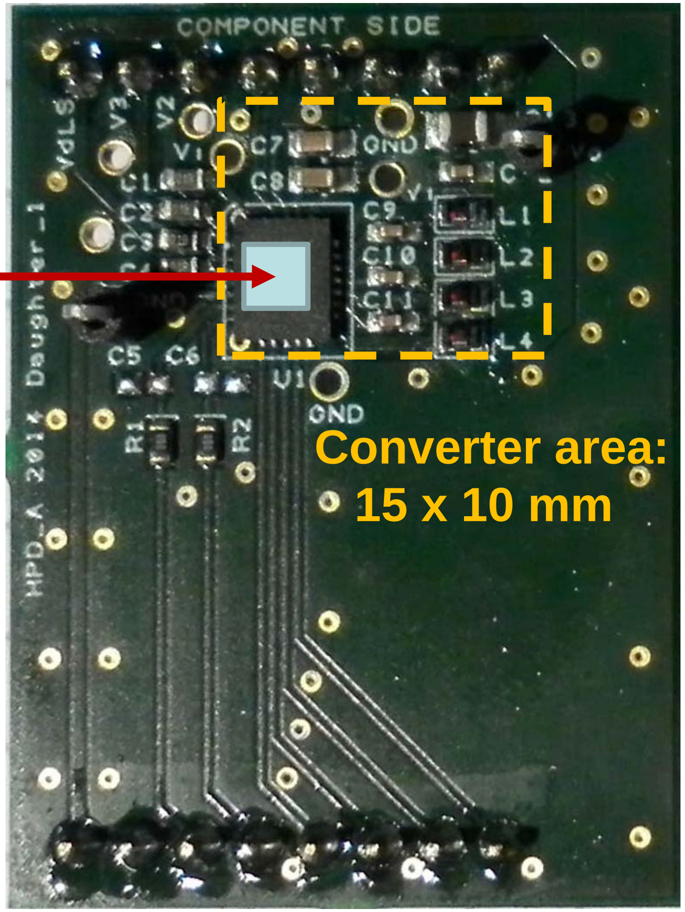
- Integrated new circuit topologies
- Miniaturized packaging
- Miniaturized passive components L,C

