
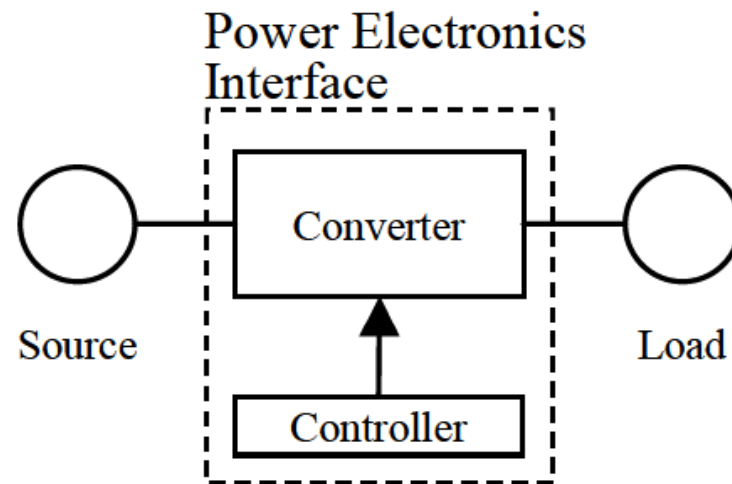


# 電力電子在消費性產品 之探討

國立雲林科技大學電機系  
林伯仁 教授

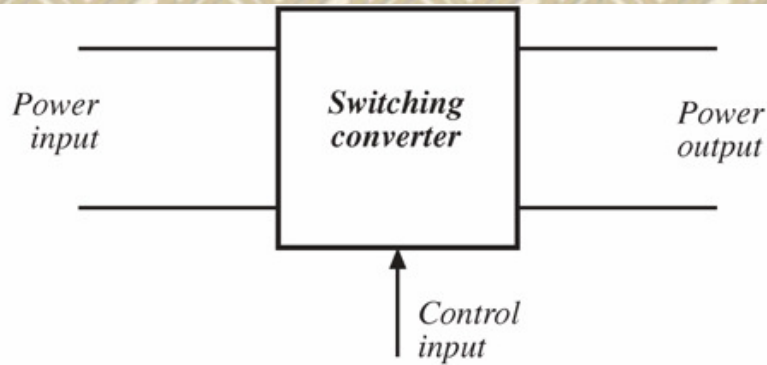


# Role of Power Electronics

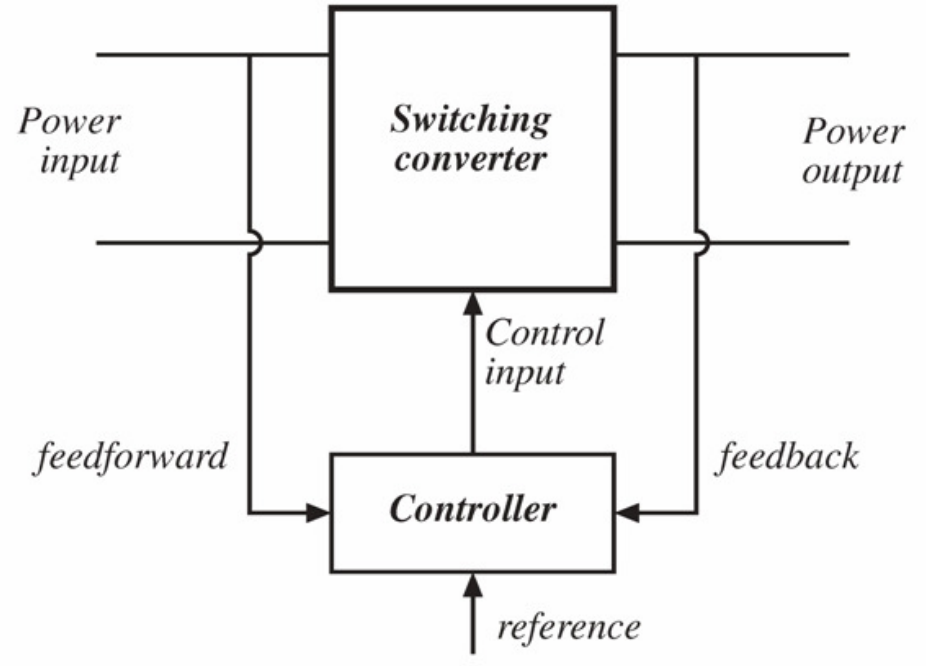


Power electronics interface between the source and the load.

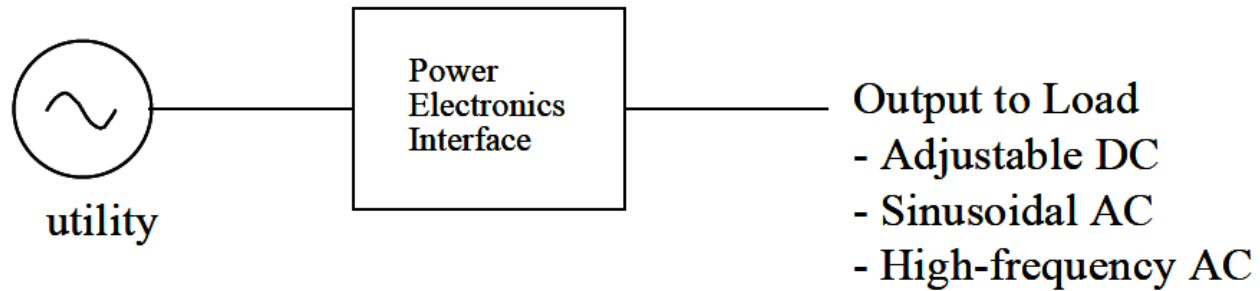
The power electronics interface facilitates the transfer of power from the source to the load by converting voltages and currents from one form to another, in which it is possible for the source and load to reverse roles.



- Dc-dc conversion:* Change and control voltage magnitude
- Ac-dc rectification:* Possibly control dc voltage, ac current
- Dc-ac inversion:* Produce sinusoid of controllable magnitude and frequency
- Ac-ac cycloconversion:* Change and control voltage magnitude and frequency

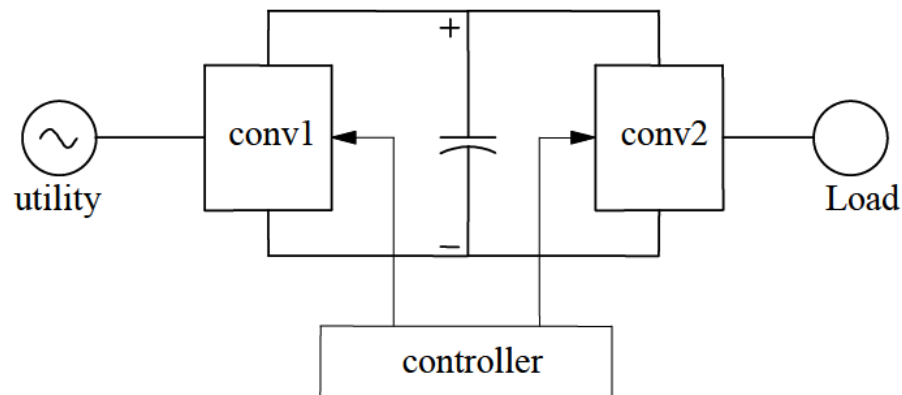


## Summarizing the Role of Power Electronics



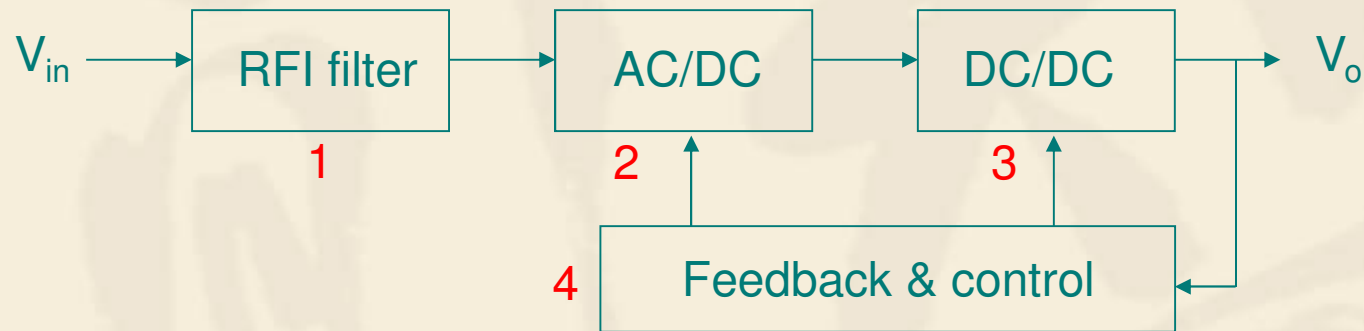
Block diagram of power electronic interface.

## STRUCTURE OF POWER ELECTRONICS INTERFACE



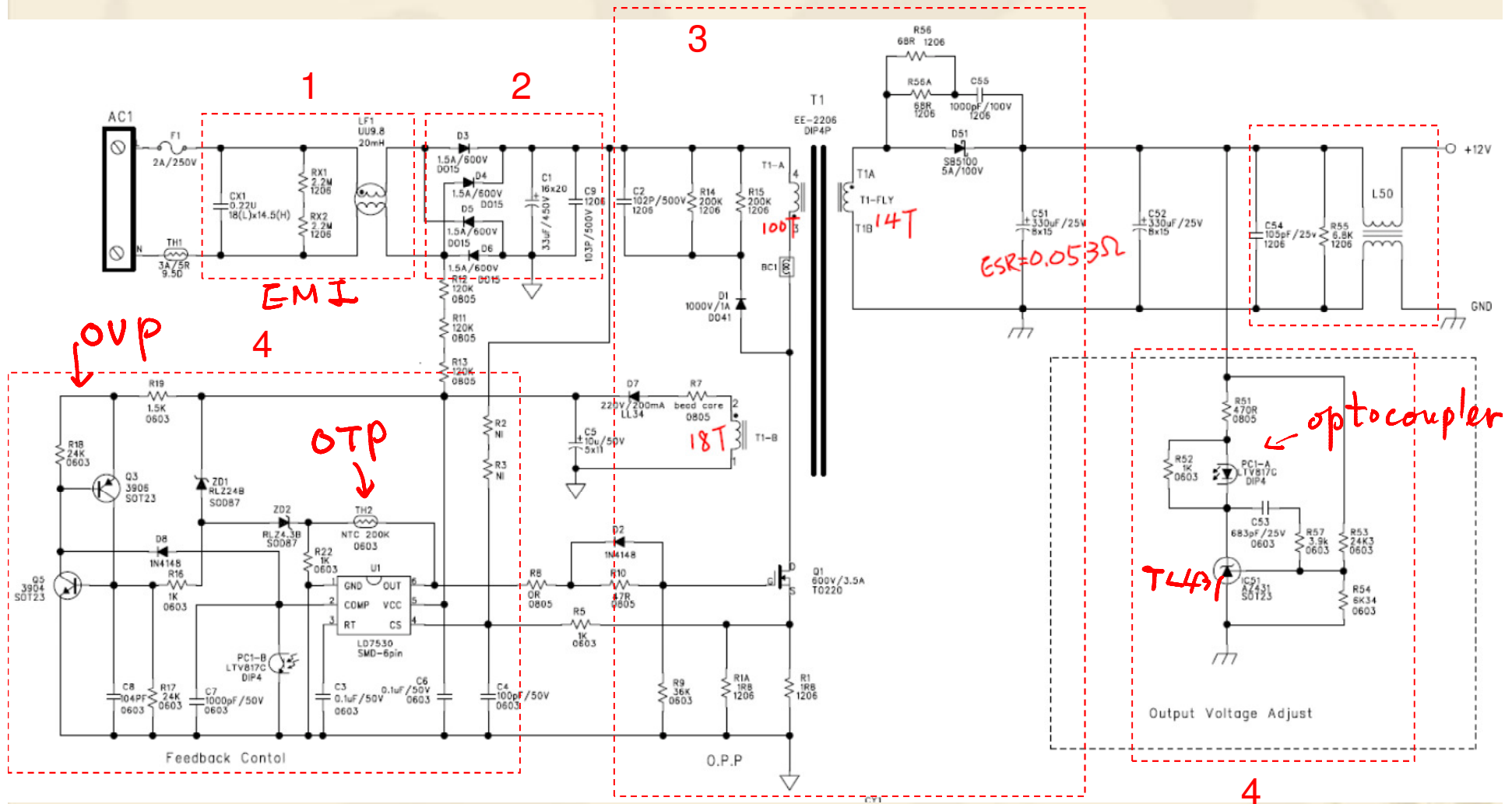
Voltage-link structure of power electronics interface.

