POWER ELECTRONIC 1

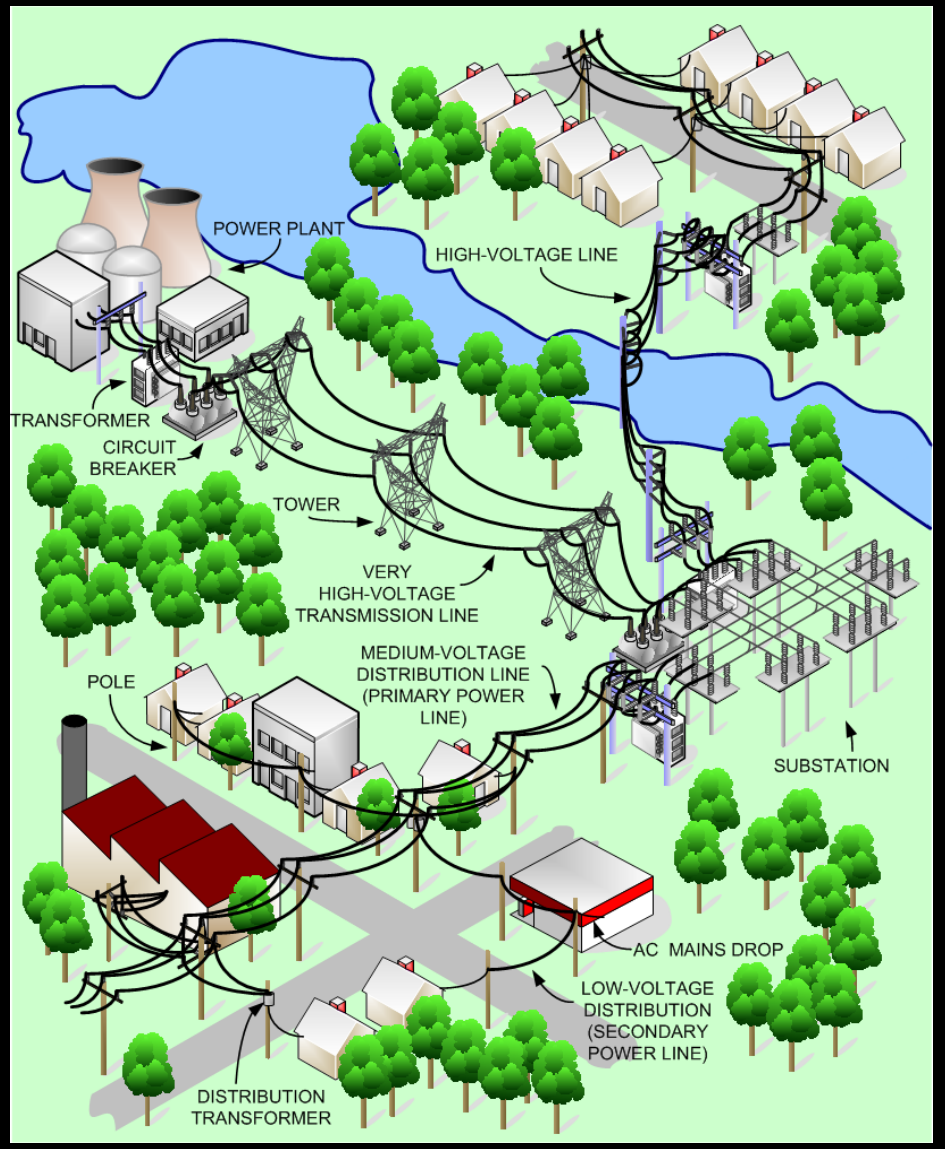
2022, Istanbul

Energy, The Basis of Power Elecronic

1. Energy Security and the Related Scenarios

Need to reduce dependence on fossil fuel based coal, natural gas, oil, and nuclear power resource Depletion of these sources is expected.

Renewable energy resources: Solar, Wind, Waste fuel-cell, ocean-wave



2. Environment issues

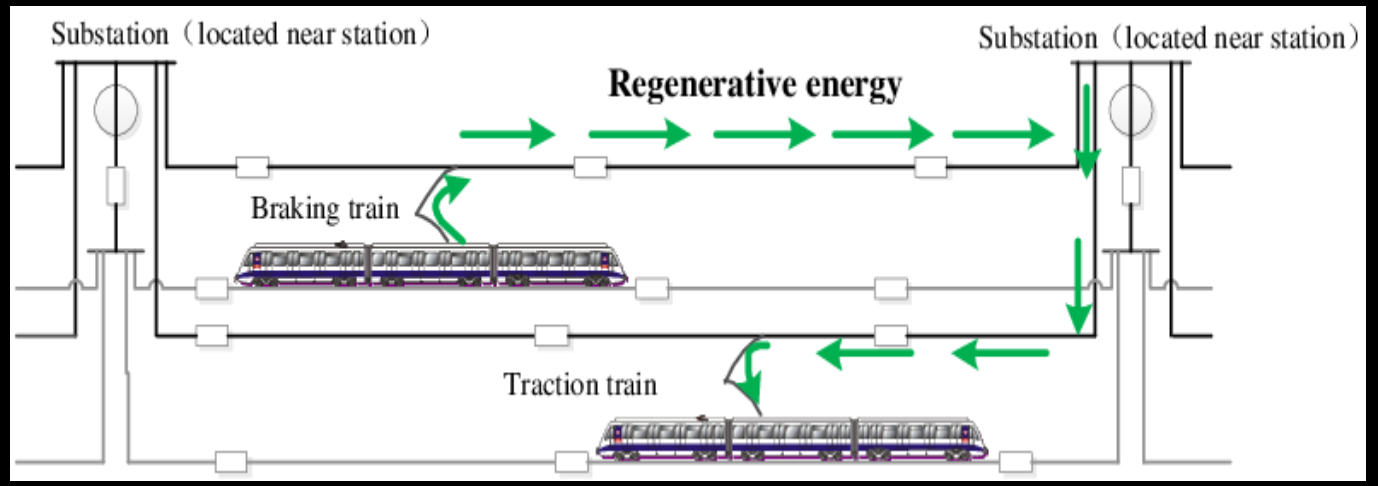
Burning of fossil fuel emits gases such as CO_2, CO (oil burning), SO_2, NO_X (coal burning) etc. Creates global warming (green house effect), acid rain and urban pollution from smokes.

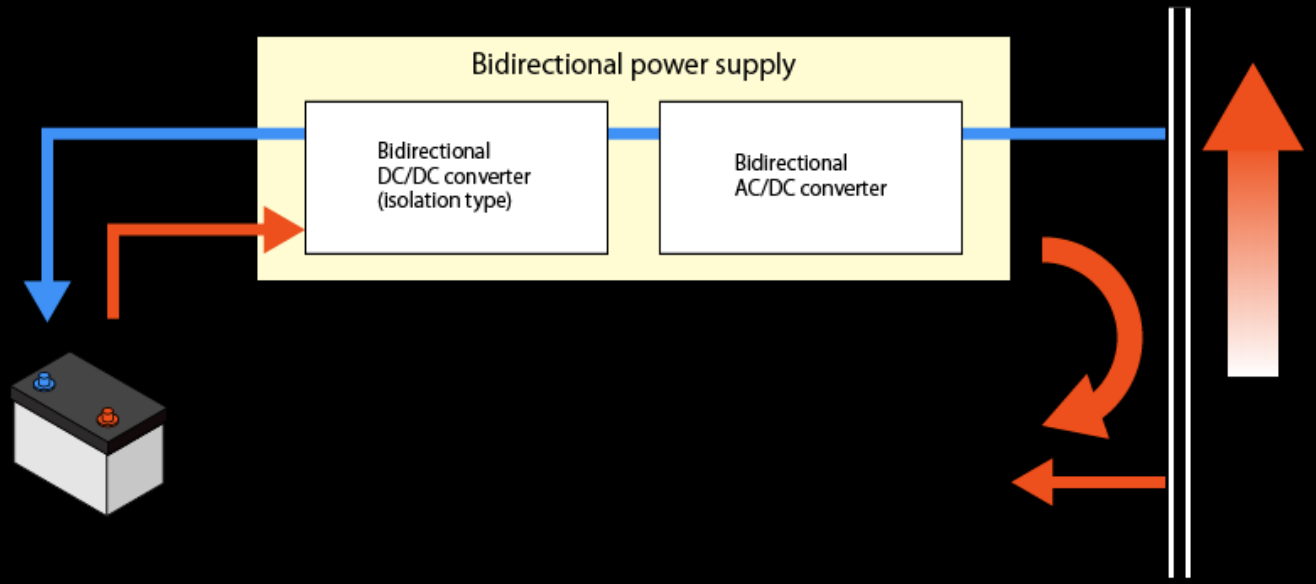
Nuclear safety.