⇨ It all results in the new trend of System in Package (SiP) power modules

DC-DC converter High Power Density Chip Design

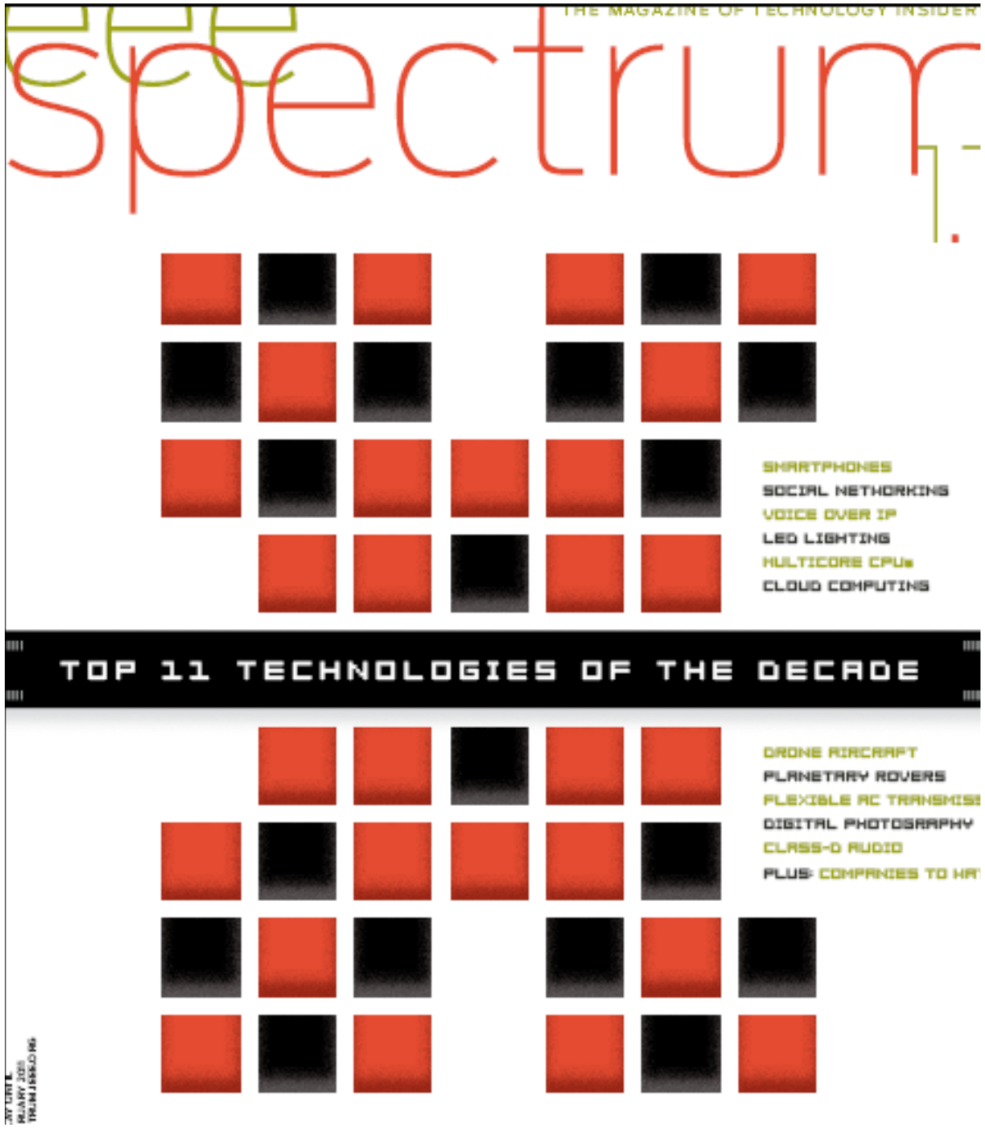
CALABRESE Giacomo, CAPINERI Lorenzo et. Al. “Integrated high step-down multiphase buck converter with high power density” 16th European Conference on Power Electronics and Applications, EPE'14 ECCE Europe, Lappeenranta, Finland from 26 -28 August 2014.





V_i	**10.8 -16 V**
V_o	1.2V optimized, range 0.6 - 2 V
I_o	2A (500 mA per phase)
f_s	10 MHz optimized, up to 15 MHz