# Isolated switching-mode-power-supplies (SMPS) function blocks



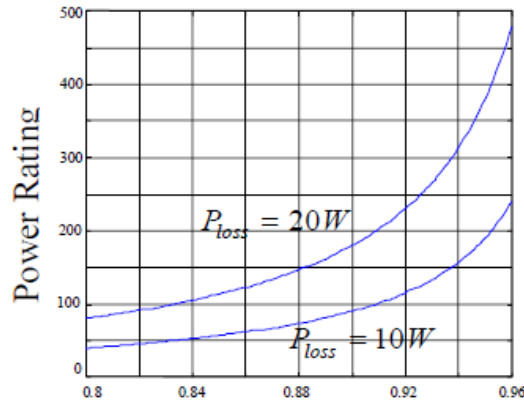
1. Depending on noise transmission, there are two categories of noise:
  - conducted noise (450 kHz to 30 MHz); **Low frequency range**
  - radiated noise (30 MHz to 1 GHz). **High frequency range**
2. AC/DC converter: **without PFC function** (diode rectifier) and **with PFC function**
3. DC/DC converter: **flyback, forward, half-bridge** and **full-bridge** (with high fre. transformer)
4. Feedback & control: **output filter (L, C), voltage divider, OVP, OCP, OTP, optocoupler, OP amp or TL431, PWM IC**

# 17W Flyback adaptor



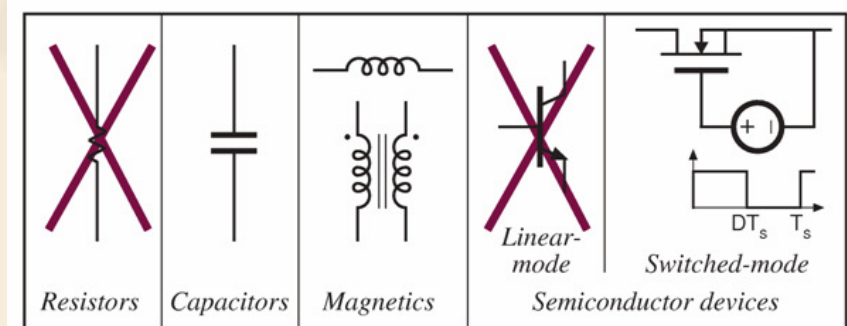
# NEED FOR HIGH EFFICIENCY AND HIGH POWER DENSITY

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



Efficiency

Power output capability as a function of efficiency.



Power processing: avoid lossy elements

## DESIGN CONSIDERATIONS

- Switching Frequency
- Selection of Transistors and Diodes
- Magnetic components
- Capacitor Selection

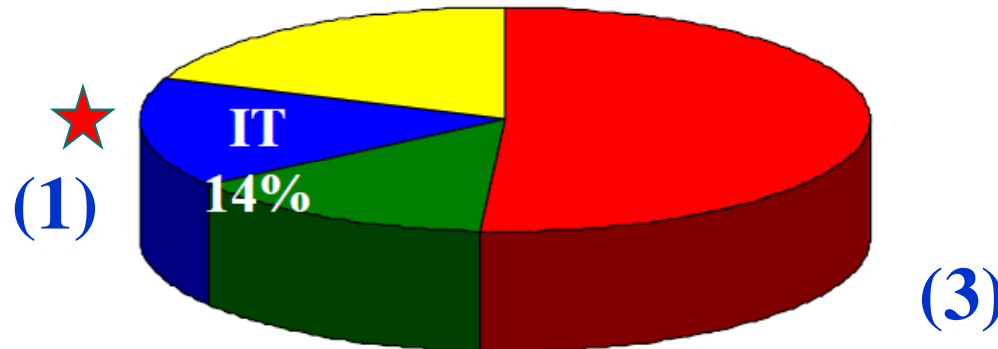
$$A_p = \frac{L \hat{I}_{rms}}{k_w J_{max} B_{max}} \quad A_p = \frac{k_{conv} \sum V_y I_{y,rms}}{k_w B_{max} J_{max} f_s}$$



Capacitor ESR and ESL.

## Energy and the Environment: The Percentage Energy Consumption

(2) ★ Lighting 19%



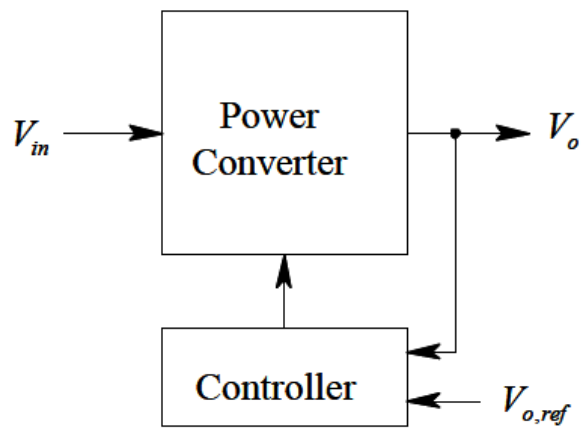
(4) HVAC 16%

Motors 51% ★

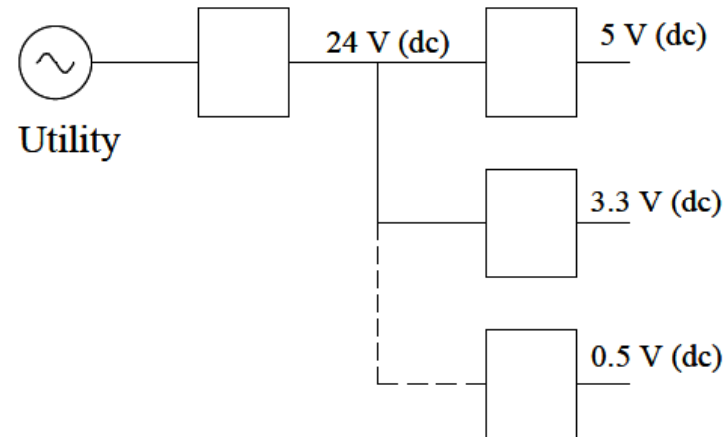
Percentage use of electricity in various sectors in the U.S.



# (1) Powering the Information Technology



(a)



(b)

Regulated low-voltage dc power supplies.

## **Power Electronics in IT Applications:**

- **Personal Computers : ATX desk-top power, adaptor.**
- **Mobile Phone: Charger**
- **Battery charger/discharger**
- **LCD or LED backlight power unit**
- **Cloud Server power unit**
- **Telecommunication power unit**
- **Medical equipment power unit**