Energy saving by Power Electronic (PE) applications.

3. Energy Saving

- Variable speed compressor air-conditioning system: 30% savings compared to thermostat-controlled system.
- Lighting using electronics ballast boost efficiency of fluorescent lamp by 20%.
- 30 % at least, regenerative energy storage for traction applications
- …….

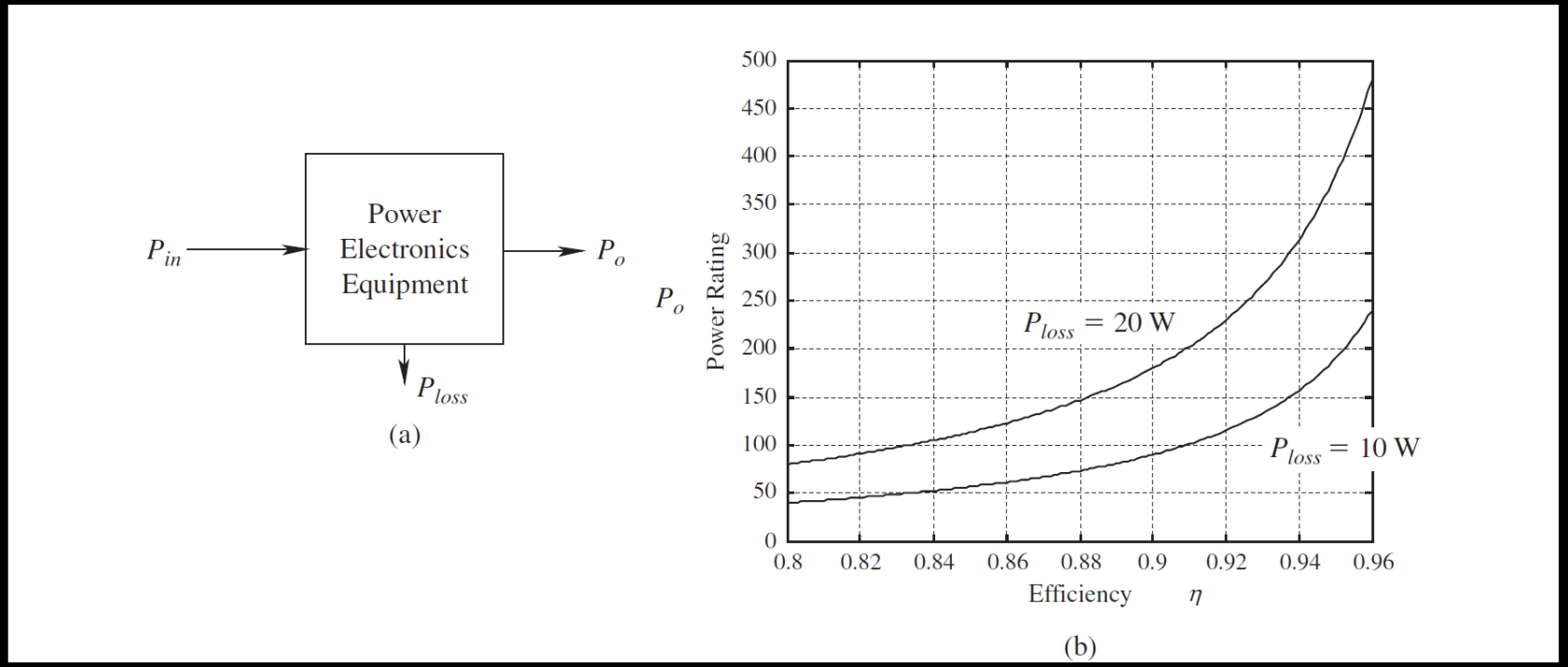




Efficiency for Itself

$$\eta = \frac{P_o}{P_o + P_{loss}}$$

$$P_o = \frac{\eta}{1 - \eta} P_{loss}$$



P_0 = Output Power

P_{loss} = Power Loss within the system

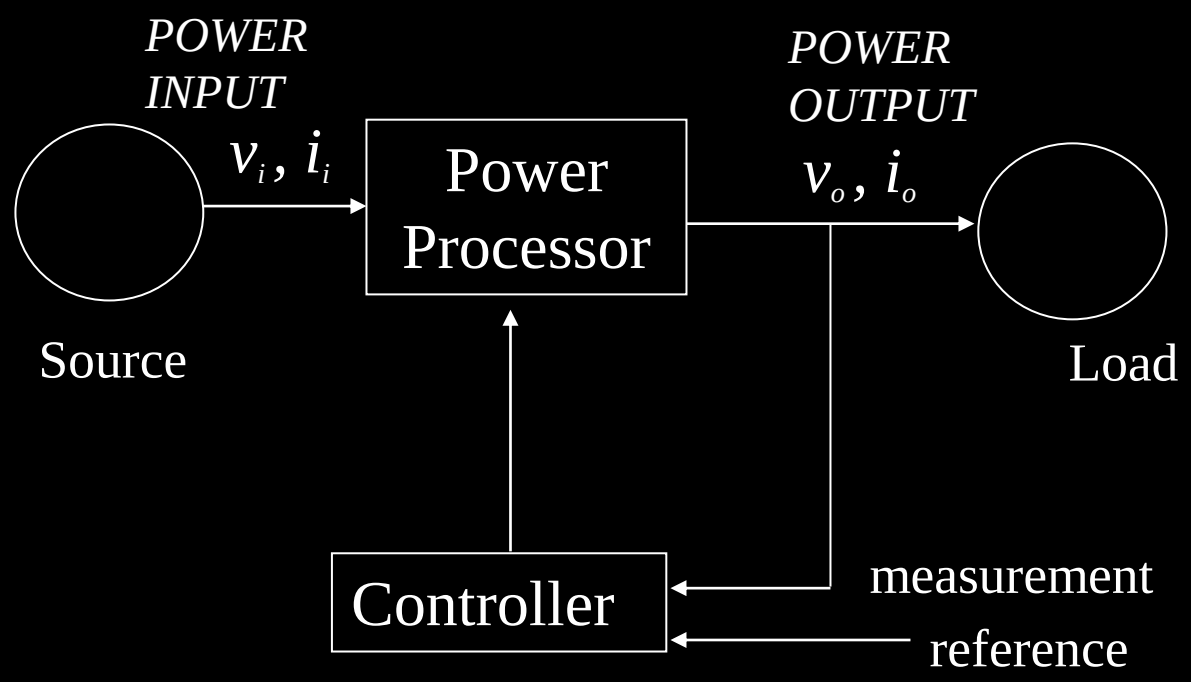
End User Demands

- The capabilities and flexibility of modern electronics?
- It is essential to consider how electronic circuits and systems can be applied to the challenges of energy conversion and management.
- This is the framework of *power electronics*

The Definition of Power Electronic?

The Definition of Power Elecronic

To convert, *process* and *control* the flow of electric power by supplying voltages and currents in a form that is optimally suited for *user loads*.



- Switches, Lossless storage elements (L, C),
- Protection Circuits,
- Control Circuits,
- Different Topologies
- Frequency: 50 Hz, 60 Hz……kHz
- Single Phase, Three Phase

