# Seminar 12 Monday June 18, 2001

## ELECTROMAGNETIC COMPATIBILITY WITHIN POWER ELECTRONICS. Part 2: ADVANCED 9:00am – 6:00pm

**Instructors: Jacques Laeuffer, PSA Peugeot Citroën, France; Jean-Marie Peter, France**

### ABOUT THE INSTRUCTORS

Jacques Laeuffer: see Seminar 11, Jean-Marie Peter: see Seminar 3

### SCOPE AND BENEFITS

Over about 1 MHz, conventional circuit theories with localized constants like "parasitic capacitances" or "stray inductances" need to be improved with a physical understanding of the electromagnetic energy propagation within and around the power circuit. Seminar's benefits include:

- How to choose and design E.M.C. optimized power designs (from 100 W up to 100 KW).
- Avoid expensive shielding. Reliability improvement.

### CONTENTS

**ISSUES TO BE SOLVED**

- High frequency (H.F.) parasitic resonances occur just after semiconductors commutation, i.e. between MOS capacitance and transformer stray inductance.
- This H.F. is radiated and envelop detected by control semiconductors, and by antennas during regulatory tests.
- Magnetic field radiations are very expensive to shield.
- Inductances reduction leads to capacitances increase, and vice versa.

**ELECTROMAGNETIC POWER PROPAGATION**

- Propagation in coaxial lines: Poynting theorem.
- Electric and magnetic energy storage; electromagnetic power flow. Waves impedance and speed.
- Energy flow through a transformer.
- To avoid resonances, the switch commutation time should be greater than circuits time constants: **3 ways:**

**1. SEMICONDUCTORS DI/DT AND DV/DT CONTROL**

- Smoothing di/dt and dv/dt front edges by gate drives.
- Control for MOS and control for IGBTs.
- Drawback: increased commutation times and losses.

**2. REDUCE PASSIVE COMPONENTS TIME CONSTANTS**

- Reduction of capacitors' inductance and inductors' capacitance. Transformers calculation and PCB layout.
- Snubbers, damping, grounding, shielding, etc.
- Drawback: increased size of passive components.

**3. TOPOLOGY CHOICE**

- When power is increased, topology change (from forward to half bridge, or to resonance) reduces the above mentioned drawbacks.
- ZVS and ZCS resonant topologies.
- DRIVES: cables magnetic shielding between inverter and motor. Damping. A.R.C.P. techniques.

**RADIATIONS REDUCTION**

- Cables, PCBs, transformers emission reduction.
- Easy magnetic field measurement. Scope probes use

### WHO SHOULD ATTEND

- Intelligent motion, systems integration, field service, and E.M.C. specialists engineers who need to understand major power electronics issues. Technical managers interested in major trends of power electronics.