ATX



LCD TV module



EPA PSU



EPA 85+ 875W



HP-AP090xxx



EPA 85+ 525W



EPA 82+ 700W



HP-OK065xxx



HP-OW120xxx



EPA 82+ 1KW



AC Module 528W

## Power Management



Delta Confidential



**Server/Workstation SPS**



**Desktop SPS**



**Networking SPS**



**BMP DC/DC Converters**



**Voltage Regulation Modules**



**Adapters**



**Telecom Power Systems**



**Distributed SPS**



**Chargers**



**UPS**



**Ballasts**

## Video Displays



Rear Projection TVs



Video Walls



PDP TVs



TFT-LCD TVs



Home Theater Projectors



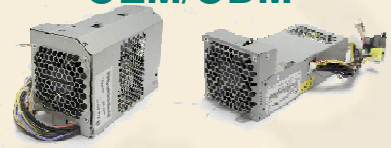
Large Venue Projectors

# DESKTOP PC PSU

## STANDARD



## OEM/ODM

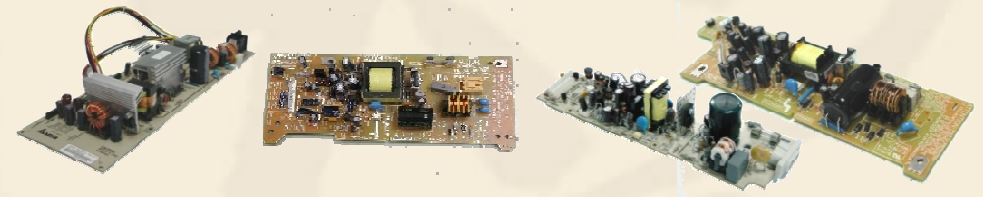


## Entry Server



# CONSUMER & PC PSU

## DVD+RW PSU



## LCD TV PSU



## STANDARD



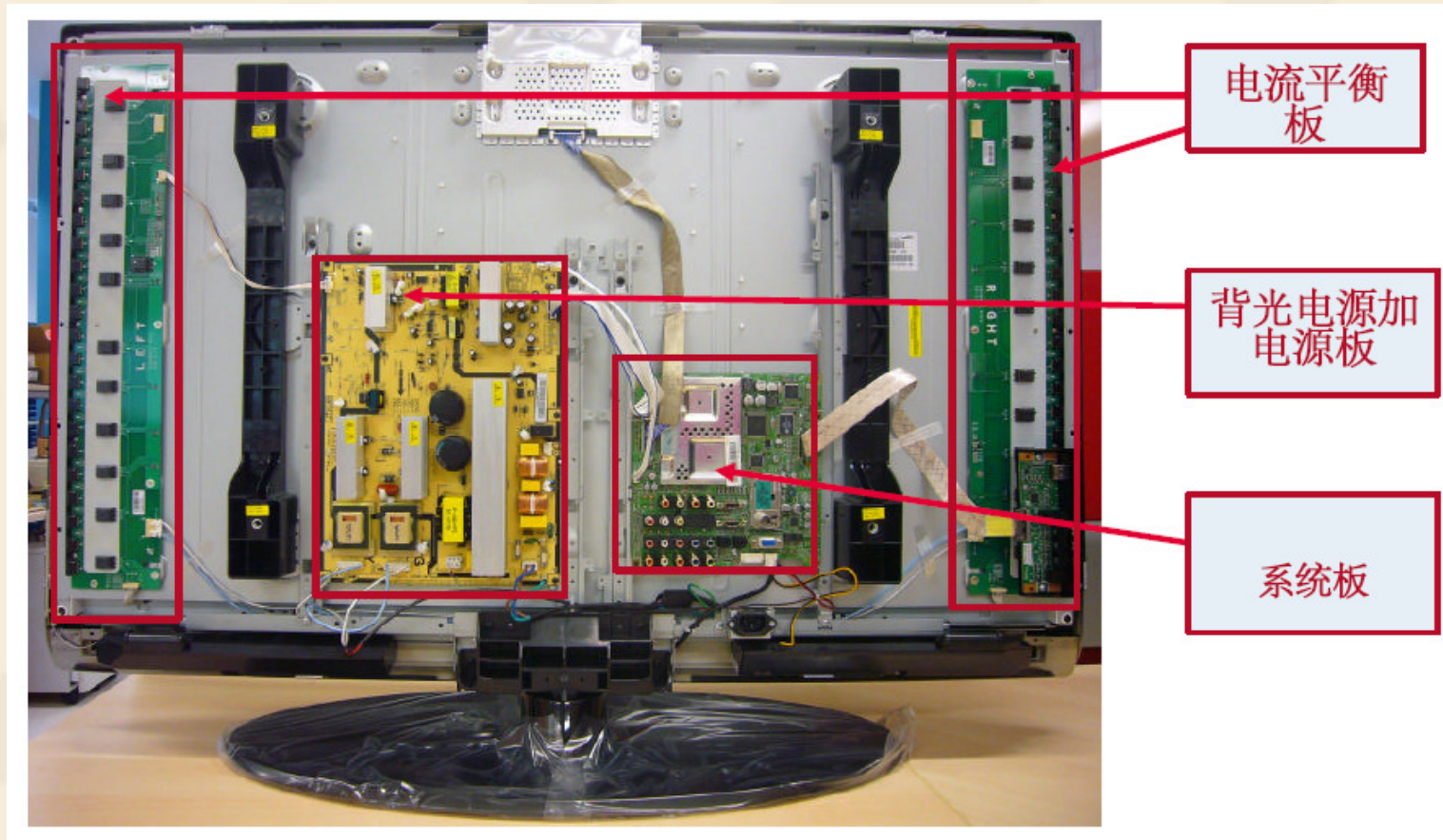
## OEM/ODM



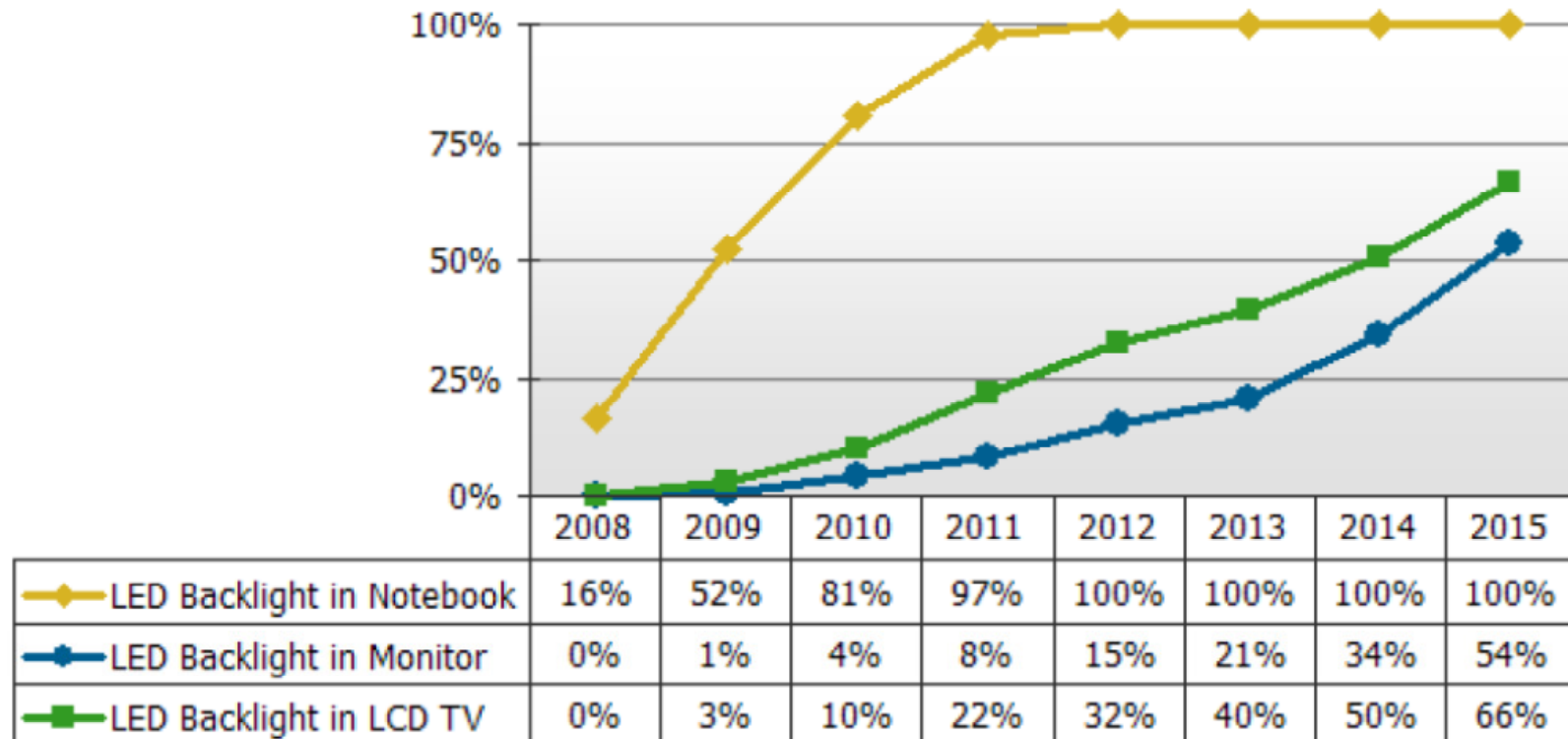
## Entry Server



## LED TV backlight power unit



## LCD-TV LED Backlighting



Source: DisplaySearch July 2009



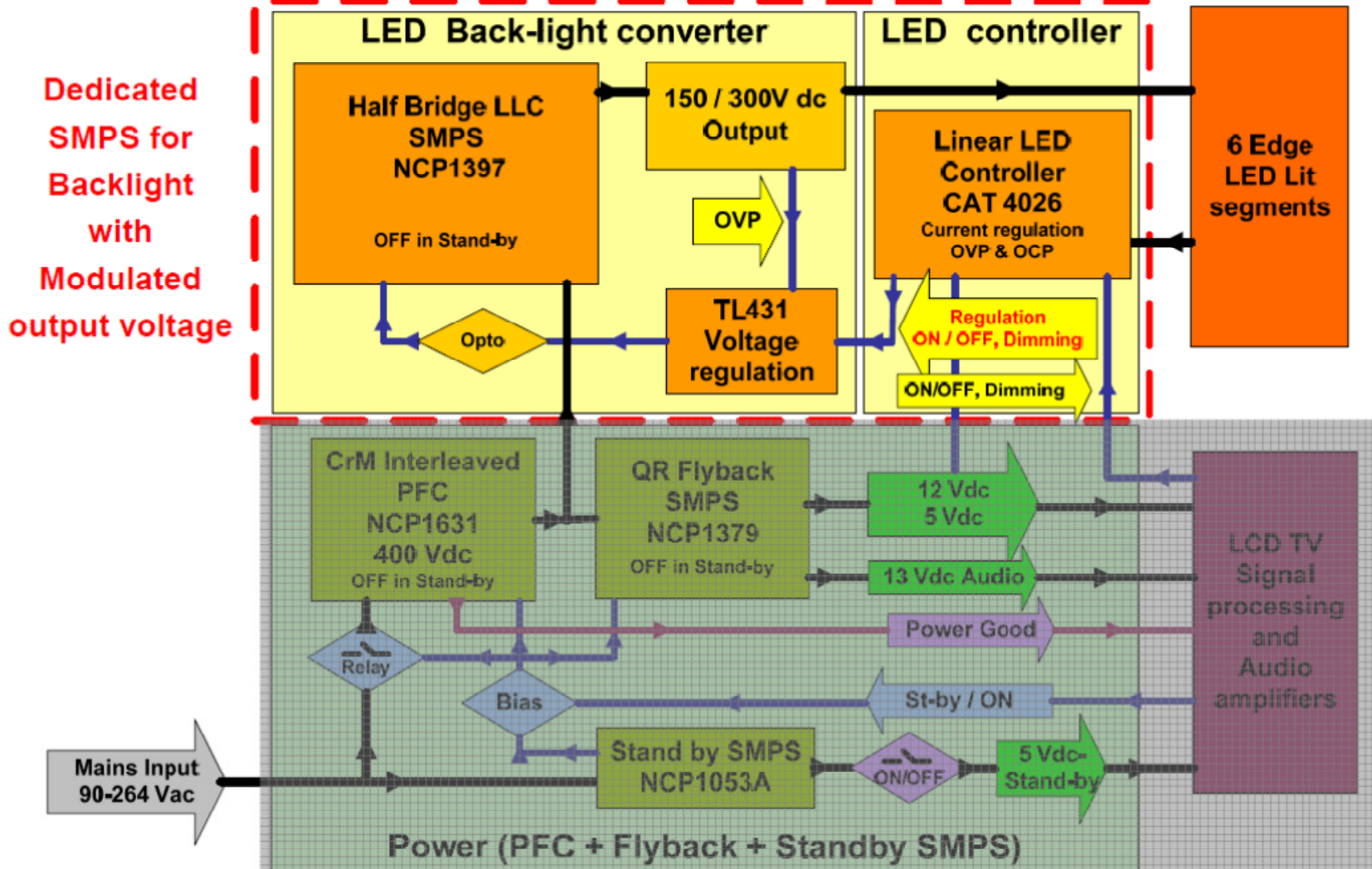
***LED TVs is forecast to grow to 20-32% (~64 M#) by 2012***



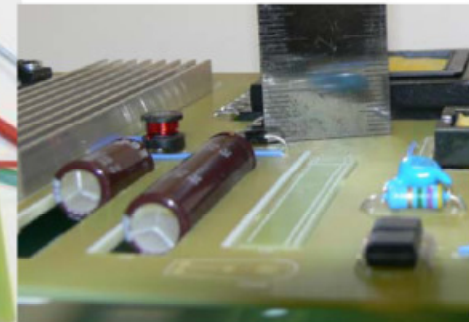
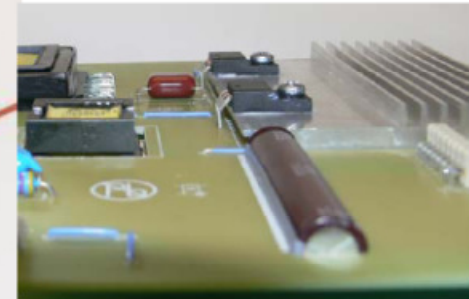
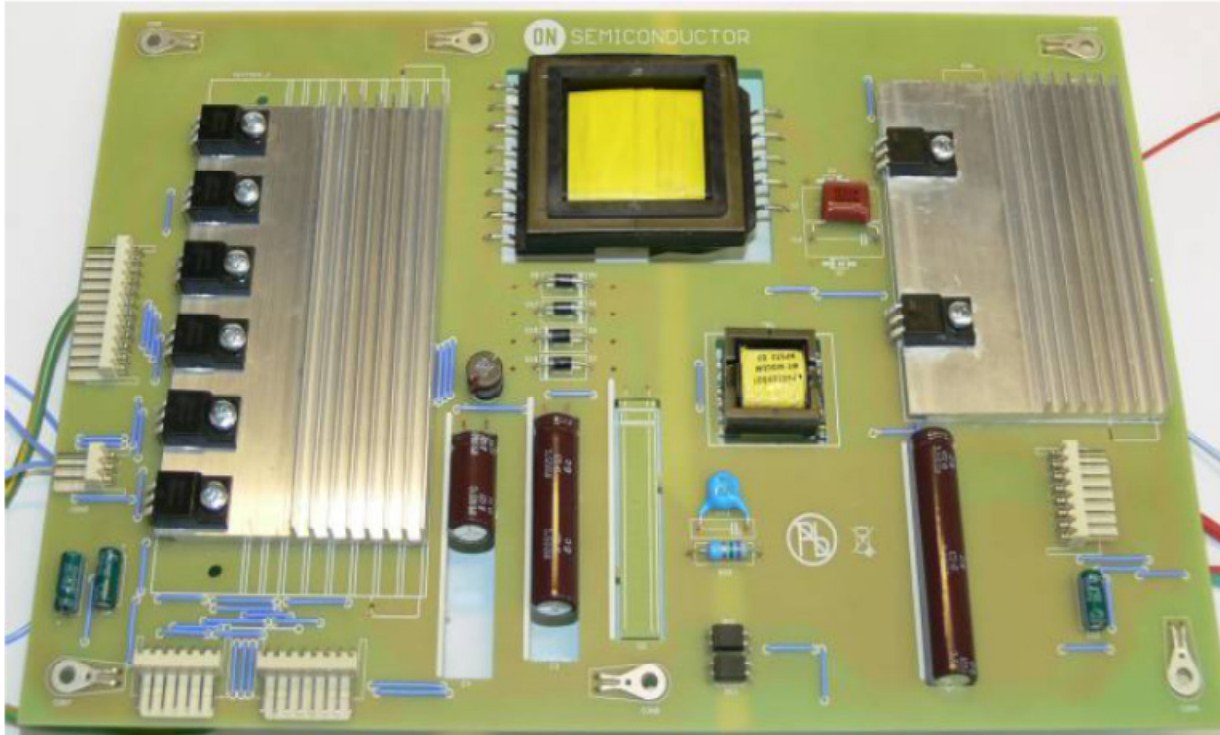
# 46" LED Backlight Power

- **Higher power LCD-TVs**
  - With extension to 40/42" or 52"/55"
  - HB LLC dedicated to Backlight power
  - High DC output voltage to power directly LED drivers
- **Separate / Dedicated LED Power module**
  - To be connected with 46" Power Ref Design step 2 < 8 mm
- **ON Semiconductor IC's**
  - New **NCP1397**
  - New
  - New LED driver controller CAT4206
- **Low profile design**
  - < 8 mm on top of PCB (< 12.5 mm total)