PE is an interdisciplinary field

Digital/analogue electronics

Power and energy

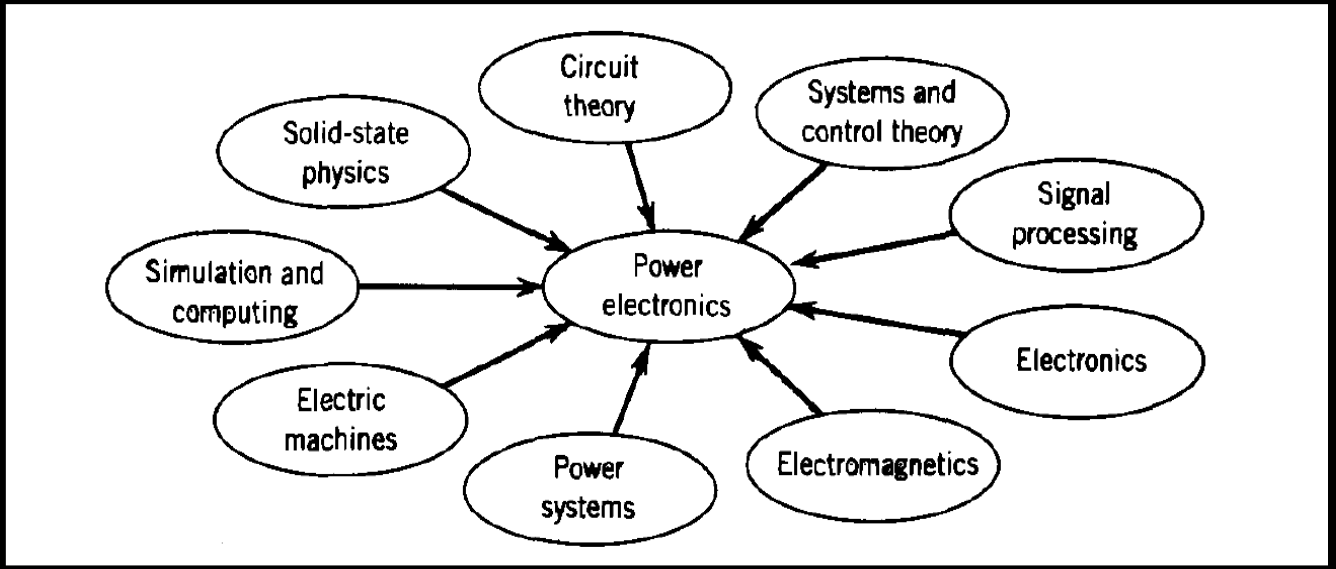
Microelectronics

Control system

Computer, simulation and software

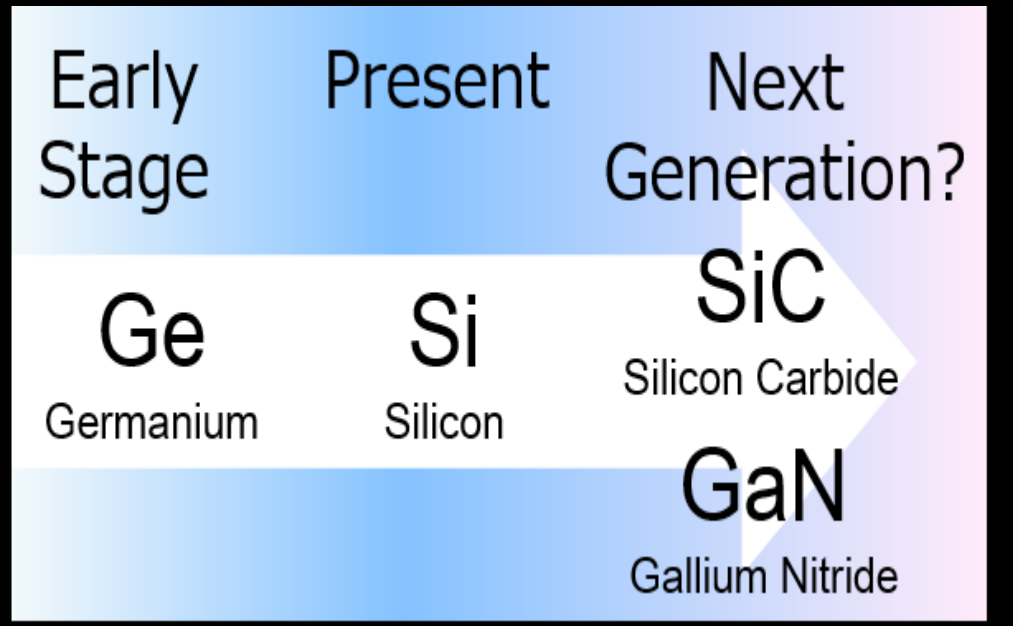
Solid-state physics and devices

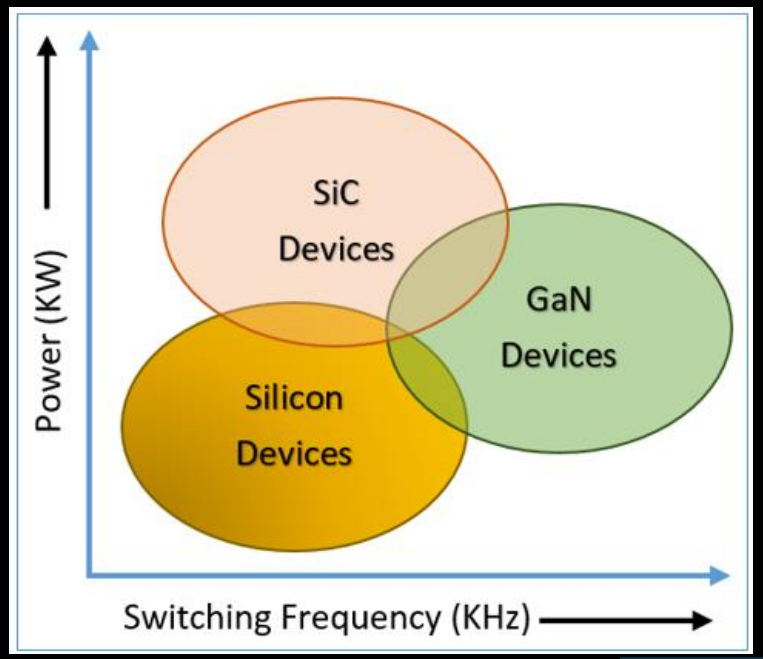
Heat transfer

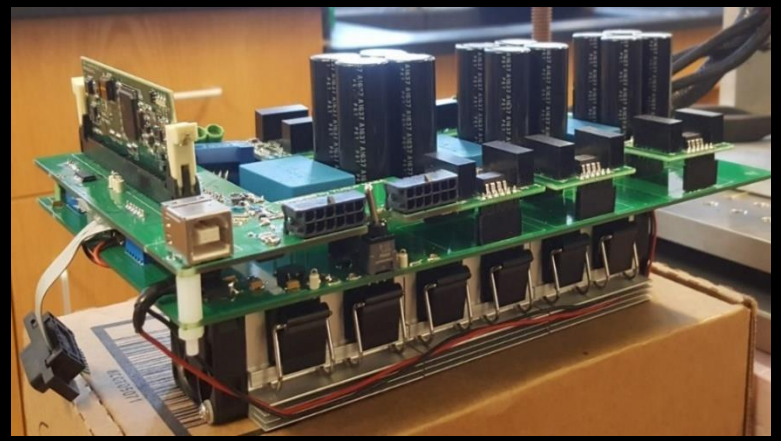


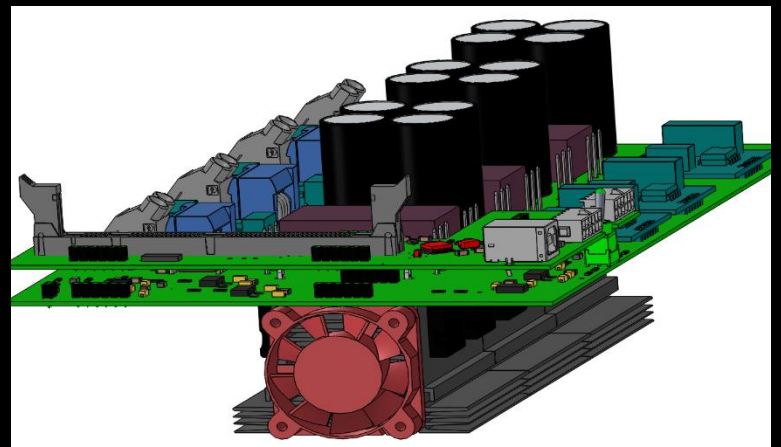
Rapid Growth

Advances in power (semiconductor) switches









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Acoustic Noise Mitigation of Switched Reluctance Machines with Leaf Springs

Publisher: IEEE | Cite This | PDF

Yusuf Yasa ; Yilmaz Sozer ; Muhammed Garip All Authors

132 Full Text Views

Abstract | Authors

Abstract:
In this study, a leaf spring insertion to the stator back iron is proposed to reduce

