Features of Power Electronic System

1. Function and Form
   - **Energy Processing**: altering the character of electrical energy
   - **Interfacing**: imposing relationship of voltages and currents at one port to the other
     - Interacting with the external systems:
       - bidirectional energy flow
       - external determines the internal function
   - **Form**: generically referred as *converters*, *power processors* (ac/dc, ac/dc, dc/dc)

2. Components
   - **Switches**: power diode (PN; Shottkey), power transistor (BJT; MOSFET), thyristor (SCR; TRIAC; MCT; GTO)
   - **Energy Storage Elements**: capacitor, inductor

3. Dynamics and Control
Power Diode 1

- Bipolar PN Junction

http://www.nobel.se/physics/educational/transistor/function/index.html
Power Diode 2

- **Shottky Diode**

**Advantages:**
1. Short Reverse Recovery Time  
   --- High speed rectifier
2. Low Voltage Drop in Forward Bias  
   --- High speed TTL IC 74S00 (ECL)  
   --- Low power TTL IC 74LS00 (TTL)

**Reason for fast speed:**
CHARGE STORAGE in PN diode due  
To slow holes to get homes  
No P-materials reduces charge storage
Power Diode 3

- **Diode Bridge**

  - Half wave rectification
  - Full wave rectification

- **Tunnel Diode**
  Heavily doped, negative resistance over forward bias range, so nice for high frequency oscillator

- **Varicap Diode**
  PN junction cap decreases when reverse biasing voltage increases
  For variable cap to eliminate the need of moving part 60pF/0v → 6pF/20v

- **Zener Diode**
  Narrow junction, Zener breakdown, large change of current causes no change of voltage, voltage regulator

- **LED**
  III-V semiconductor, emitting photon when electron passes junction
Power Transistor 1

- Bipolar Junction Transistor (BJT)

[Diagram of BJT]

http://jas.eng.buffalo.edu/education/fab/BjtFet/

**Advantage:** High current density, medium to high Voltage operation. Low forward voltage drop.

**Disadvantage:** Complex base control, not fast switching
Power Transistor 2

- Metal-Oxide-Semiconductor Field Effect Transistor (MOSFET)

**Advantage:** Simple gate control
Excellent fast switching

**Disadvantage:** Low to medium Voltage(<200V, bulk resistance)
Low current conduction capability
Power Transistor 3

- Insulated Gate Bipolar Transistor (IGBT)

Combine the advantages of MOSFET and BJT.
Gate structure like MOS
Output structure like BJT
High voltage 300-1700V

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Power Transistor 4

- Junction Field Effect Transistor (JFET)

**Advantage:**
1. Fast Speed
2. Low Noise
Power Transistor 5

- Darlington Transistor (Super Alfa Pair)

High Current Gain: $\beta = \beta_1 \times \beta_2$
Thyristor 1

- **Four Layer Diode (Triode)**

  ![Four Layer Diode Diagram]

  **Application:**
  1. Sawtooth waveform generator trigger pulse generator;
  2. Protection circuit

- **Silicon Controlled Rectifier (SCR)**

  ![Silicon Controlled Rectifier Diagram]

- **Silicon Controlled Switch (SCS)**

  ![Silicon Controlled Switch Diagram]

  **Advantages:**
  1. Guarantee proper firing voltage dV/dt
  2. Actively turn off without reducing v or i
Thyristor 2

- Diode AC Switch (DIAC)

- Triode AC Switch (TRIAC)

Characteristic parameters:
1. Breakover voltage
2. Breakback voltage
3. Voltage symmetry
4. Rating current
5. Power dissipation

Advantages:
1. Controllable trigger
2. Four quadrant device

Application:
1. Light dimmer control
2. Motor speed control

Reason:
Trigger pulse can control Any percentage of half cycle
The Relay uses electromagnetic coil to move the poles of the switch when powered. The center terminal block is the **common** connection (CO). When not switched, CO is connect to **normal close** (NC); when switched, CO is connected to **normal open** (NO).

Driving voltage: 12V  
Max Resistance voltage (AC): 240V  
Permissible current limit (AC): 5A  

**Using Low voltage to switch high voltage**
Power Supply

- DC High Current Power Supply
  Test Equipment
  
  Output voltage: 0– 64V  
  Output current: 0– 10A  
  $/W: $2

- Portable Power Supply
  
  Output Power: 75—100W  
  Output Current: 0—25A  
  $/W: $1.6-$2
Power Supply

- DC High Voltage Power Supply

EMCO 4000 series

Programmable Output voltage: 0 – 33kV
Output Power: 10W
$/Power: ?

Click on a symbol at a given voltage and current to access the corresponding data sheet.
Power Supply

• AC Power Supply

Output Power: 1000VA
Output Voltage: 0—110V
Output Current: 0—11A