# 46" Linear Edge LED Driver TV Block Diagram



## 46" Linear LED Driver Backlight Solution

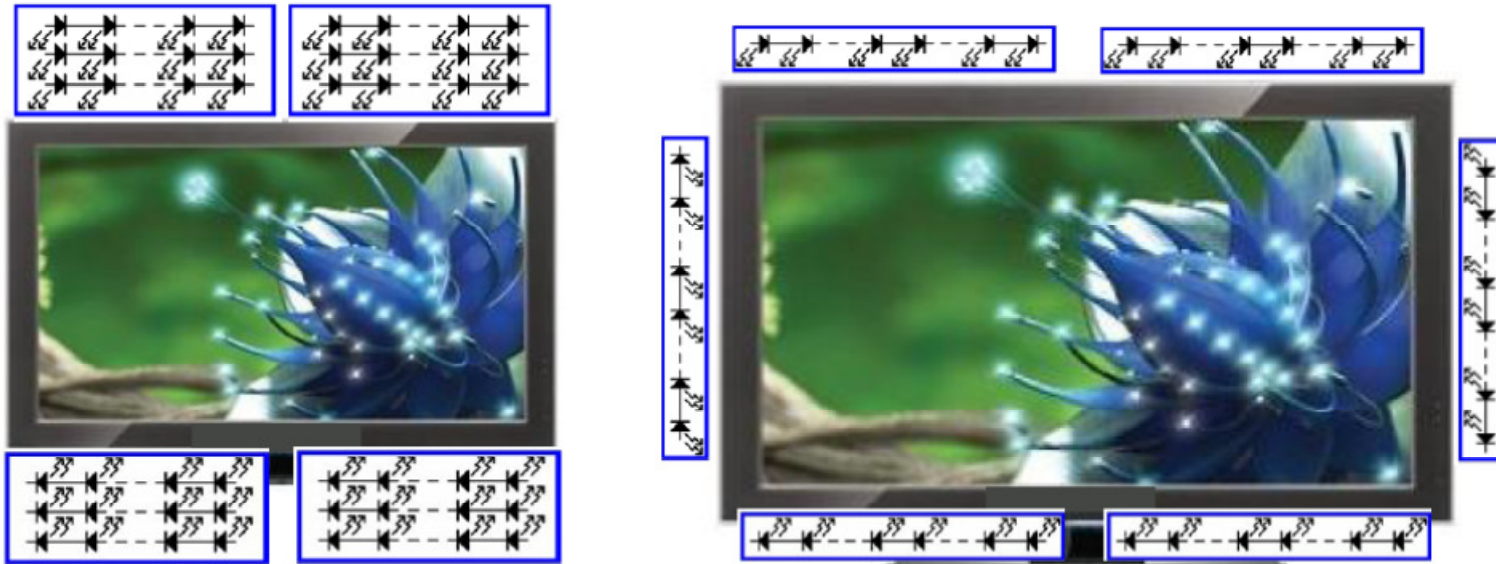


- Special technologies
- PCB size: 250 mm x 165 mm



**Ultra SLIM design < 8 mm / 12.5 mm total**

## Edge-LIT LED Backlighting Trends



- 'LED Light bars' vary in configuration
  - Single LED Strings of High Power ( $\sim 200\text{ V}+$  ,  $100\text{ mA}+$ )
  - Multiple LED Strings (up to 4) of Lower Power ( $\sim 100\text{ V}+$  ,  $50\text{ mA}+$ )

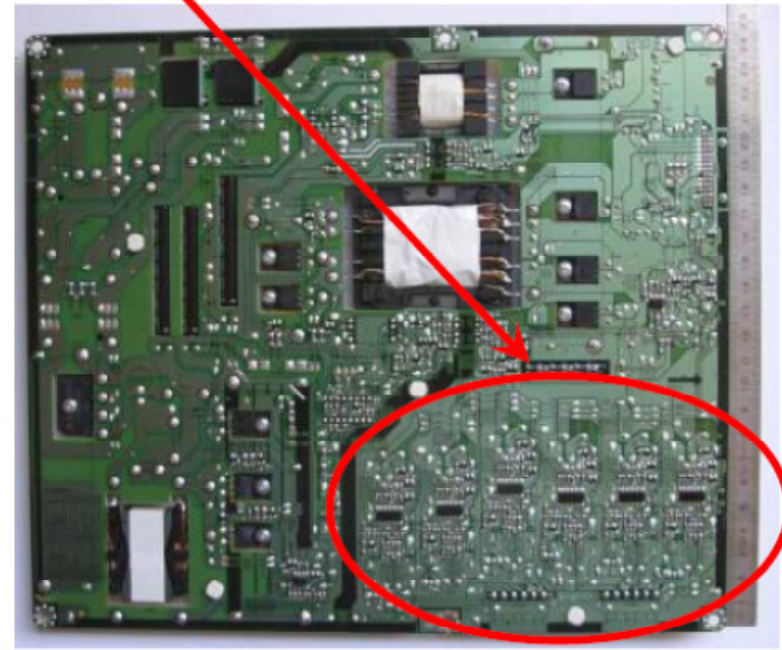
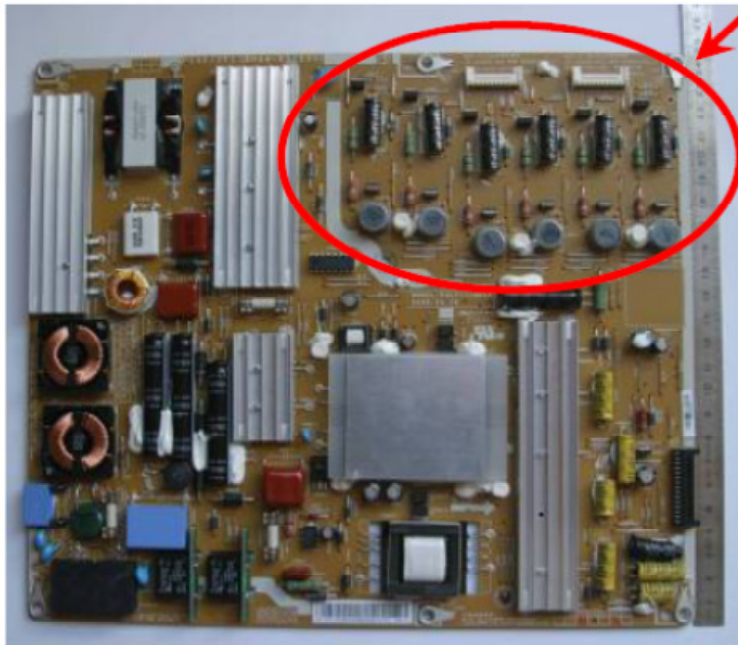


**LED Driver solutions must handle from 4 to 16 channels**

# Existing LED Driver Backlight Solution

- Large-size panel power Module used for 6 Channel Edge-LIT LED TV
- Each channel has a **Dedicated Driver IC + inductive DC/DC boost + switch**

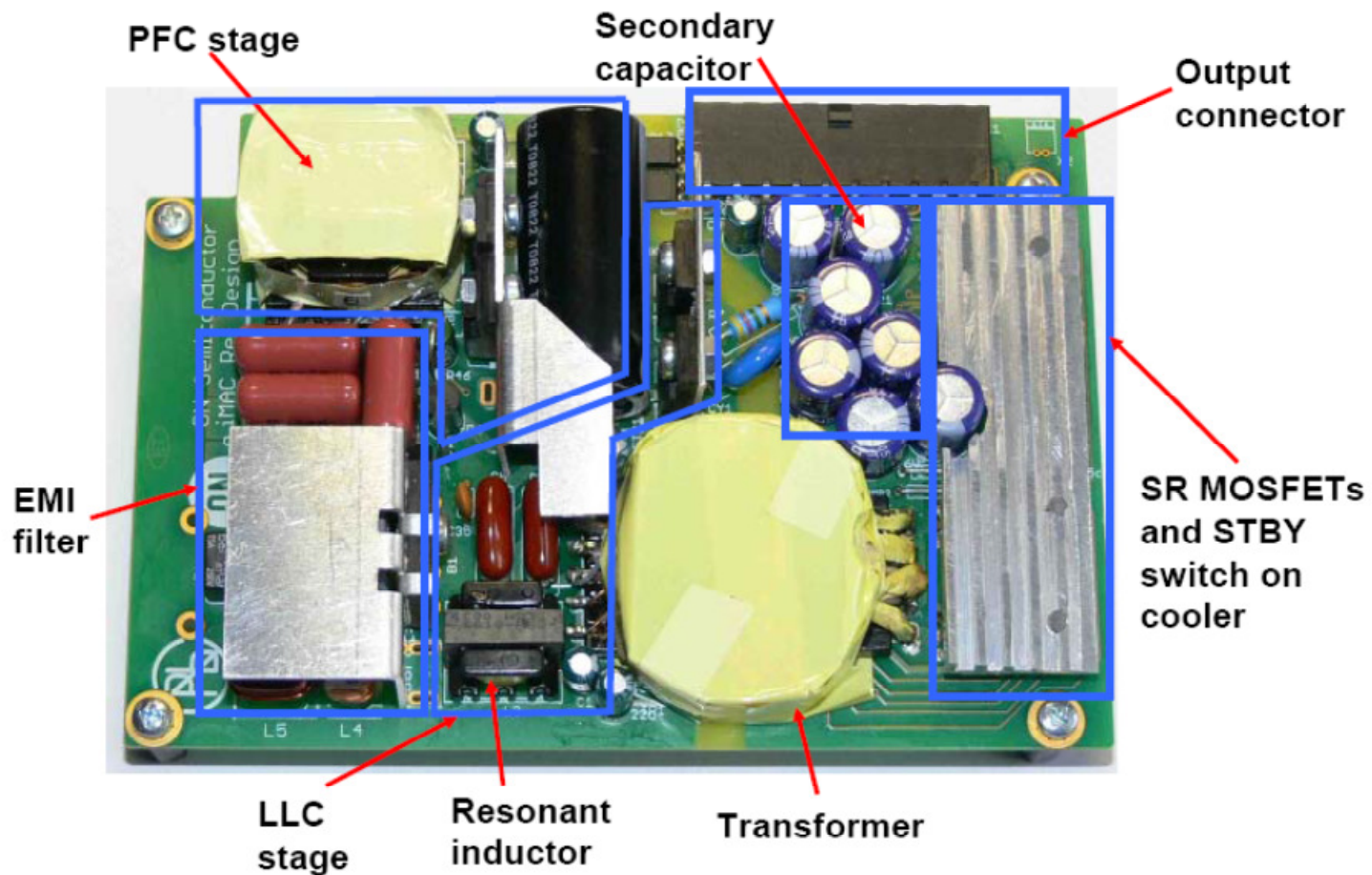
6 Ch = 6 x ( DC-DC Boost +  
additional switch )