Rapid Growth

New ideas in control algorithms

Voltage Mode Control

Current Mode Control

PID Control

Sliding Mode Control

Fuzzy Logic Control

Artificial Neural Network

Model Predictive Control

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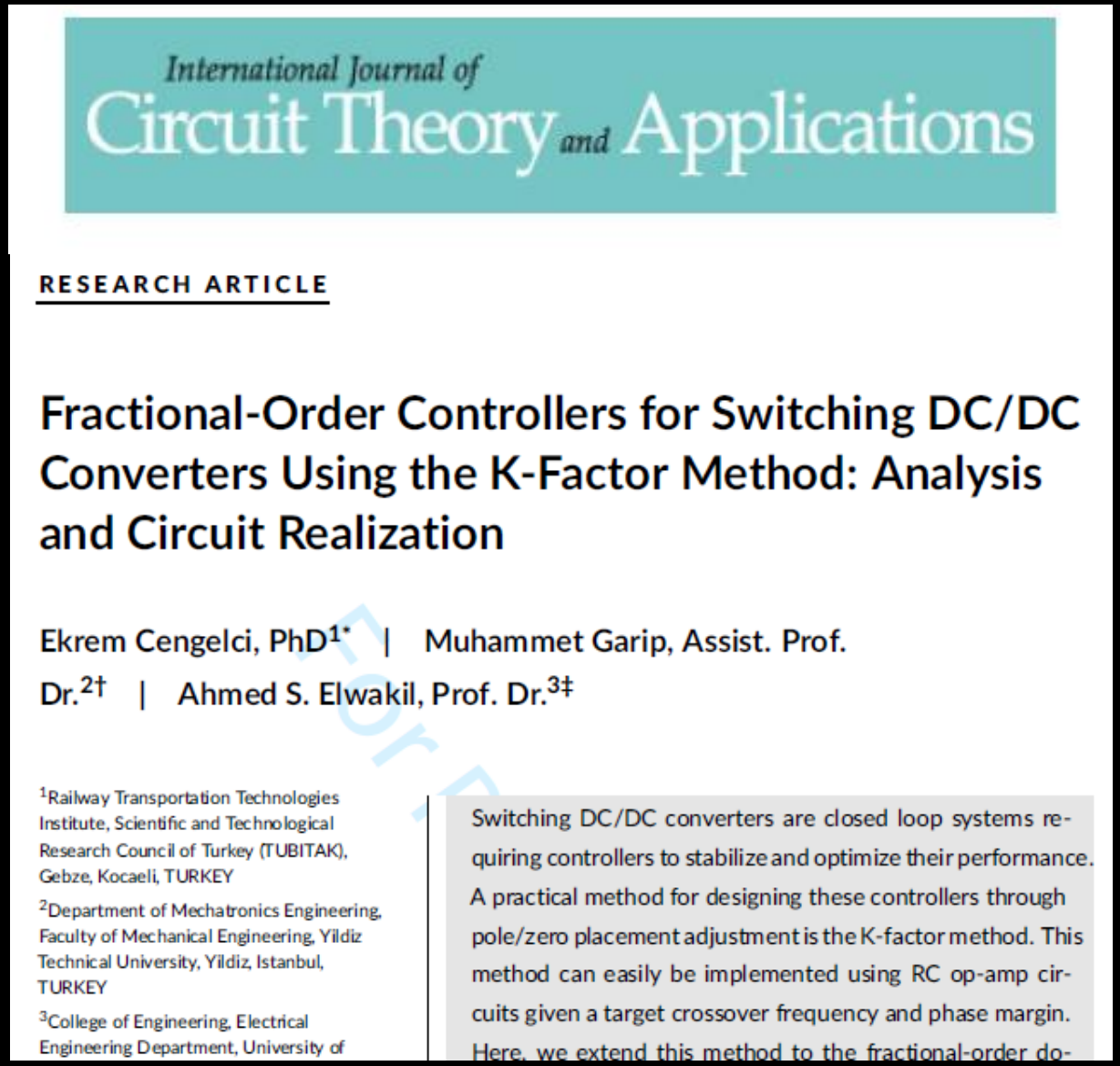

International Journal of Circuit Theory and Applications

RESEARCH ARTICLE

Fractional-Order Controllers for Switching DC/DC Converters Using the K-Factor Method: Analysis and Circuit Realization

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Switching DC/DC converters are closed loop systems requiring controllers to stabilize and optimize their performance. A practical method for designing these controllers through pole/zero placement adjustment is the K-factor method. This method can easily be implemented using RC op-amp circuits given a target crossover frequency and phase margin. Here, we extend this method to the fractional-order do-

Rapid Growth

- Advances in microelectronics (DSP, VLSI, Microprocessor/microcontroller, ASIC)

- Demands for new applications

  - Consumer Electronics
  - Automotive
  - IT & Telecommunication
  - Energy & Power
  - Industrial
  - Military & Aerospace

The Application Areas for Power Electronic

- Dynamic:
  - Variable speed drives in industries
  - Wind generation
  - Electric and hybrid electric cars (and other transportation applications)

- Stationary:
  - UPS
  - Energy storage integration
  - Information and communication technologies
  - Power plants
  - Power supplies
  - Solar power
  - Micro-grids
  -
  -
  -

(a) *Residential*
- Refrigeration and freezers
- Space heating
- Air conditioning
- Cooking
- Lighting
- Electronics (personal computers, other entertainment equipment)

(b) *Commercial*
- Heating, ventilating, and air conditioning
- Central refrigeration
- Lighting
- Computers and office equipment
- Uninterruptible power supplies (UPSs)
- Elevators

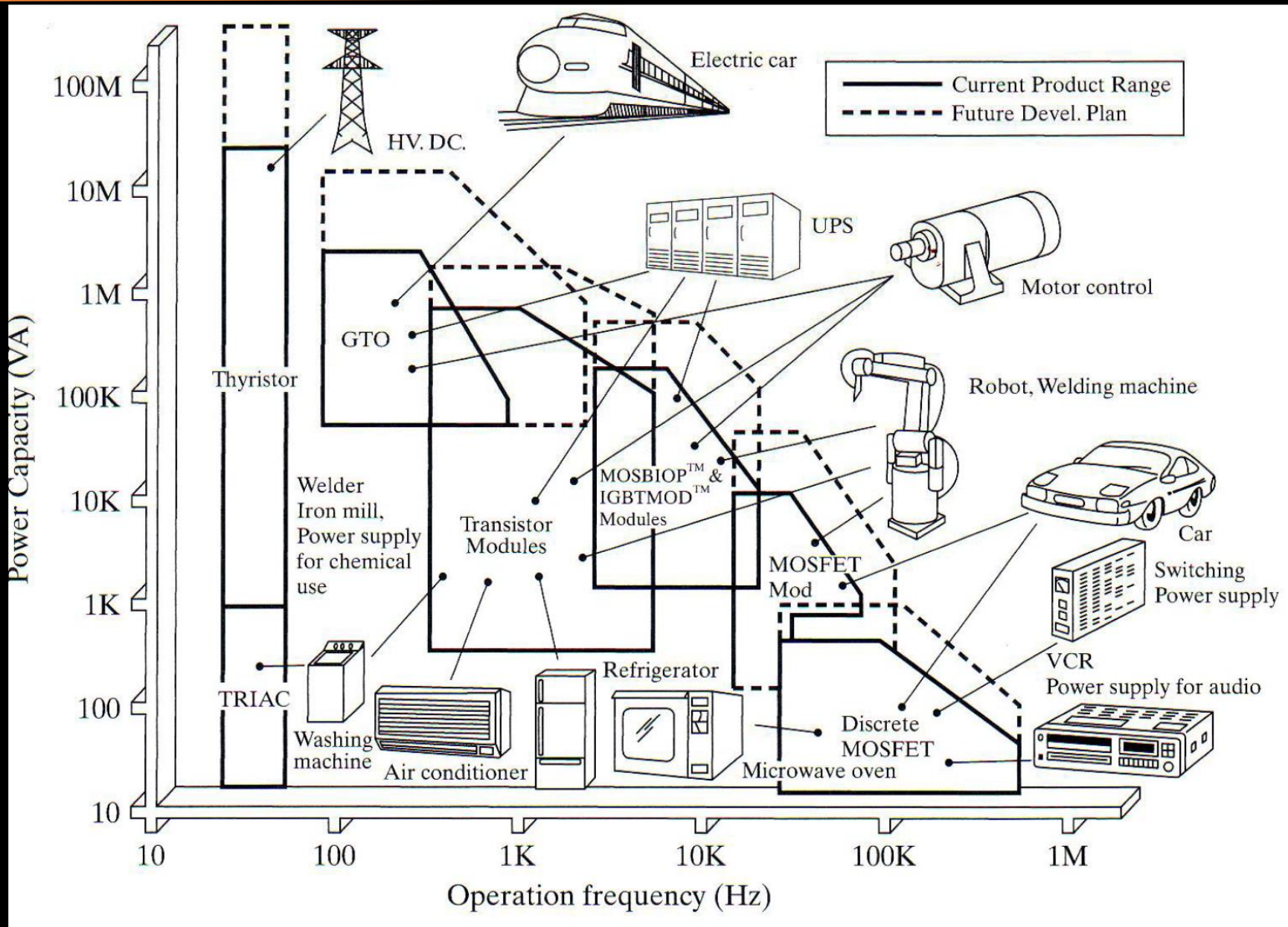
(c) *Industrial*
- Pumps
- Compressors
- Blowers and fans
- Machine tools (robots)
- Arc furnaces, induction furnaces
- Lighting
- Industrial lasers
- Induction heating
- Welding

(d) *Transportation*
- Traction control of electric vehicles
- Battery chargers for electric vehicles
- Electric locomotives
- Street cars, trolley buses
- Subways
- Automotive electronics including engine controls

(e) *Utility systems*
- High-voltage dc transmission (HVDC)
- Static var compensation (SVC)
- Supplemental energy sources (wind, photovoltaic), fuel cells
- Energy storage systems
- Induced-draft fans and boiler feedwater pumps

