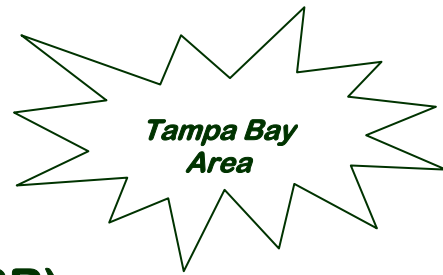




Advanced MotorTech, LLC
9117 Park Blvd.
Largo, FL 33777



Design of Switched Reluctance (SR) Machines and Drive Application

Learn practical Switched Reluctance Machine Design and Application by applying motor principles, academic theory and practical manufacturing experience

March 1-3, 2010, Clearwater, FL

- ◆ ***SR Motor Operation Principles***
- ◆ ***SR Drive Topologies & Operation***
- ◆ ***Geometry and Control Details for Low Torque Ripple, Low Noise***
- ◆ ***Integrated SR Motor and System Design for Traction and High Speed***
- ◆ ***SR Motor Design Tools***
- ◆ ***Realistic Possibilities and Limitations for SR Motor Design***

Objectives and Benefits

The principles of the Switched Reluctance (SR) machines are simple, but its design is difficult because of non-linear effects and sensitivity to key dimensions. They are usually designed for specific applications, and produced using unique manufacturing methods, which make the design decisions even more difficult.

This course will use basic motor principles to increase your understanding of machine design in the context of Switched Reluctance machines and the drives they require. Academic theory will be reduced to practical results with examples and calculation 'how-to', taking realistic manufacturing constraints and especially magnetic saturation into account. Special emphasis will be on design of application-specific SR motors, and on design features and tools to achieve specifications such as torque, power density, speed, low noise, etc. The similarities and differences of induction machines, BLDC machines and Switched Reluctance machines are in almost all topics.

The primary goal of this course will be to use a foundation of machine and magnetic concepts to learn Switched Reluctance machine design and performance based on the electrical, magnetic, mechanical, and thermal interactions.

Those who will benefit:

- Motor design engineers
- Application engineers
- Suppliers to motor manufacturers
- Control engineers, Drives engineers
- Engineering managers
- Others who design, manufacture, use or service (or want to) Switched Reluctance machines

You should have some background in machine design, operation and construction with the equivalent of a B.S. degree in electrical engineering. Understanding of basic magnetic circuits and inverter principles is needed, but advanced motor theory and control techniques are not essential.

Instructors:

Dr. George Holling is currently the Technical Director of Rocky Mountain Technologies, a manufacturing and consulting firm for switched reluctance and custom motors and drives and is a globally recognized expert in electromagnetic theory and design of advanced electric motors. He has a diverse background with over 30 years of experience in industrial, appliance, automotive and aerospace motor and drive systems. Dr. Holling has design engineering and technical management experience for companies such as General Electric, Honeywell, Pacific Scientific, Advanced Motion Control, Raser, and Rocky Mountain Technologies. He has been a consultant for major US and international corporations for motor and drive design and the development of new motor and control technology, and holds numerous patents in electric machines and control.

Dr. Keith W. Klontz is President and Founder of Advanced MotorTech LLC, a computer-aided engineering (CAE) services company with emphasis on electric machine and magnetic component design. He holds BS & MS degrees in Electrical Engineering from the University of Illinois, Champaign-Urbana, and a PhD in Electrical Engineering from the University of Wisconsin-Madison. Dr. Klontz is a world-recognized expert in electric machine design and has over 35 years hands-on experience with electric machine design engineering, from concept to performance to failure analysis. He has been involved in the research, development and testing of very high performance machines from 10 Watts to 8 MW, with speeds ranging from angle positioning torque-motors to 60,000 rpm machines. Recent work includes implementing CAE tools and developing design techniques for the design of alternators and motors for high efficiency, high power density and cost effectiveness.