6 Ch = 6 x Driver IC

# ALL IN ONE Computer power unit

## Reference Design Photo – Top Side



## (2) Lighting

### LED Bulb

					
3 W PAR16	3x2 W PAR20	10 W PAR30	15 W PAR30	15 W PAR38	22 W PAR38
					
1 W G13	3 W GU10		1 W MR11	3 W MR16	
					
3 W Down Light	9 W Down Light	15 W Down Light	1 W LED Reading Lamp	100 W LED Street Light	

## AC-DC Lighting Solutions

AC-DC

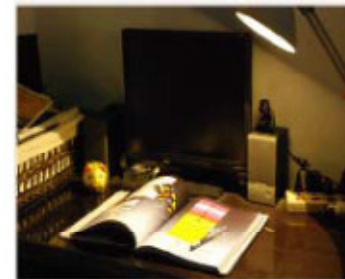


**G13/GU10/PAR16/PAR20(1 W-8 W)**

**PAR30/PAR38/Down Light(8 W-25 W)**

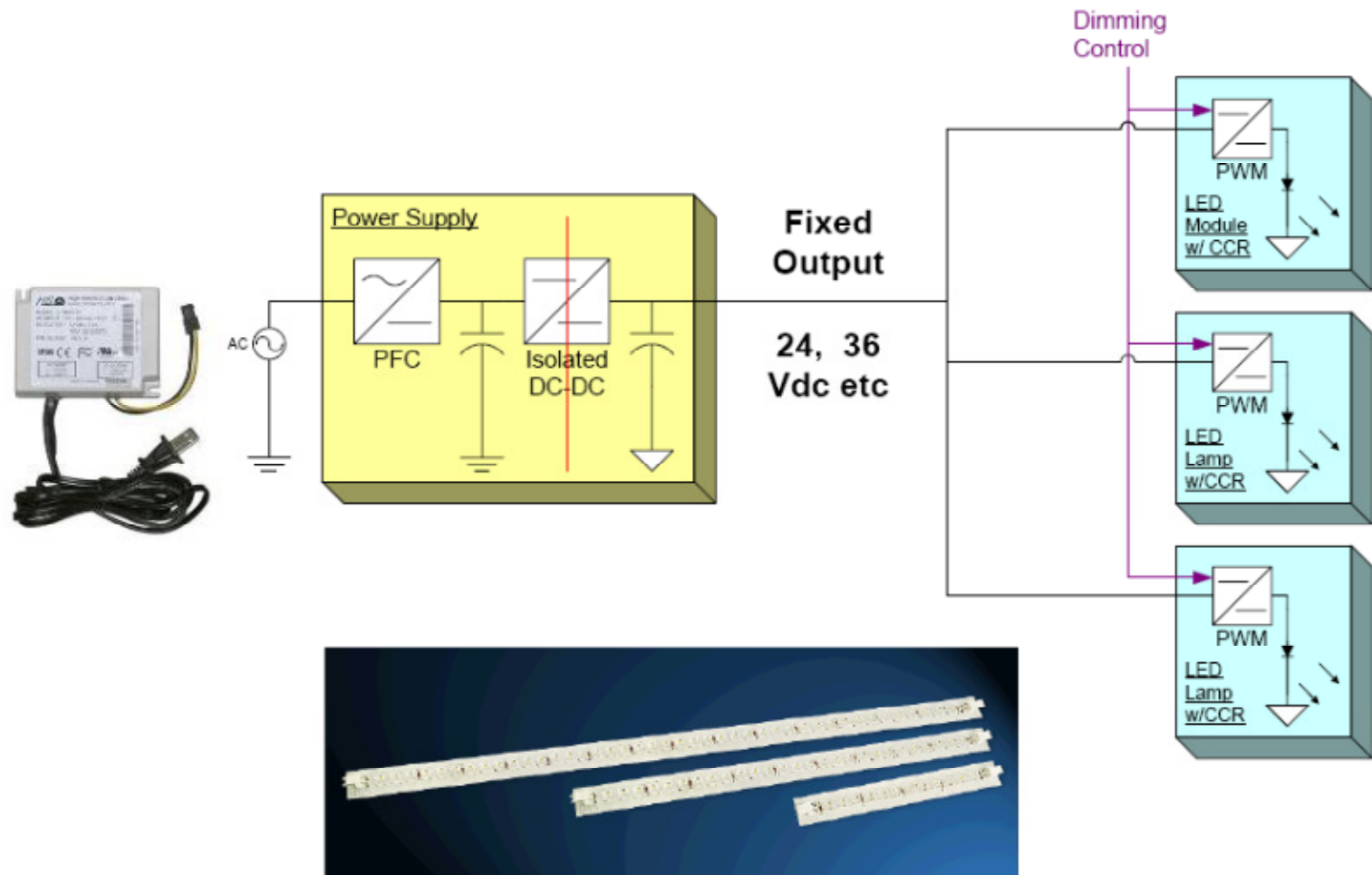
**Area Lighting(50 W-150 W)**

**Area Lighting(100 W-300 W)**



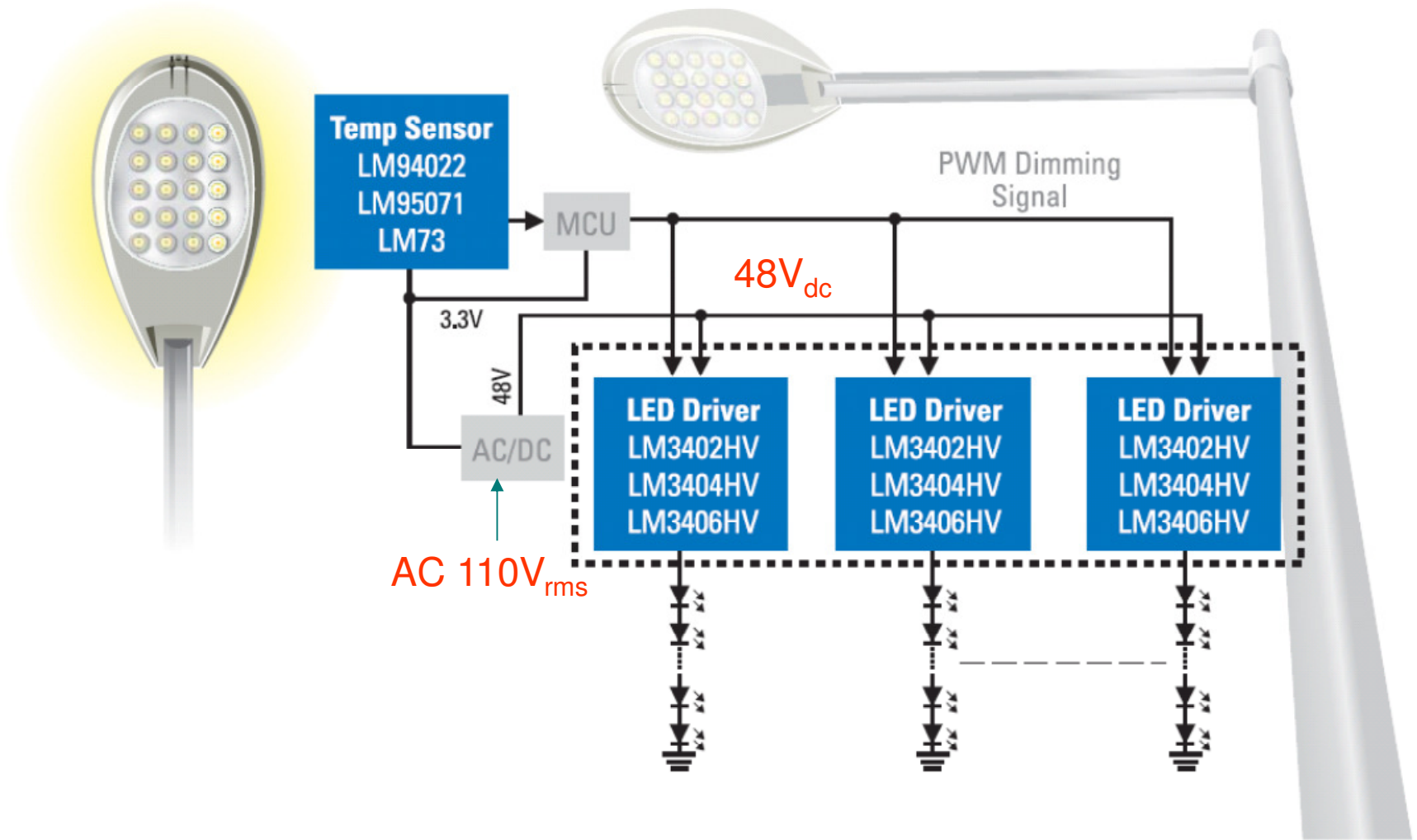


# Example of a Distribution LED Configuration



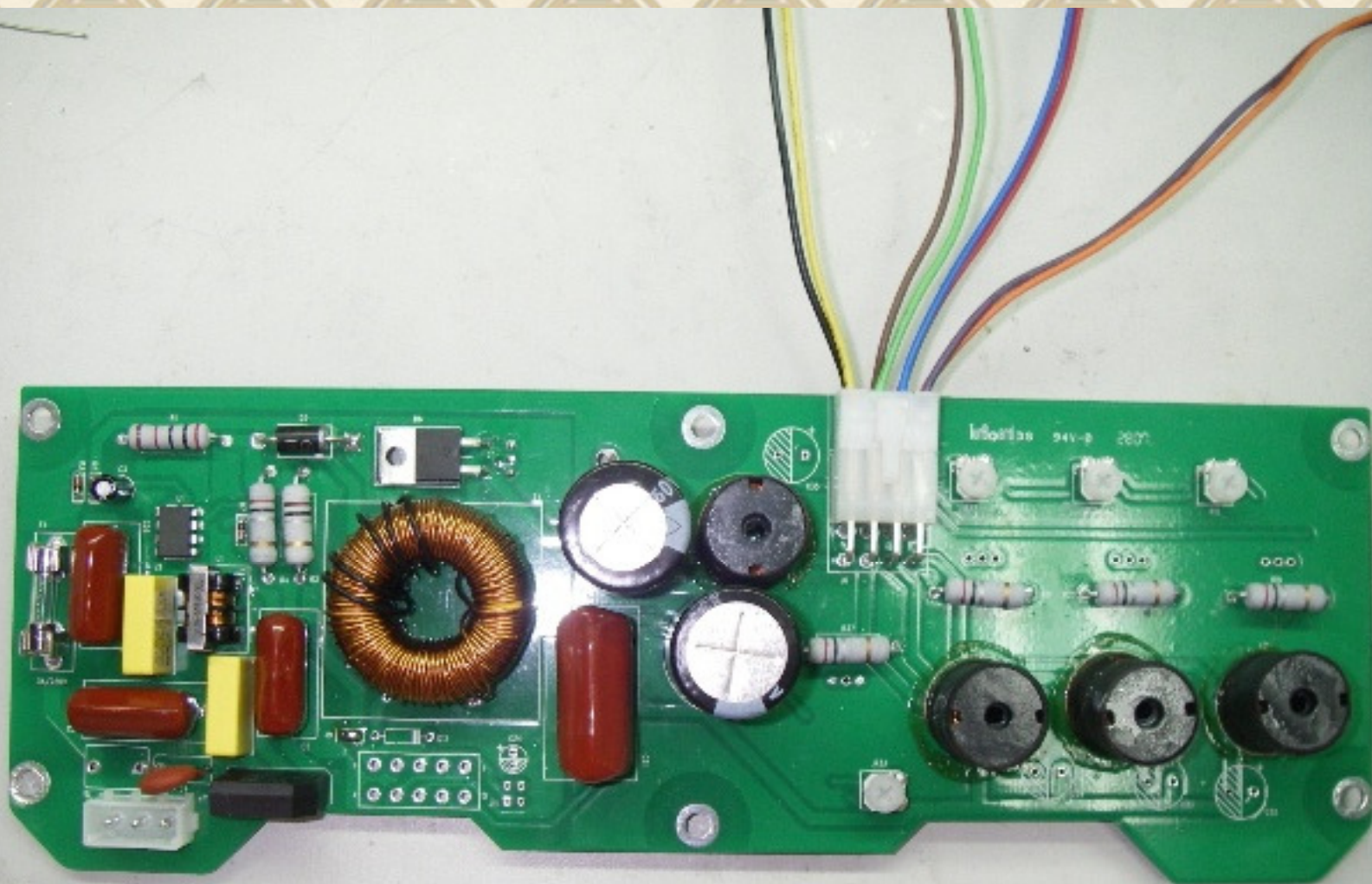
# 48V Bus Street Lamp

## LED Street Lamp Architecture

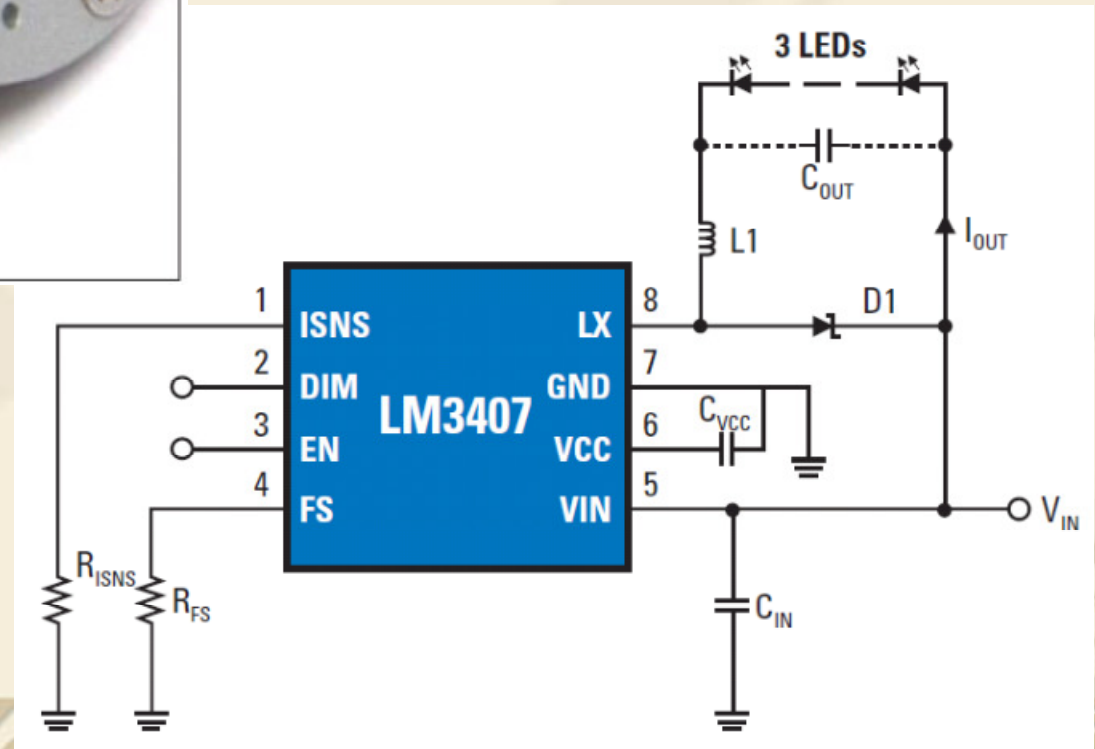
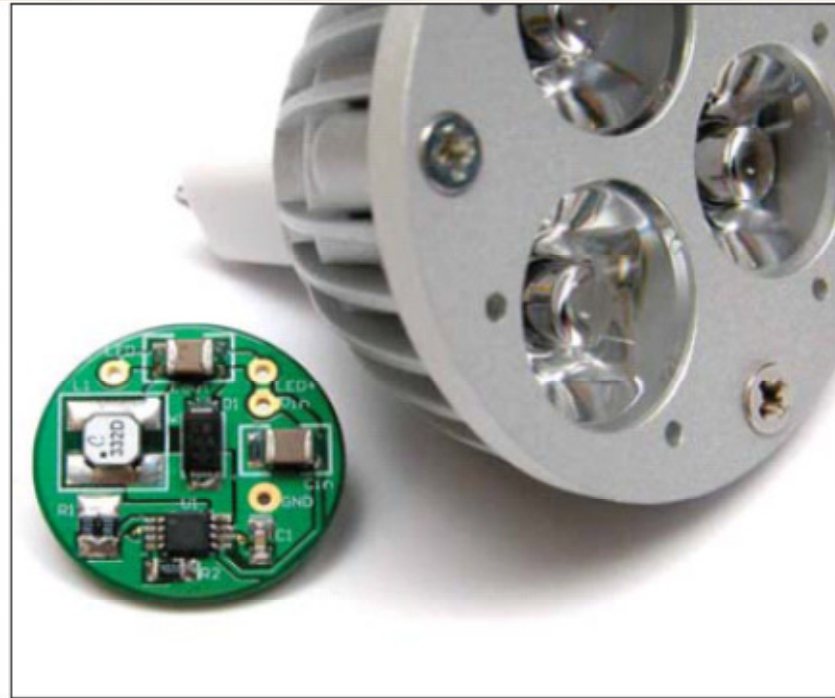








## Design 2: MR16 Using LM3407

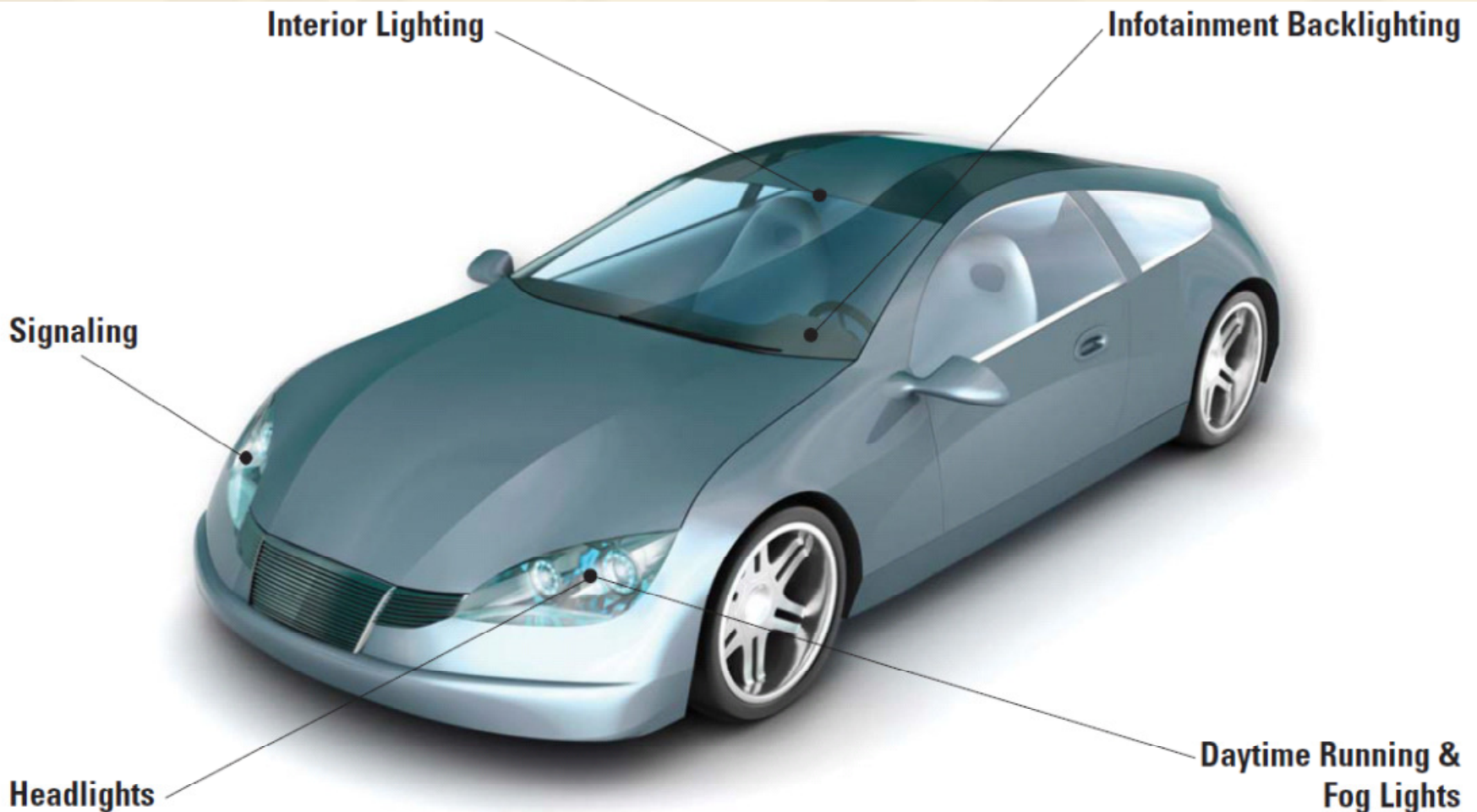