(f) *Aerospace*
- Space shuttle power supply systems
- Satellite power systems
- Aircraft power systems

(g) *Telecommunications*
- Battery chargers
- Power supplies (dc and UPS)


Electric car
Current Product Range
Future Devel. Plan
HV. DC.
UPS
Motor control
GTO
Thyristor
Robot, Welding machine
MOSBIOP™ &
IGBTMOD™
Modules
Welder
Iron mill,
Power supply
for chemical
use
Transistor
Modules
Car
MOSFET
Mod
Switching
Power supply
VCR
Power supply for audio
Refrigerator
TRIAC
Washing
machine
Air conditioner
Discrete
MOSFET
Microwave oven
Power Capacity (VA)
100M
10M
1M
100K
10K
1K
100
10
10
100
1K
10K
100K
1M
Operation frequency (Hz)

Focusing on some applications

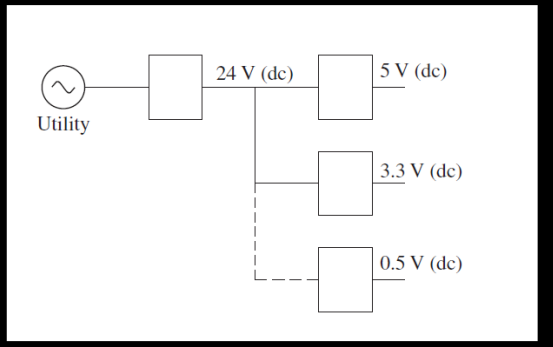
Powering the information technology

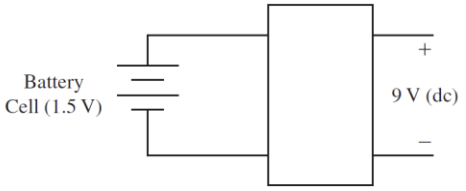
Consumer electronics, PCs and entertaintment systems

Switch mode power supplies

Distributed voltage

Lower voltage levels on board



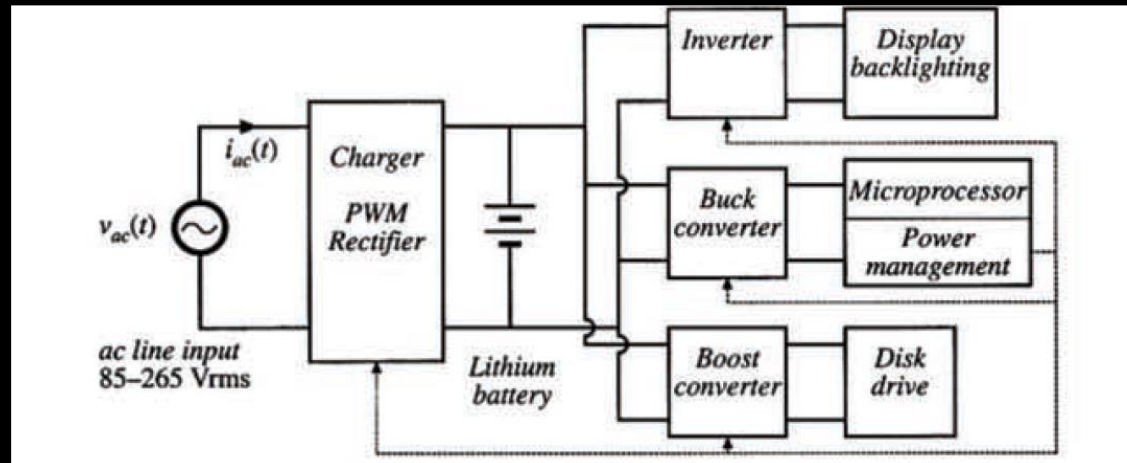


Boost dc-dc converter needed in cell operated equipment.

Supplying higher voltage to Cell Phones

Higher voltage

Boost type converter



A laptop computer power supply system.

Robotics and Flexible Production

For Industrial competitiveness

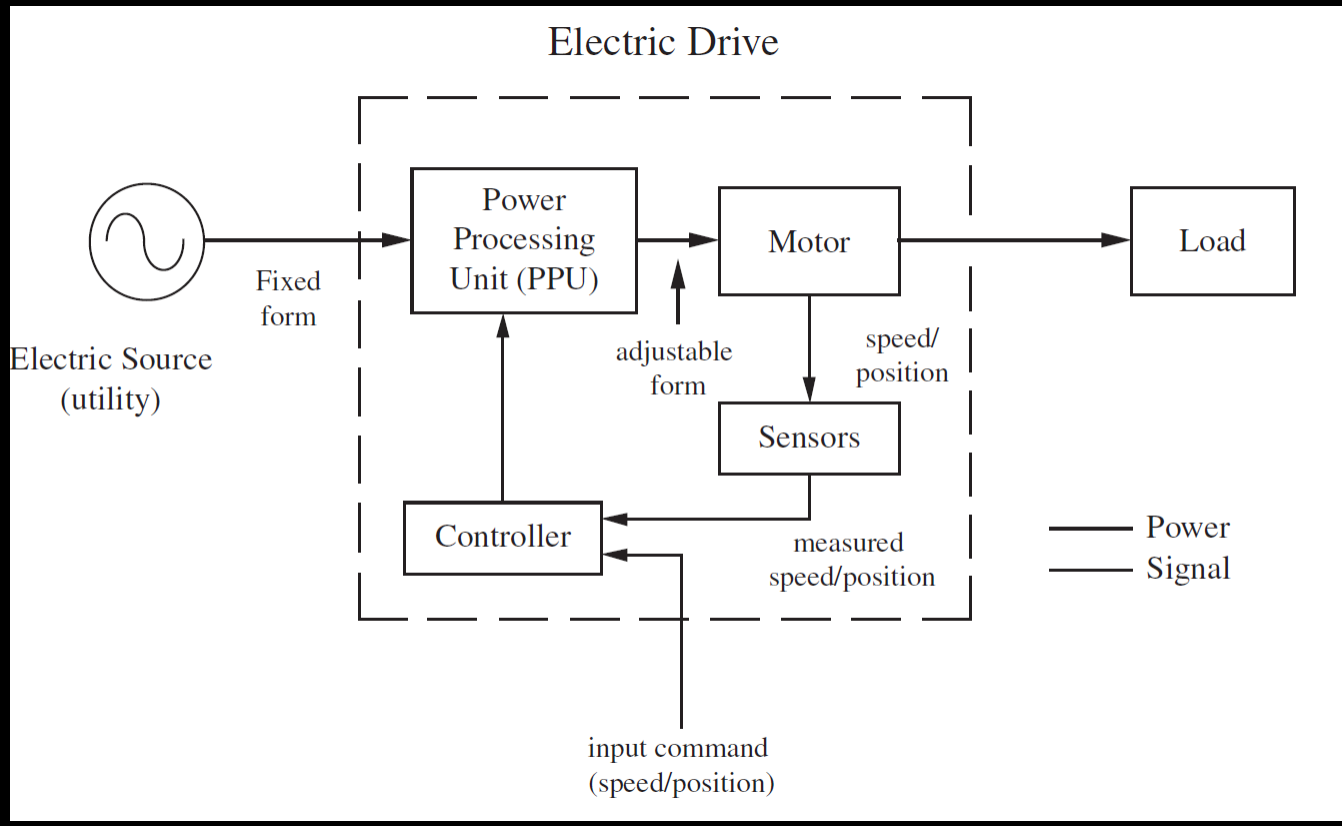
Precise speed and position controls

Required voltage for specific target

Dc adjustable magnitude

Ac adjustable amplitude and frequency

Bi-directional power flow

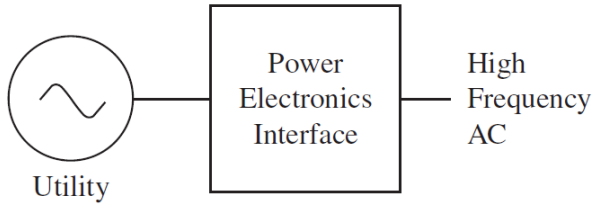


Induction Heating and Welding

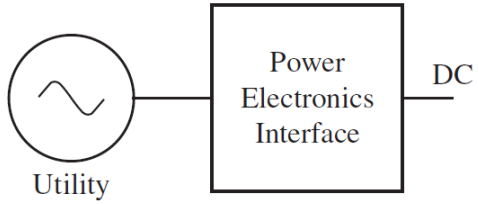
Demand of High Current

Special cooling measurements

Higher Power Capability



Power electronics interface required for induction heating.



Power electronics interface required for electric welding.