Electronics for LED bulbs



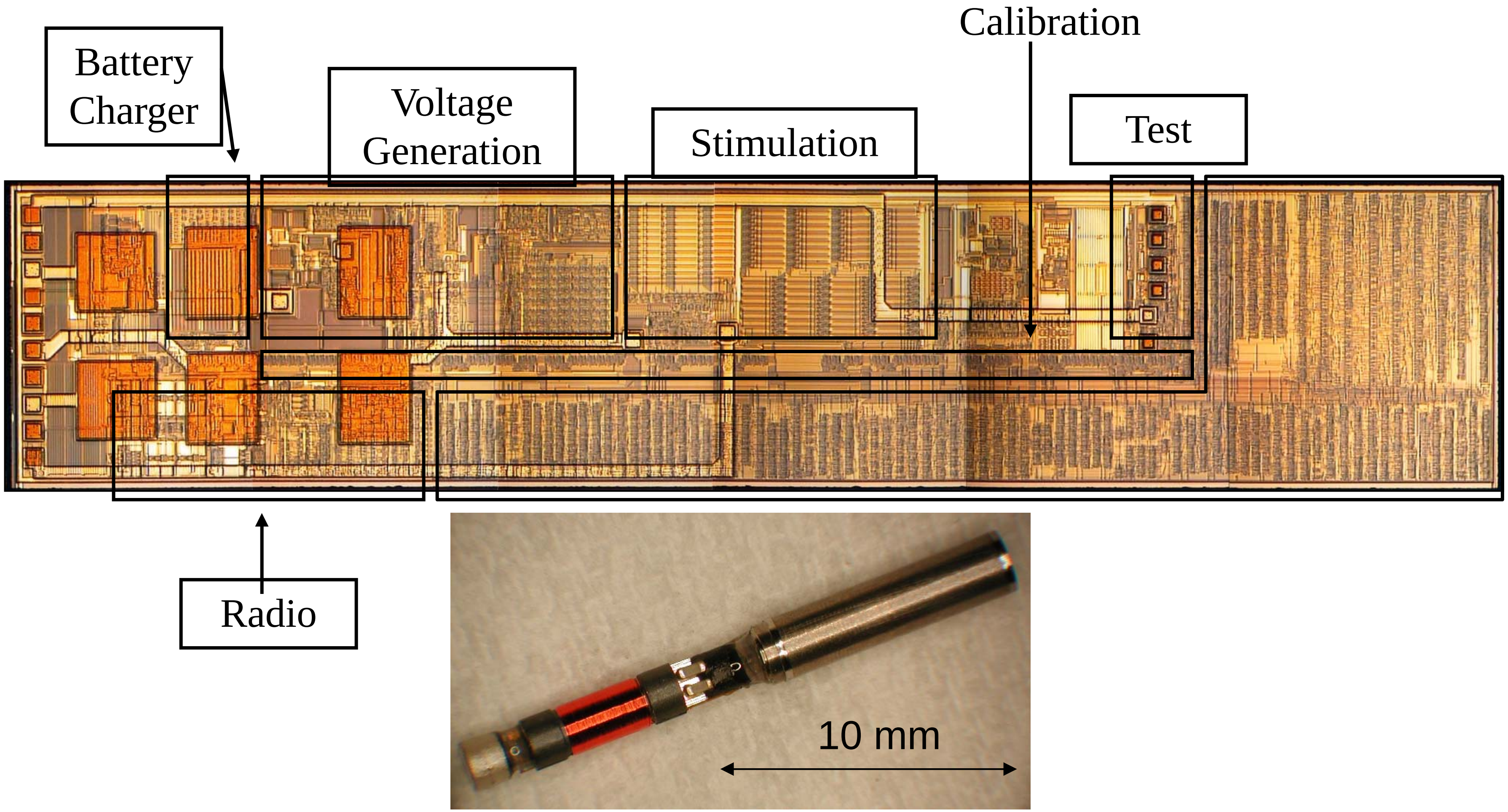
warmer incarnations, produce spectra with a handful of sharp peaks. The spectrum of a warm-white LED, by contrast, is relatively smooth, much more like that of a glowing filament. LEDs also turn on instantly, with constant brightness, unlike CFLs. What's more, they beat CFLs where CFLs beat incandescents, by lasting even longer and saving you even more on your electricity bill. And, of course, an LED bulb looks much more like a regular lightbulb than does the CFL corkscrew.

Ironically, although LED bulbs produce far less heat than incandescents, dissipating what heat

consumers—especially those in the United States—want. So manufacturers lower the color temperature by painting on phosphors that absorb much of the blue and re-emit it as yellow and red light. But as more long-wavelength phosphors get added, more energy gets lost in the conversion process. Consider for example, LED manufacturer Cree's XLamp MX-3 bulb. It comes in a 6500-K version that produces roughly 94 lumens per watt, while a 3500-K version (only slightly bluer than halogen) emits a mere 77. So exactly how much efficiency you get depends on whether you want to feel like you're next to a cozy fireplace or under a cloudless arctic sky.

Electronics for implantable medical devices

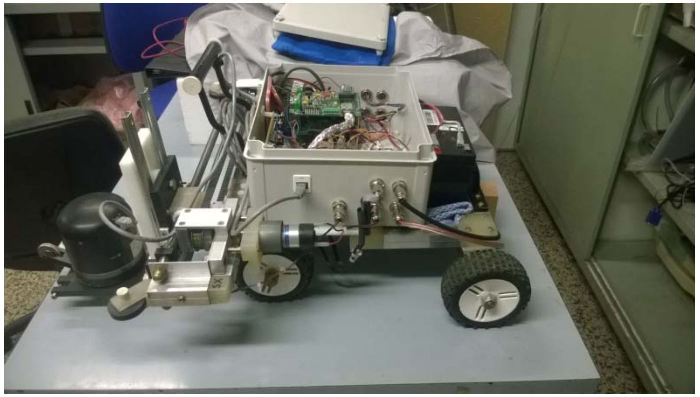
***bion®:* A Battery Powered Microstimulator System for the Treatment of Urge Urinary Incontinence,** M. Haller Ph.D. Advanced Bionics Corporation, Santa Clarita, CA