# High-Brightness LED Applications

## Automotive Lighting

From headlights to LCD backlighting in infotainment systems, LEDs are an integral part of the driving experience. National's portfolio of LED drivers offer key features like PWM dimming, accurate Under Voltage Lockout (UVLO), and high-side current sensing. Plus, low

LED ripple current and external oscillator sync capabilities allow designers to reduce issues with EMI. These LED drivers provide maximum efficiency and effectiveness in any automotive lighting system.

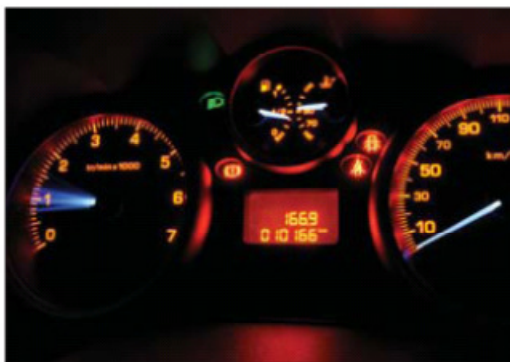


# Design 3: LED Backlighting Applications Using LM3431

## LED Backlighting for TFT Displays



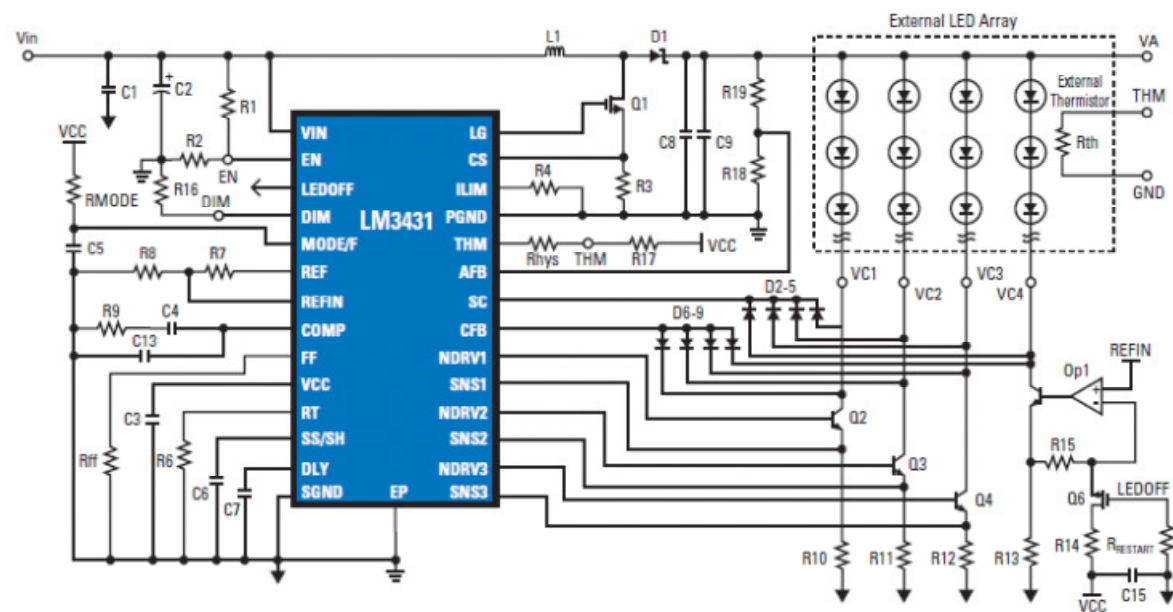
## LED Backlighting for Dashboards



## Description:

- Designed to drive four channels of 8 series-connected 140 mA LEDs from a 12V bus battery input for automotive LED backlighting in a TFT display.