Electric-Motor Driven Systems

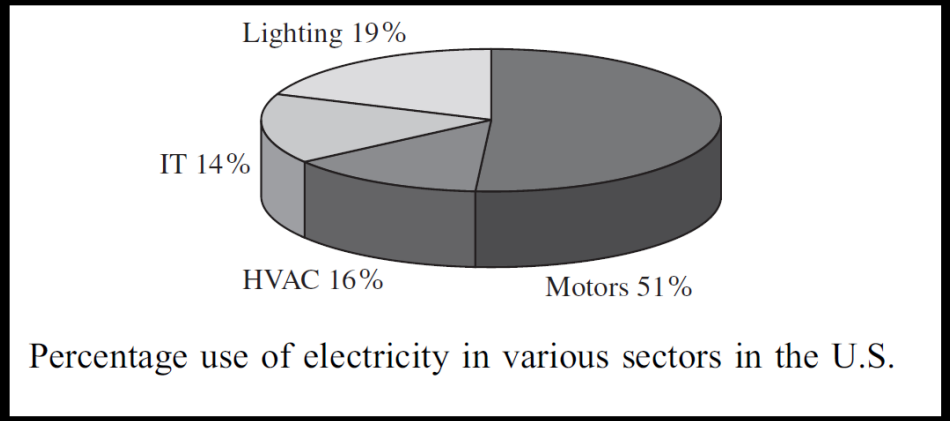
Heating, Ventilating and Air Conditioning (HVAC) systems

Motors in Industry,

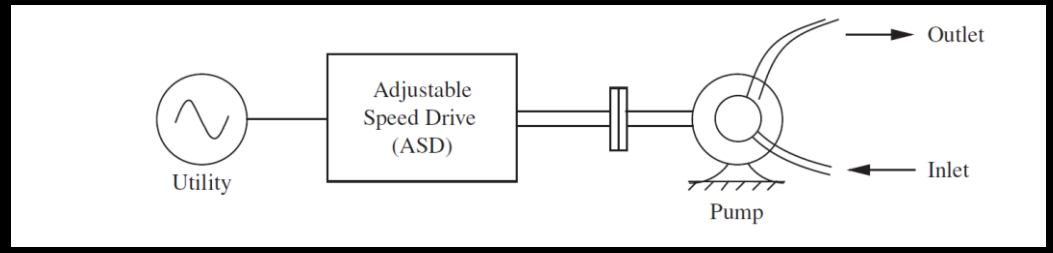
Conventional Controlling of Water pumps

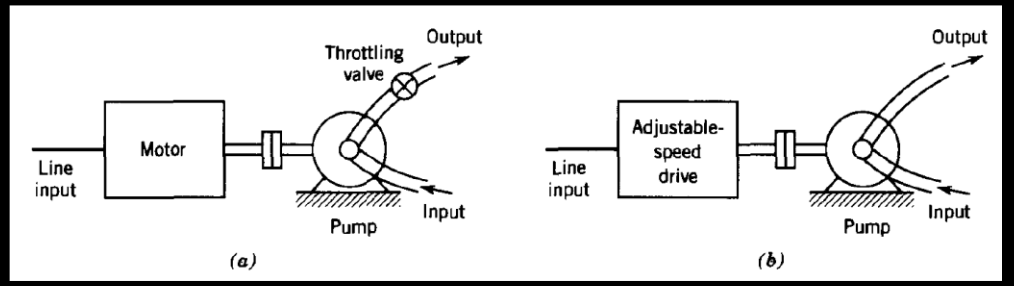
Adjustable-speed drive

%30 off consumption in heat pumps and air conditioners



Percentage use of electricity in various sectors in the U.S.



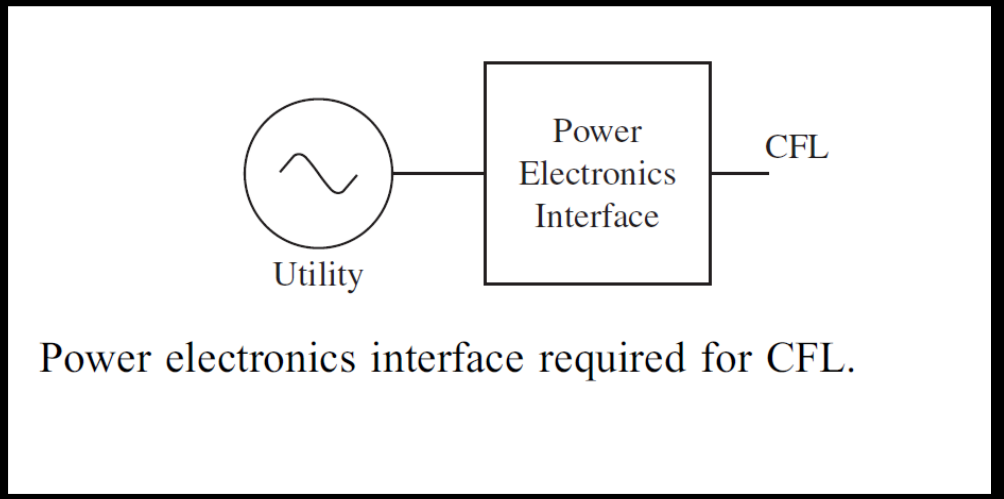


Lighting

High Frequency Electronic Ballast

Increasing Efficiency % 15 thanks to PE

LED, higher efficiency and longer lifetime



Power electronics interface required for CFL.