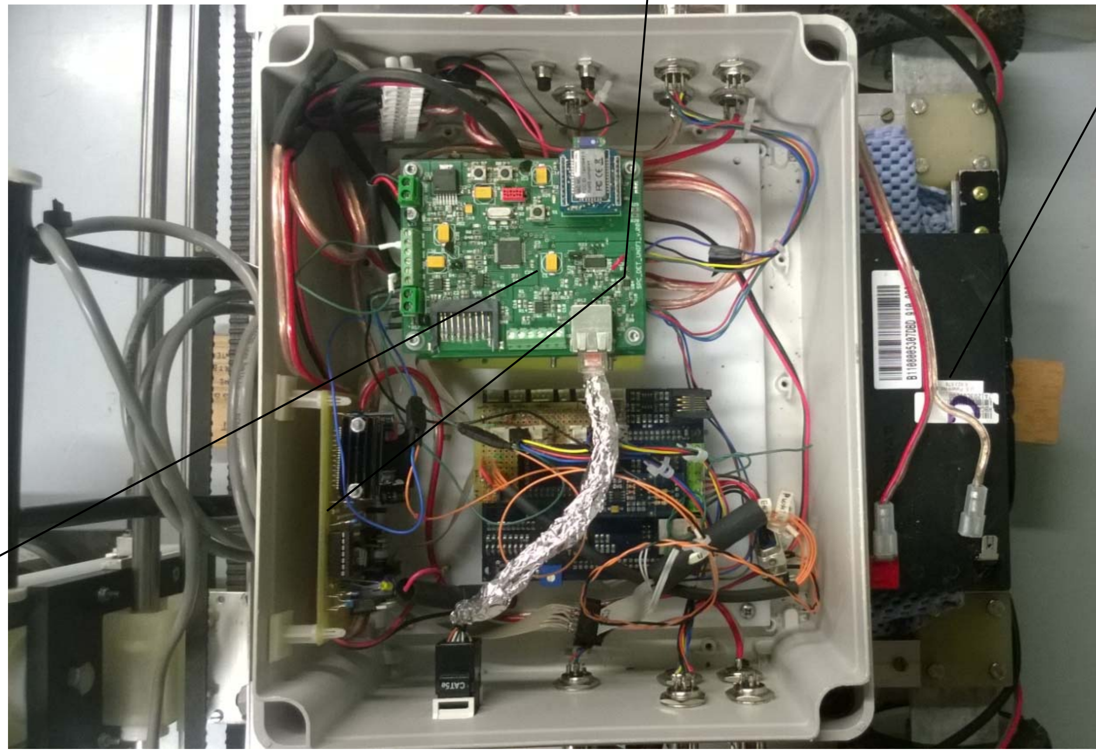


System on a chip electronics: Using high voltage BiCMOS technology, integrated analog, digital and RF circuits using the same chip with minimal "off-chip" components

Robotics

Radar Object Scanner





- •DC Motor power control
- •Data acquisition and communication system
- •Power Management

Primary Lead Acid +12 V Battery

Voltage regulators for holographic radar

Radar Object Scanner: http://www.scientificamerican.com/blog/post.cfm?id=radar-holography-could-offer-a-safe-2010-07-21

Components and Devices for Power Management

- Battery Management
- Digital Power
- AC/DC and Isolated DC/DC Power
- LCD/OLED Display Bias Solutions
- LED Driver
- Linear Regulators
- Load Switches/High-Side Switches
- NexFET™ Power MOSFETs
- Non-Isolated DC/DC
- Power Modules
- PMU
- Power Interface
- SIMPLE SWITCHER®
- Sequencers
- Supervisor and Reset IC
- Wireless Power
- /etc... Power

Course Topics

• Passive components and semiconductor devices for power management systems (MOSFET, Thyristor, BJT, Diode).
• Drivers for power semiconductor devices.
• Power converters: linear and switching voltage regulators.
• Advanced topologies for integrated voltage regulators and design criteria. System in Package power modules.
• Voltage transients and solid state suppressors.
• Seminars with practice on microcontrollers for industrial electronics are planned at the end of the course.
• The course includes 4 laboratory units based on CAD simulations of power control circuits and characterization of state of the art switching and LDO voltage regulators. Characterization of load and line regulation is carried out by students with automatic measurements systems on PMLK Pro (TI) Laboratory Kit.