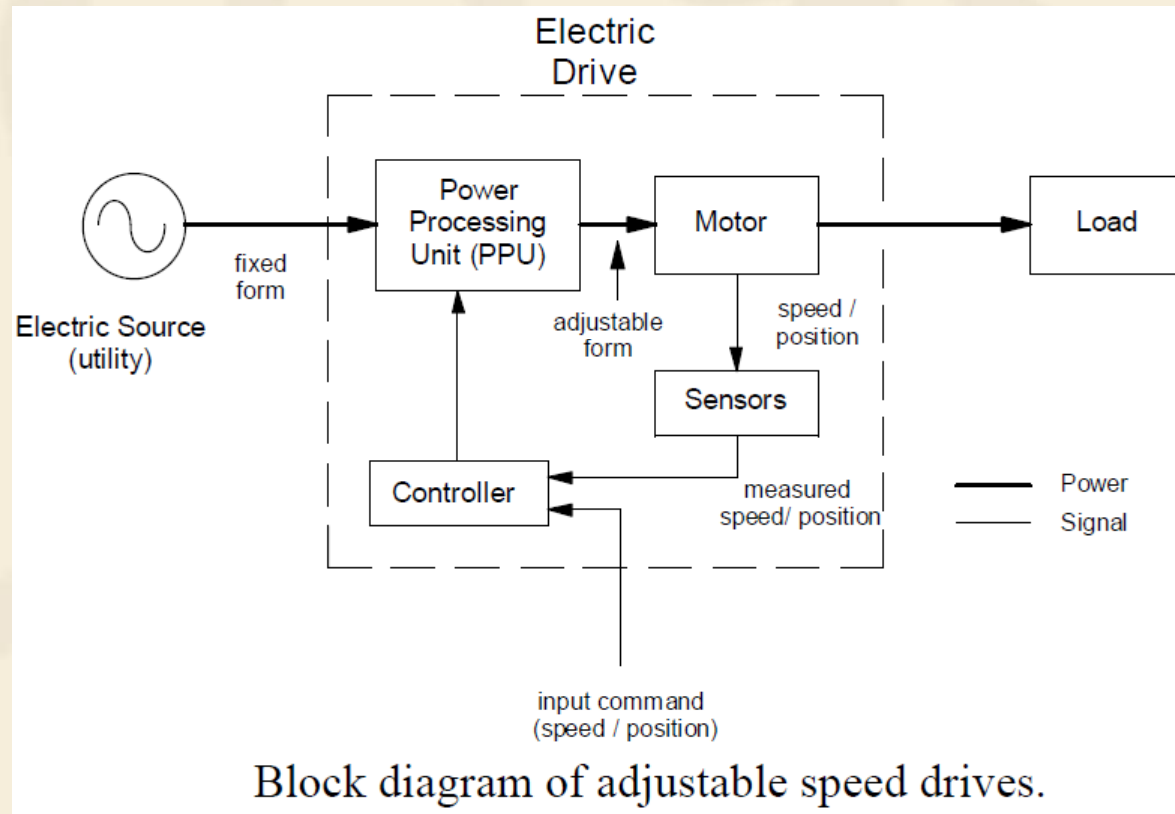
**Vin: 8-18V, 4 strings of 8 LEDs, 140 mA per string.**





### (3) Motor

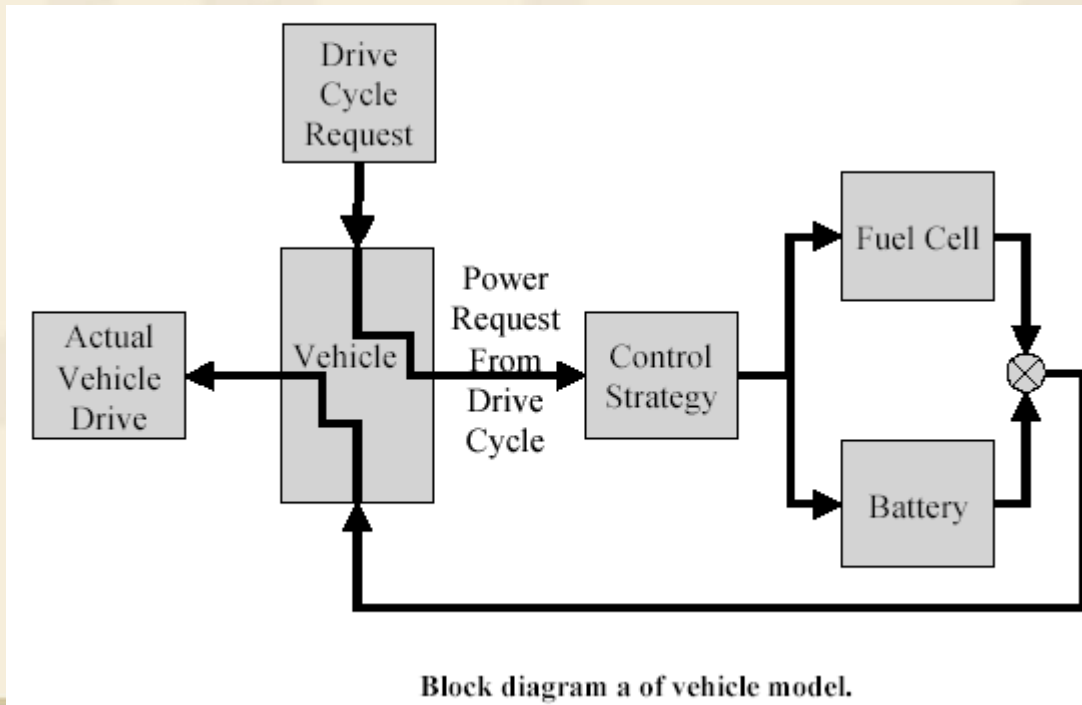
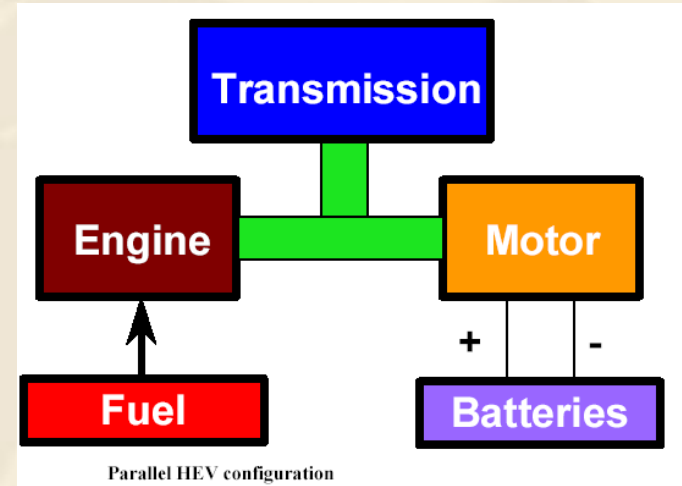
## Adjustable Speed Drives

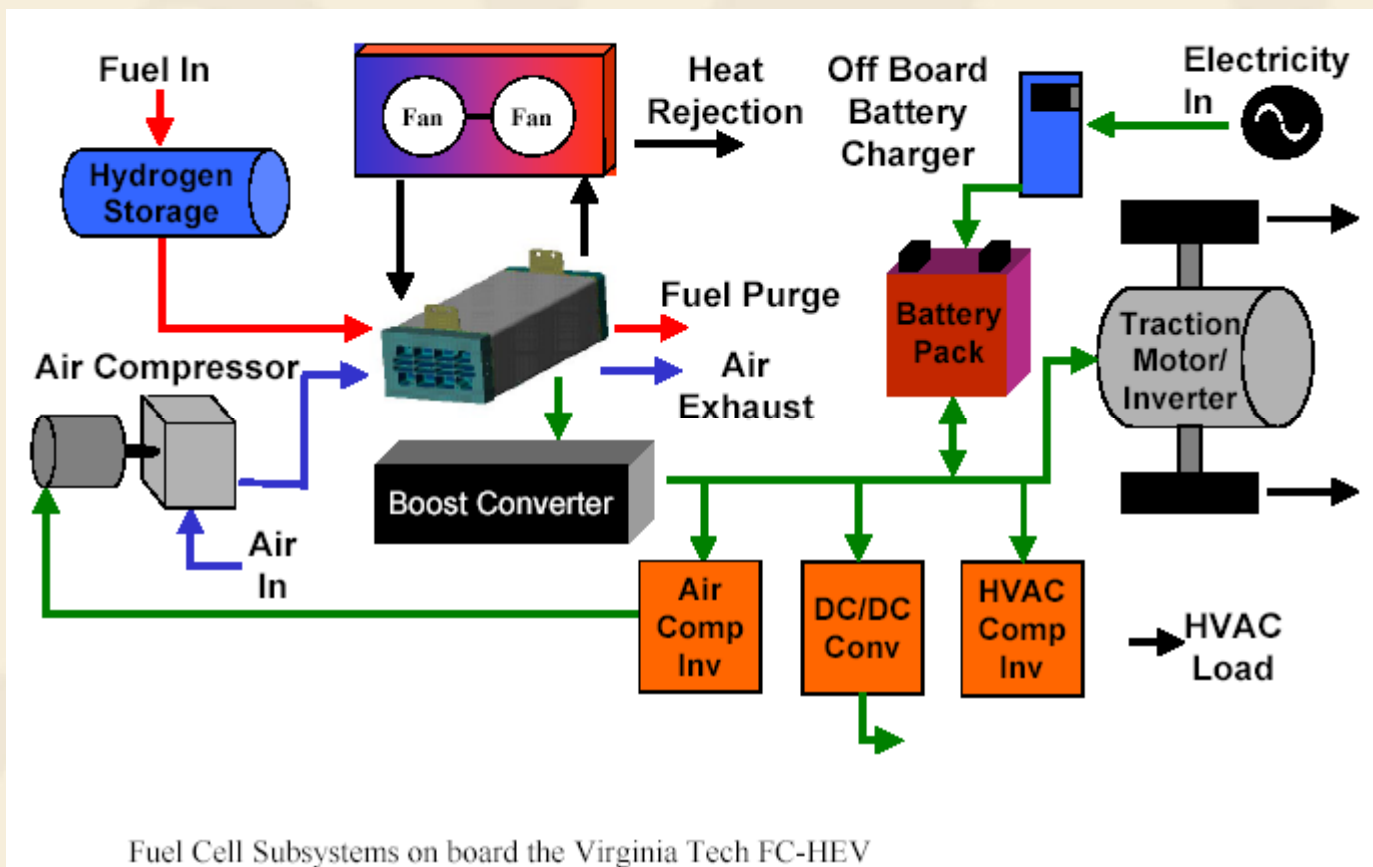


# Transportation



Hybrid electric vehicles with much higher gas mileage.





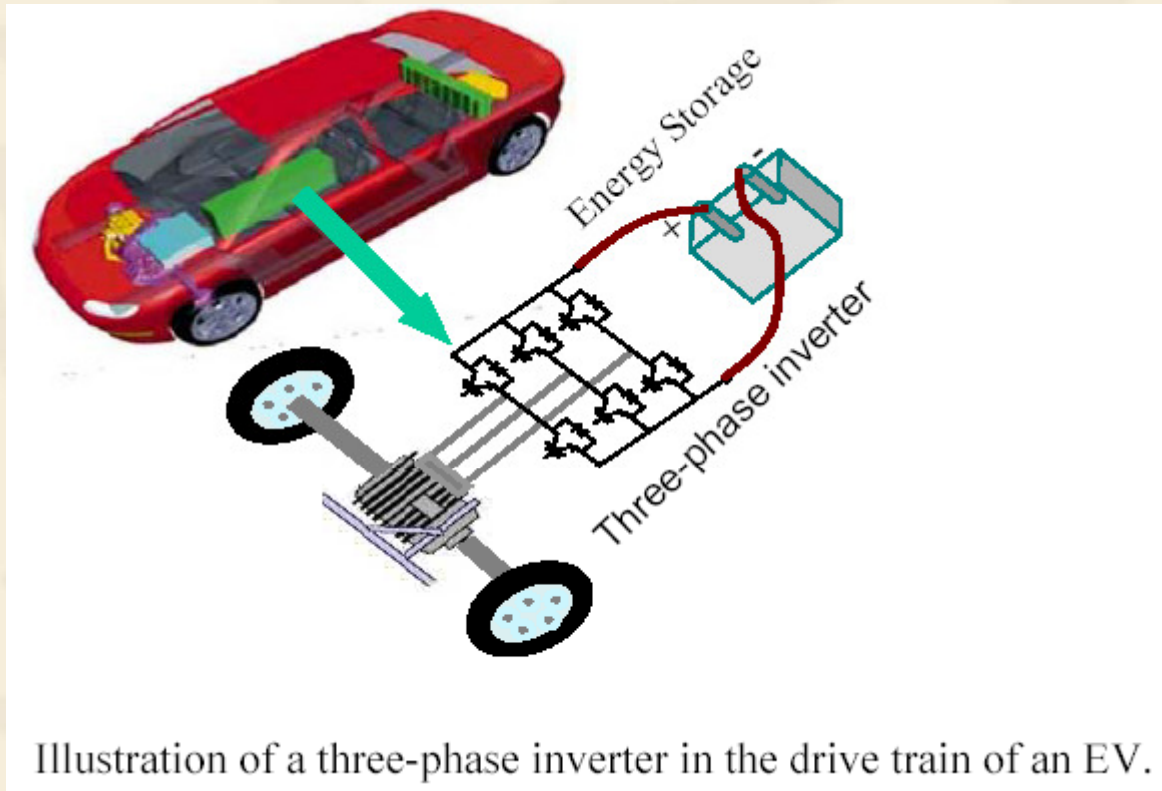
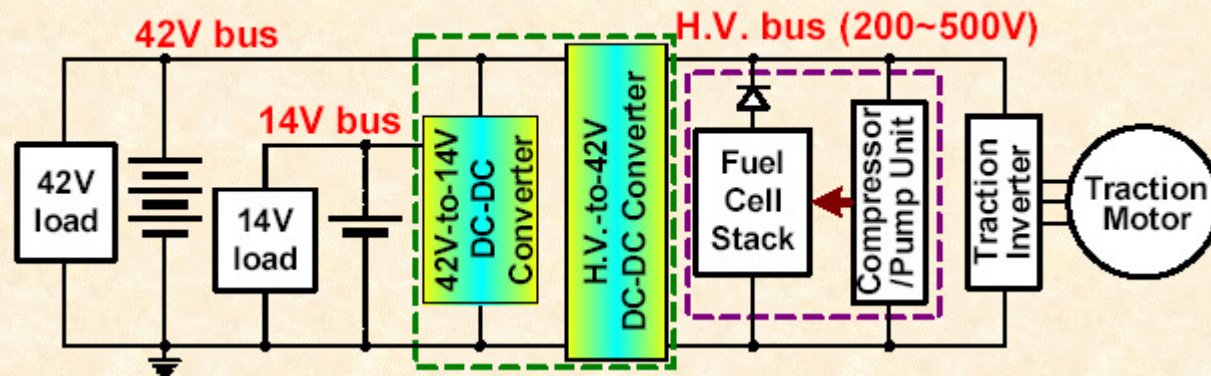


