E742 Power Electronics
Part II Applications

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Schedule & Syllabus

- 11 Feb - 14 Mar 2005, 5 weeks
- Monday - 15.00 - 16.00, GS302
- Friday - 15.00 - 17.00, Roberts Building 508

- Lecture 1: Applications & Devices overview
- Lecture 2 – 5: Converters (Ideal operation)
- Lecture 6: Converters (Overlap)
- Lecture 7: Converters (Inverting mode)
- Lecture 8: Converters (Design aspects)
- Lecture 9: Commutation circuits
- Lecture 10: DC Choppers
- Lecture 11: Inverters
- Lecture 12: Driver Circuits
- Lecture 13: DC Motor Control and Traction
- Lecture 14: Switched mode power supplies

Recommended Texts

- Power Electronics – D.A. Bradley CRC Press 2nd Ed 1995
- Power Electronics, Circuits, Devices, and Applications – Muhammad H. Rashid, Pearson Prentice Hall, 3rd Ed. 2004

- Rapid development of power semiconductor devices, such as
  - Thyristor
  - High power bipolar transistors,
  - High power Metal Oxide Semiconductor (MOS)

,led to significant improvement in,

  - Speed
  - Power capability
  - Efficiency

- Hence increase the range of applications
  - AC motor control
  - Servo and control
  - High power DC transmission
  - Sophisticated power supplies (switching-mode, uninterruptible)

Devices for Power Electronics

- Thyristor
- Gate turn-off (GTO) thyristor
- Power bipolar transistor
- Power Metal Oxide Semiconductor Field Effect Transistor (MOSFET)
- Insulated Gate Bipolar Transistor (IGBT)

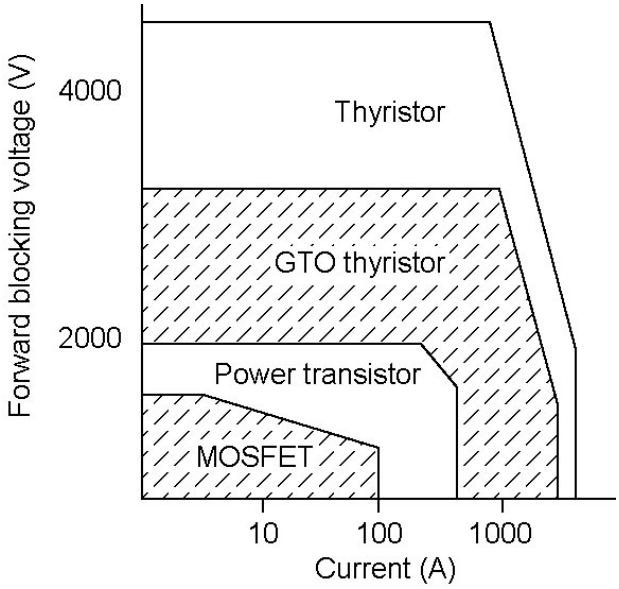

Figure 1 Comparisons of power electronics devices

Performance Comparisons

Performance parameter	Thyristor	GTO thyristor	BJT	Power MOSFET	IGBT
Switching speed	**	****	****	*****	*****
Switching loss	**	**	***	*****	*****
On-state loss	**	**	****	**	***
Ease of turn-on	*****	***	***	****	****
Ease of turn-off	*	**	**	****	****
Current rating	*****	****	***	**	**
Voltage rating	*****	***	****	***	***
Surge current	*****	****	***	***	***

Table 1 Comparisons power electronics devices performance ***** Best * Worst

Note: Difference in power handling capacity

- mega Watts for thyristors
- kilo Watts for MOSFETs

Control of Power Electronics Devices

- Control in power electronics
  - Variation of the device switching sequences
- Microprocessor and microelectronics technologies
  - Expansion of the control function
  - Enhanced performance of the controlled element

e.g.

- Shaping of motor characteristics
- AC and DC servomotor control
- Pulse width modulated inverter drives
- Optimisation of system operation at all times and under all conditions
- Improved efficiencies

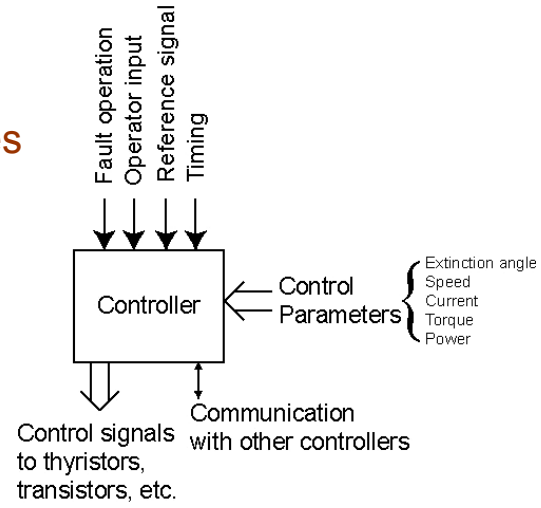

Fig 2 Typical control system employing power semiconducto

Distributed and Embedded Control Processing

- Co-ordination of operation of a number of discrete systems.

  e.g.
  - Control of speed of a series of drives, such as paper mill or steel strip mill
- The acceleration and deceleration profiles of a number of drives can be co-ordinated across the entire process

Future Development

- Advanced control strategies
- Fuzzy logic
- Neural networks at both the device and system level
- Self-learning and self-turning (adaptivity)
- Systems can be based on
  - Microprocessors or microcontrollers
  - Applications specific integrated circuits (ASICs) to maximise individual performance capabilities