Background

Analog and digital systems, sensors, solid state physics, automatic control.

Programma del corso

--- Potenza > kW

Interruttori allo stato solido: dispositivi a quattro strati (SCR, TRIAC, DIAC, IGBT, GTO, MCT)

Sistemi di controllo della potenza mediante dispositivi a quattro strati.

--- Potenza < kW

Mosfet di Potenza.

Configurazione a ponte e semiponte.

Controllo con PWM per applicazioni di potenza (Motori, LED, Alimentatori a commutazione)

Introduzione agli alimentatori a commutazione e lineari.

Componenti reali Induttori e Condensatori.

Alimentatori in continua a commutazione (convertitori DC/DC, flyback, forward)

Alimentatori in continua con regolatori lineari a dissipazione, dispositivi integrati, regolatori a bassa caduta di tensione (LDO)

Protezioni negli alimentatori .

Filtri per armoniche e soppressori dei disturbi di rete, schermi.

Utilizzo dei microcontrollori avanzati nell’elettronica industriale

Text books

“Fundamentals of Power Electronics”, R. W. Erickson,D. Maksimovic, 2nd edition

“Electronic circuits: design and applications”, U. Tietze, C. Schenk, E. Schmid, 2nd edition

“Principles of Power Electronics”, Kassakian John G

Course notes and slides

http://www.uscndlab.dinfo.unifi.it/

Final test

It is requested the participation to the laboratory units with the support of teaching assistants.
The reports on the lab units must be delivered within 7 days.
Oral interview on the course topics and on the delivered reports.

Teaching Assistants

- Ing Andrea Bulletti (Scholarship Holder)
- Ing Pietro Giannelli (PhD student)
- Ing Eugenio Marino Merlo (PhD Student)
- Sig Marco Calzolai (Senior Technician)
- Prof Antonio Chini (Collaborator)
- Andrea Giombetti Piergentili (Technician)

Reference person for laboratory units : Andrea Giombetti
giombetti@unifi.it ; Tel. +39 055 2758609

More info : http://www.uscndlab.dinfo.unifi.it/

Calendario Esercitazioni di Elettronica Industriale
II° Periodo dal 01/03 - 10/06- A.A. 2015-2016

Eserc.#	Data	Oggetto esercitazione	Assistenti	Tipologia
1	11/3/16	**Controllore di potenza di un carico resistivo con OPTO-TRIAC**	Giombetti/ Bulletti	Realizzazione circuito e misure
2	18/4/16	**Misura dei parametri di stabilizzazione di regolatori di tensione lineari e caratterizzazione con sistema automatico di misura con carico elettronico**	Calzolai/Chini/Giannelli/Giombetti	Misure
3	6/5/16	**Simulazione modulatore PWM per DC - DC converter**	Capineri	Simulazione con programma CAD
4	9/5/16	**Progetto Termico**	Capineri	Teoria/ Simulazione
5	13/5/16	**Convertitore Boost sincrono**	Giannelli	Seminario/Simulazione
6	20/5/16	**Conv. DC/DC su scheda Texas Instruments PMKL – caratterizzazione con sistema automatico di misura con carico elettronico**	Giannelli/Calzolai/Giombetti	Misure
7	27/5/16	**Introduzione ai Microcontrollori e loro applicazioni.**	Giardina /Marino	Teoria e microprogrammazione
8	30/5/16	**Esempio di Utilizzo dei Microcontrollori per Elettronica Industriale**	Giardina/Marino	Realizzazione circuito e firmware
9	3/6/16	**Esempio di Utilizzo dei Microcontrollori per Elettronica Industriale**	Giardina/Marino	Realizzazione circuito e firmware