Course Schedule

Day 1: Monday, Mar 1

7:30-8:00 Registration

8:15 Session Begins
Introductions

Overview of Switched
Reluctance Motors & Drives

- The generalized SR machine
- SR Performance
- Key construction factors
- SR Drives & Control

Principles of SR Motor
Operation

- Torque vs. Speed, Position
- Current Waveform
- Energy flow analysis, losses
- SR Motor Physics
- Inductance considerations
- SR vs. Stepper

SR Motor Topologies

- Rotor/Stator Poles & phases
- 2, 3, 4+ phases
- Saliency, tooth shapes
- Air gap effect, practical size

SR Motor/Generator Operation

- Drive System Torque control
- How to get generation
- Acoustic noise issues

SR Motor Construction &
Considerations

- Practical windings
- Practical stator & rotor cores
- Other configurations, geometries
- Frame, noise

SR Motor Sizing & Application

- Principles of scaling laws
- General scale factors, sensitivity
- Practical limits to scaling
- High Speed or High Torque
- Traction System Example

4:45 Session Ends

Day 2: Tuesday, Mar 2

8:15 Session Begins

Relationship between SR Motor
Performance & Commutation

- SR commutation: what to expect
- Drive topology choices & current control
- Getting high torque ripple
- High phase order drives

Steel Saturation and High
Speed Motor Performance

- Magnetic material data
- Losses, heat, efficiency
- High speed issues, limits
- Reference Data

Geometry Details for Better SR
Motor Performance

- Ways to get more torque
- More on low torque ripple, low noise
- Operating frequency & speed
- Leakage/magnetizing reactance, saturation effects

How to Design SR Motors

- Key trade-offs
- Achieving high power density
- Operating frequency & losses
- Application – specific design

SR Motor Design Tools

- Analytic tools
- FEA tools, Linked Analysis
- Magnetic circuit design
- Design Example

How to Interpret the Design
Data and What to Look For

- Key design data
- Figures of merit
- Performance, Simulation Limits
- Design Overview

4:45 Session Ends

Day 3: Wednesday, Mar 3

8:15 Session Begins

Full Integrated SR Motor and
System Design – Macro
Modeling and Optimization with
examples

- System design concepts
- Models & Simulation
- What to optimize, & How
- Sensor or sensorless

Full Integrated SR Motor and
System Design – FEA and
Simulink with examples

- System design with FEA
- Adding link to simulink
- How to Design productively

Interactive Design Examples,
Application Experience and
Discussion of Results

- Design examples
- Experience, Lessons Learned
- Discussion

Interactive Q&A with
Discussion of Application
Examples from Attendees

11:45 Adjourn

(Note: contents are still evolving, more material will be added, some material may be removed)

Future Courses:

To receive brochures on upcoming courses, please tell us your interests:

- IPM/BLDC Machines Design
- Selection & Operation of Electric Motors for Energy Conservation
- Design of Magnetic Components for Power Electronic Circuits
- Traction Motor Design and Drives
- Focused motor type or issue:

Other _____



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General Information

Fee Includes: Workbook, program materials, break refreshments, and certificate.

Cancellation: Notify us at least seven days before the course starts for 100% refund. Cancellations received later than seven days before the course are subject to a 15% late cancellation fee. Cancellations made after the course starts are subject to the full course fee.

Location: Marriott, Sand Key
1201 Gulf Blvd.
Clearwater Beach, FL
Phone: 888-303-4428



Accommodations: A **reduced-rate block** of rooms has been reserved at the Marriott Sand Key Hotel for reservations made **before February 15th**. Identify yourself as a participant in this course (ask for the group name: Advanced MotorTech) to reserve a room at the reduced rate. Additional directions and information will be sent with your enrollment confirmation. Please make your own reservations.

- Yes! Please enroll me in **Course No. SRMD-0310**
'Design of Switched Reluctance Machines & Drive Application', Mar 1-3, 2010
Fee: \$1275.00 (USD only)

PAYMENT: (Deadline: must be received before start of course)

- MasterCard VISA Amex
- Cardholder Name _____
- Card No. _____
- Exp ___/___/___ Billing Zip _____ Security Code: _____
- Check enclosed (payable to Advanced MotorTech, LLC) *
- Bill my company* Purchase Order*
- * Please note payment deadline above; no exceptions; subject to approved credit.

Name _____
 Title _____
 Company _____
 Address _____
 City _____ State _____ Zip _____
 Phone () _____ email _____

To Enroll: Phone: (727) 412-8200 Fax: (727) 412-8203
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