Transportation

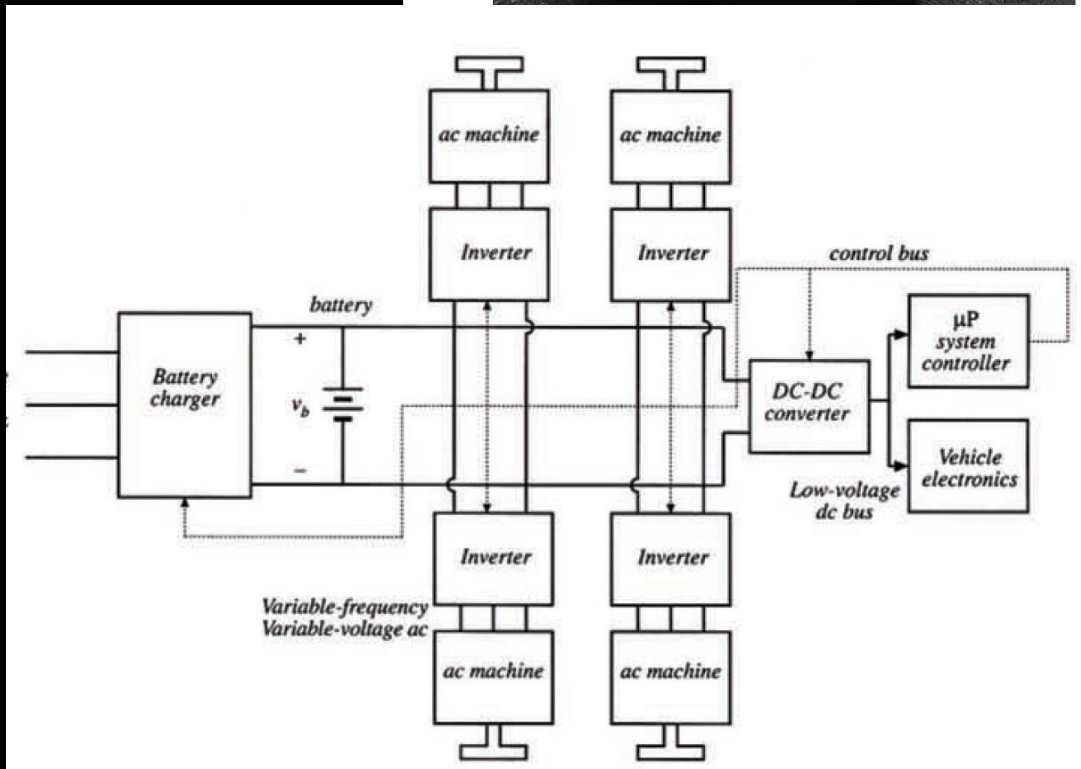
HEVs

EVs

Light-Rail

Underground, Metro systems

All-electric supplied ships



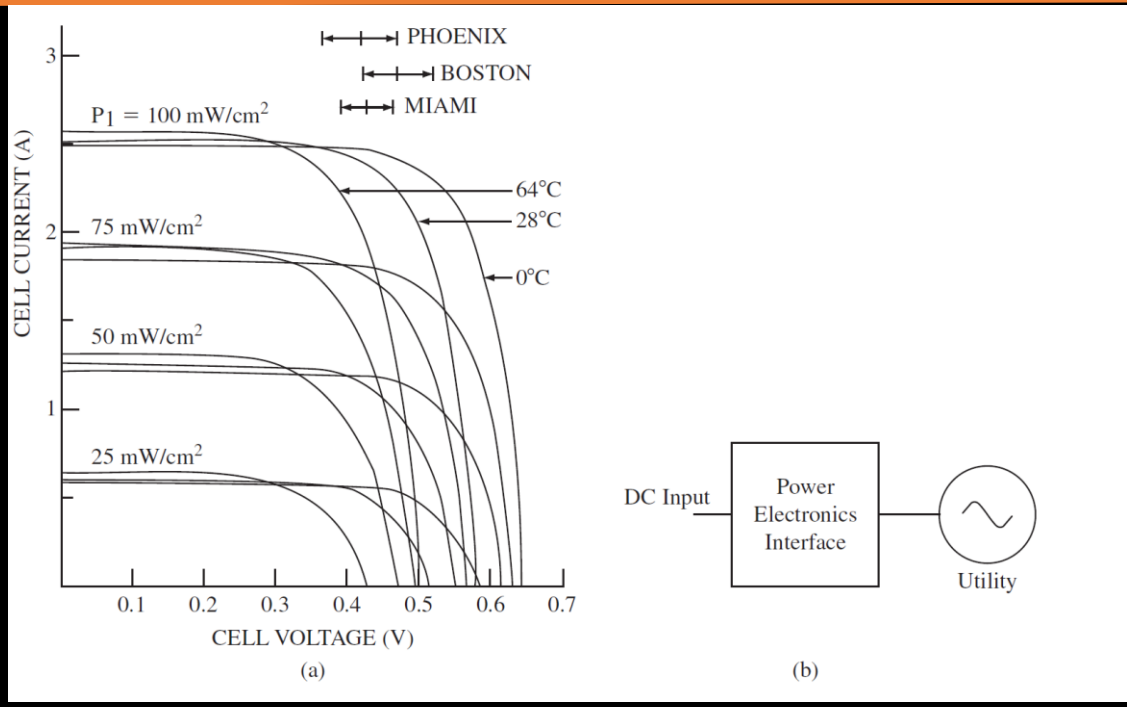
An electric vehicle power and drive system.

Renewable Energy

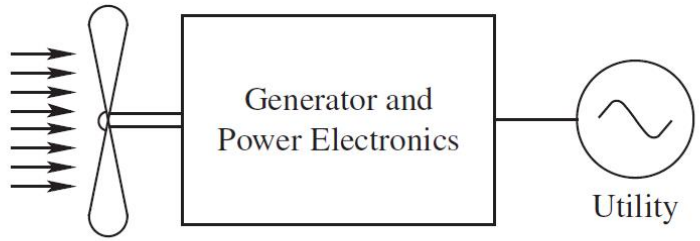
In photovoltaic systems, solar cells produce dc,

Transfer power to the utility system

Frequency sensitivity



Renewable Energy



Wind is the fastest-growing energy resource with enormous potential

Connect to utility with same frequncy and voltage

Emergency braking

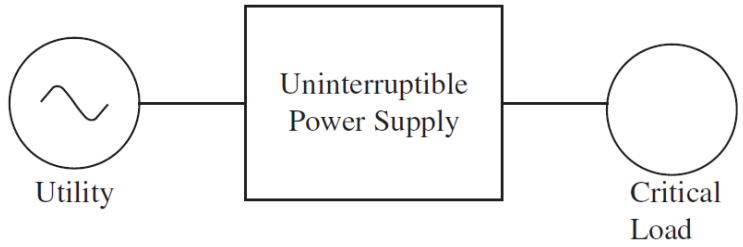
Grid Connections (Utility Applications)

Smart Grid Connections

Control the power flow on transmission lines

Security and Efficiency of Power Systems

Uninterruptible Power Supplies (UPS)

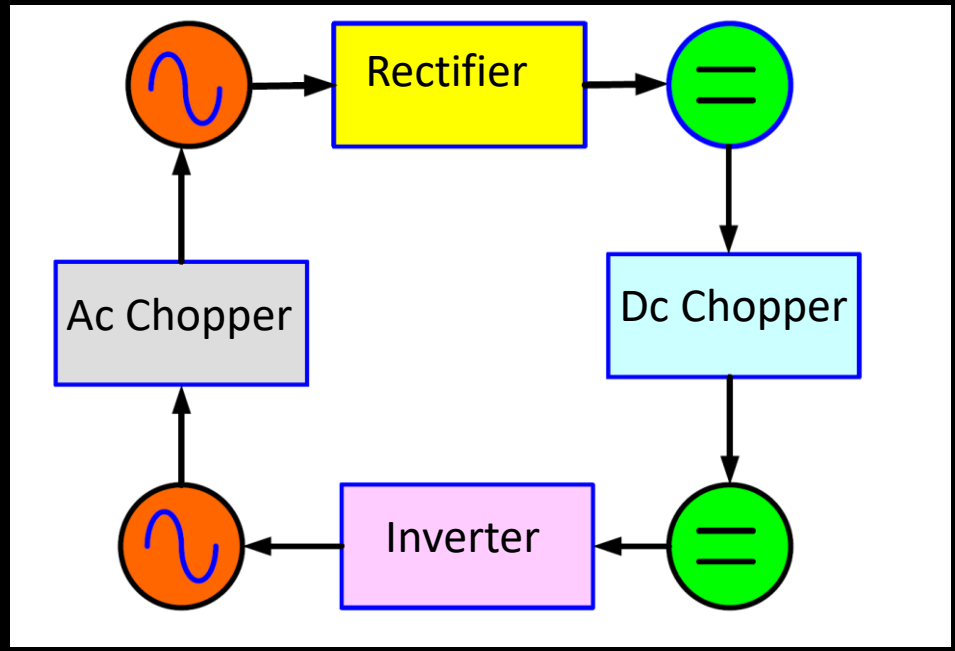


Uninterruptible power supply (UPS) system.

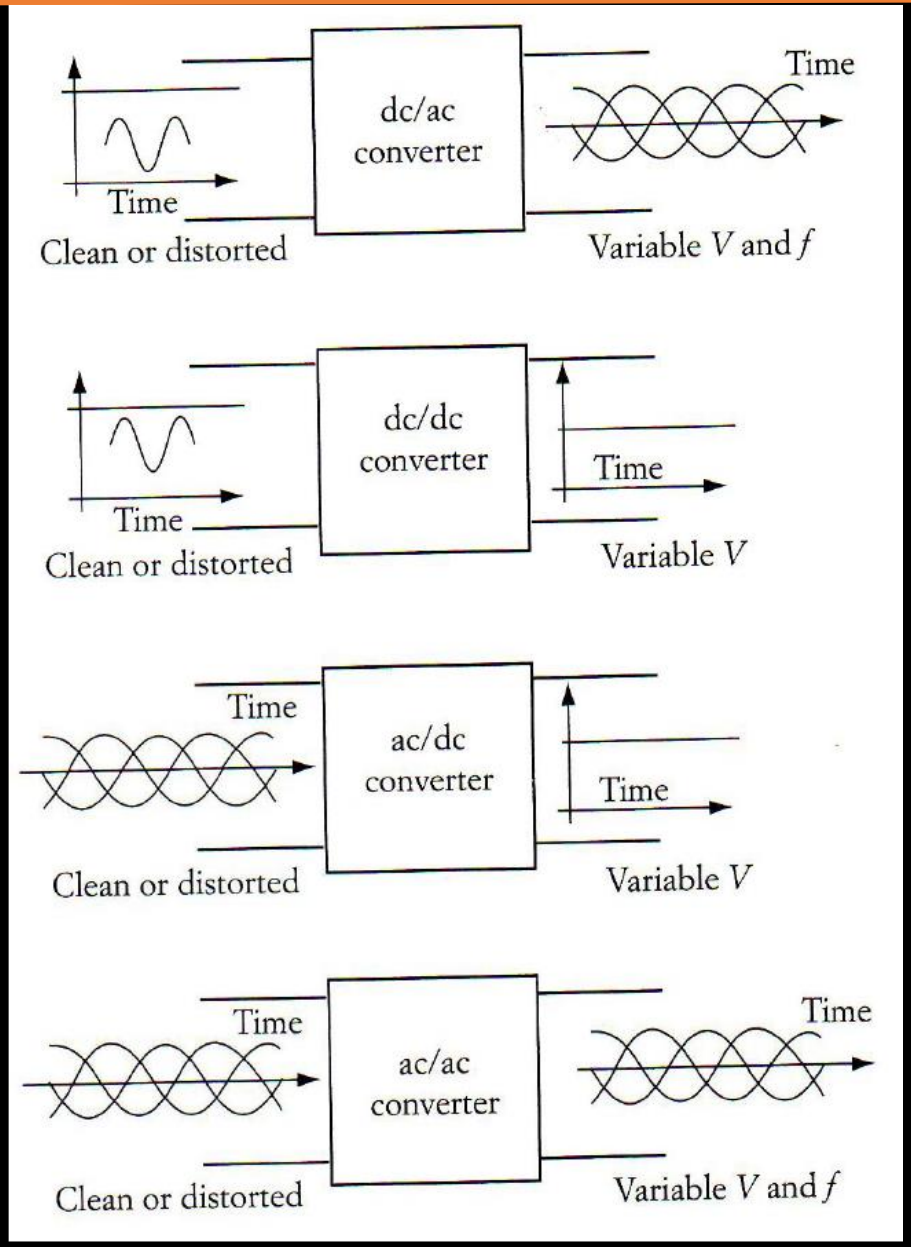
PE Classifications Based on Functions Of Converters

The Power Electronic Converter can be classified into six types:

1. **Diode Rectifier**
2. **AC to DC Converter (Controlled Rectifier)**
3. **DC to DC Converter (DC Chopper)**
4. **AC to AC Converter (AC voltage regulator)**
5. **DC to AC Converter (Inverter)**
6. **Static Switches**



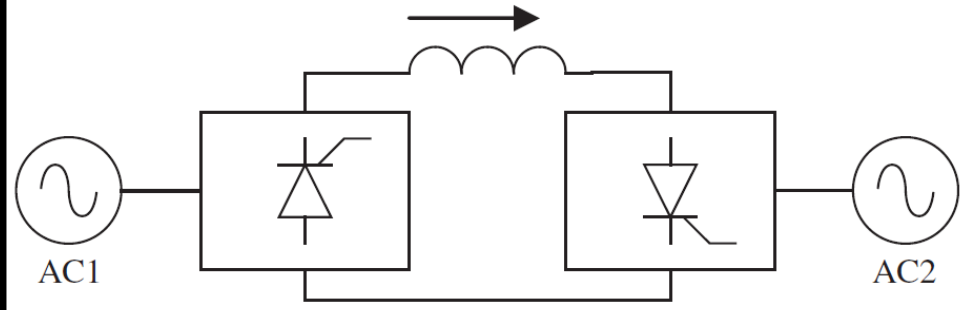
1. dc
   (a) regulated (constant) magnitude
   (b) adjustable magnitude
2. ac
   (a) constant frequency, adjustable magnitude
   (b) adjustable frequency and adjustable magnitude



Based on Connection Types

Current-Source (current-link, current-fed) Converters

- Thyristors can block voltages of both polarities but conduct current only in the forward direction.
- The transfer of power can be reversed in direction by reversing the voltage polarity
- At extremely high power levels, usually in utility-related applications

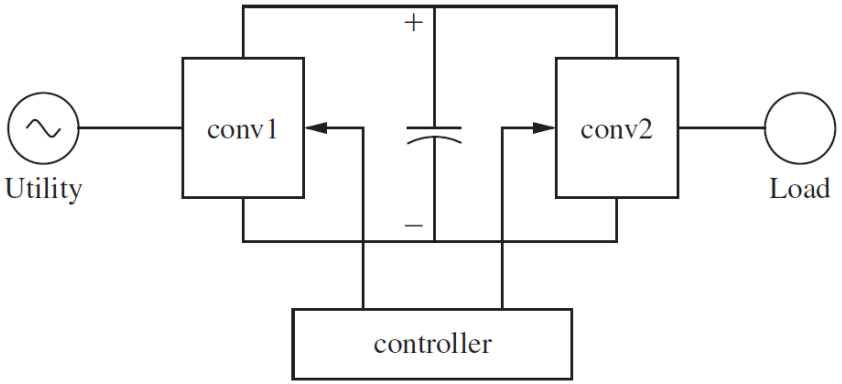


Current-link structure of power electronics interface.

Based on Connection Types

Voltage-Source (voltage-link, voltage-fed) Converters

- The semiconductor devices such as transistors of various types and diodes can only block forward-polarity voltages.
- These devices with only unipolar voltage-blocking capability have led to the structure with two converters.

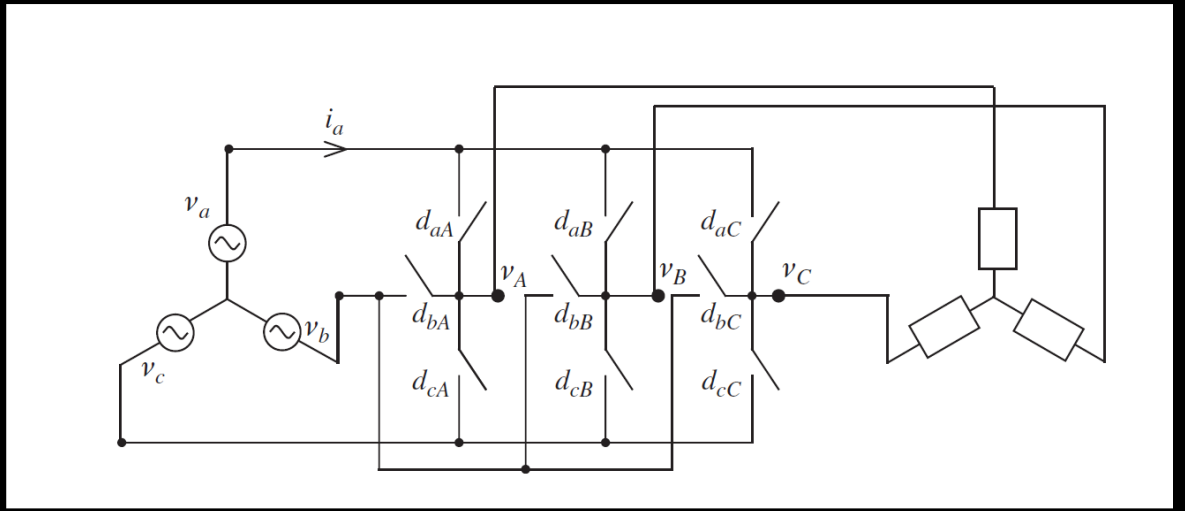


Voltage-link structure of power electronics interface.

Direct-Link Structure)

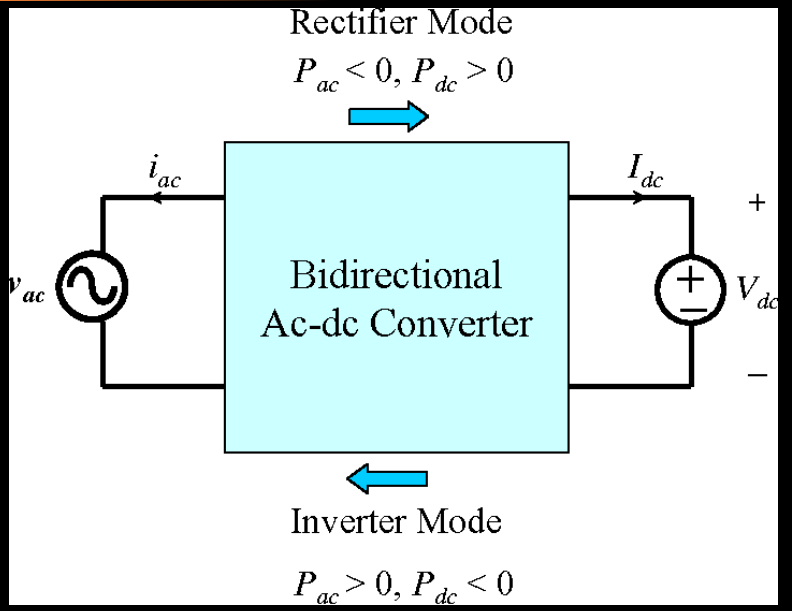
There is no energy storage element between the input and the output sides.

Therefore, we can consider it to be a direct-link structure



Based On Power Flow Direction

Bi-directional converters
Uni-directional converters



A bi-directional converter is something where power can flow at both direction. That means you can feed power to the load and the load can also feed the power back to the source.

TRACTION SYSTEMS

(1) It converts a fixed DC battery voltage into a higher DC voltage suitable for traction motor. Also, the output DC voltage can be varied to control the speed of the motor.
(2) During regenerative braking (a kind of energy saving electrical braking), the kinetic energy of wheels is fed back to the battery. During this process, motor acts as generator, converts wheel rotation into electricity and feeds it back to the battery through converter.

PV SYSTEMS

You can charge the battery from the PV panel and PV panel supplies the load continuously. However, in night when there is no sun the charged battery will supply power to the load which is connected directly across the PV panel.

Other Classifications

Isolated converters

Non-Isolated converters

Uni-directional Converters

Bi-directional Converters

REFERENCES

Ned Mohan, Power Electronic

Toshiba Company internet pages

https://www.globaltrademag.com/3-prominent-trends-influencing-the-demand-for-power-electronics-market-between-2021-2027/

https://www.matsusada.com/column/regenerative_energy.html

https://www.researchgate.net/figure/The-scheme-of-using-regenerative-braking-energy-by-another-vehicle-Source-own-study_fig1_335864701