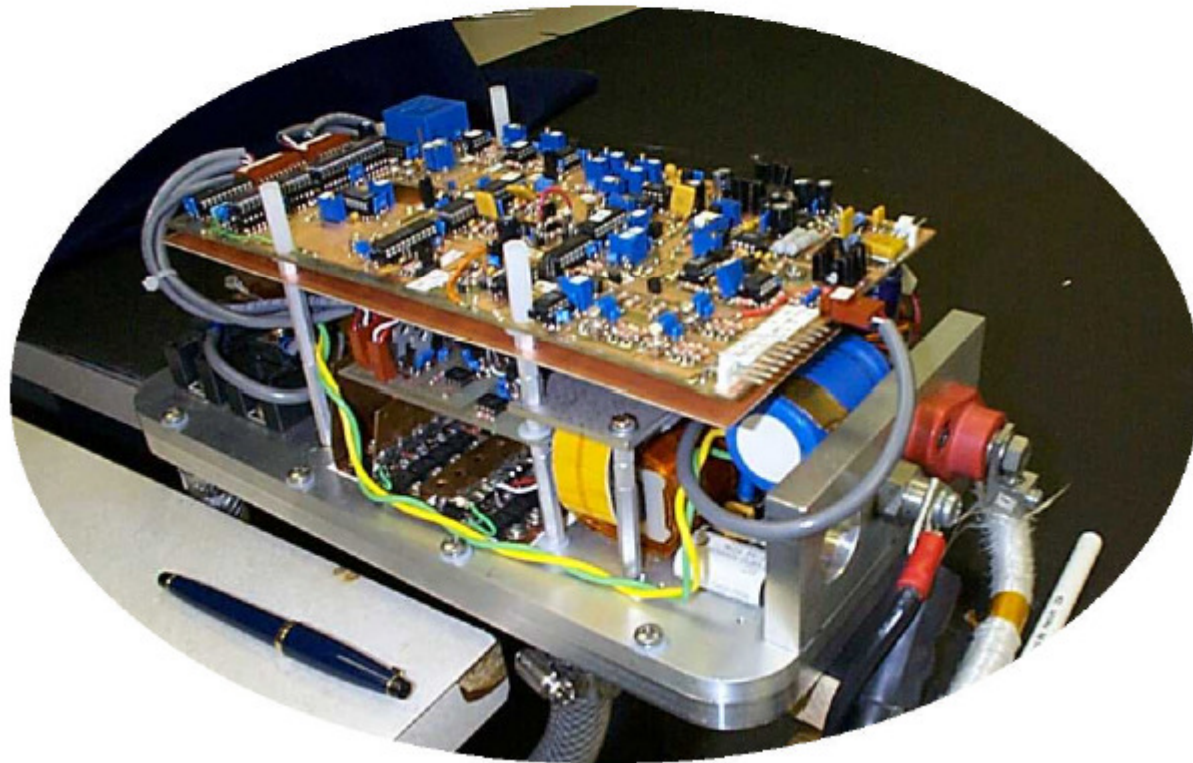
Illustration of a three-phase inverter in the drive train of an EV.

## • Background

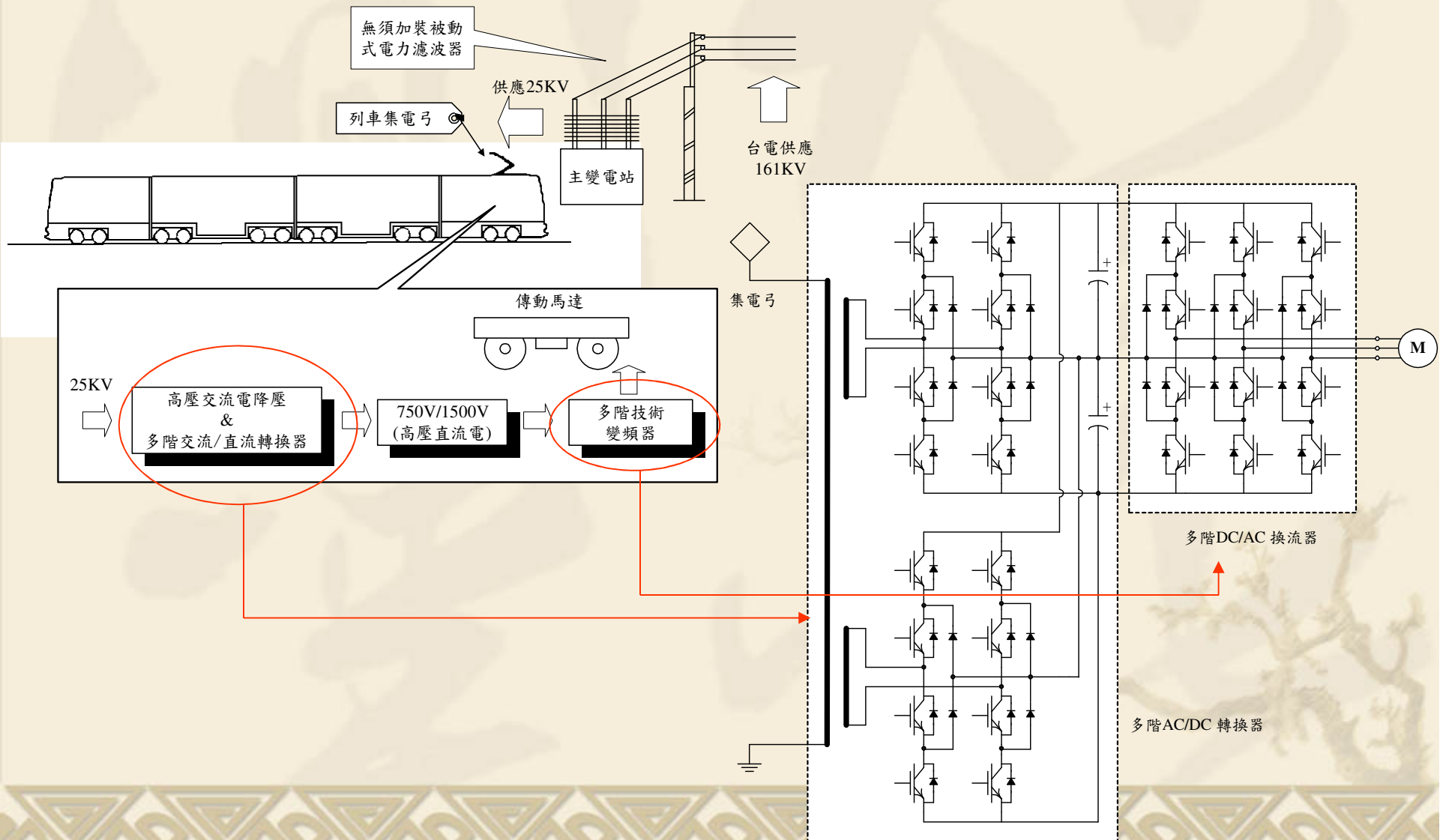
- A triple voltage bus (14V/42V/H.V.) system may be required in HEVs and FCVs
- Two separate dc/dc converters are needed with available technologies
- A bidirectional dc/dc converter is needed
- It is desirable to integrate the two dc/dc converters to reduce component count, size, and cost



## Prototype of a Liquid Cooled 5-kW Bi-directional DC-DC Converter



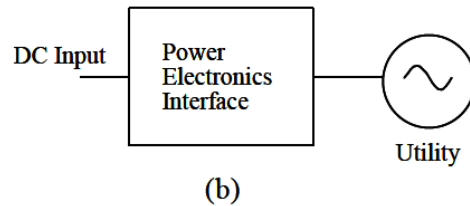
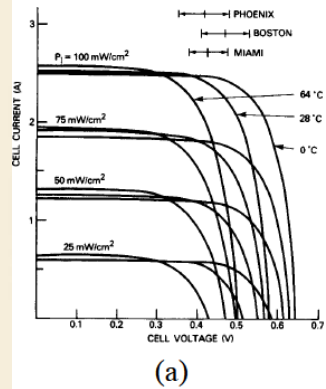
# Conventional Traction System with Three-Level PWM Scheme



## (4) Utility Applications

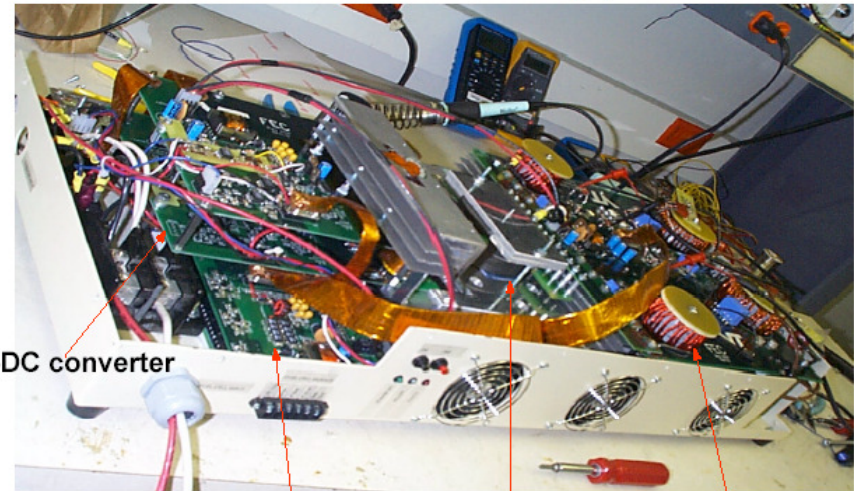
### Renewable Energy

#### Photovoltaic Systems



Photovoltaic Systems.

#### A 10-kW Split Single-Phase Fuel Cell Inverter for Residential Applications



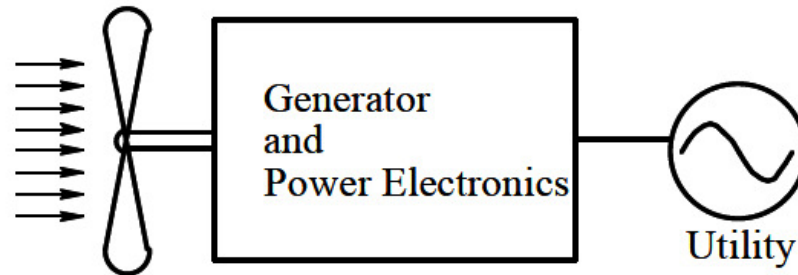
DC-DC converter

Digital controller

High-frequency transformer

DC-AC inverter

#### Wind-Electric Systems

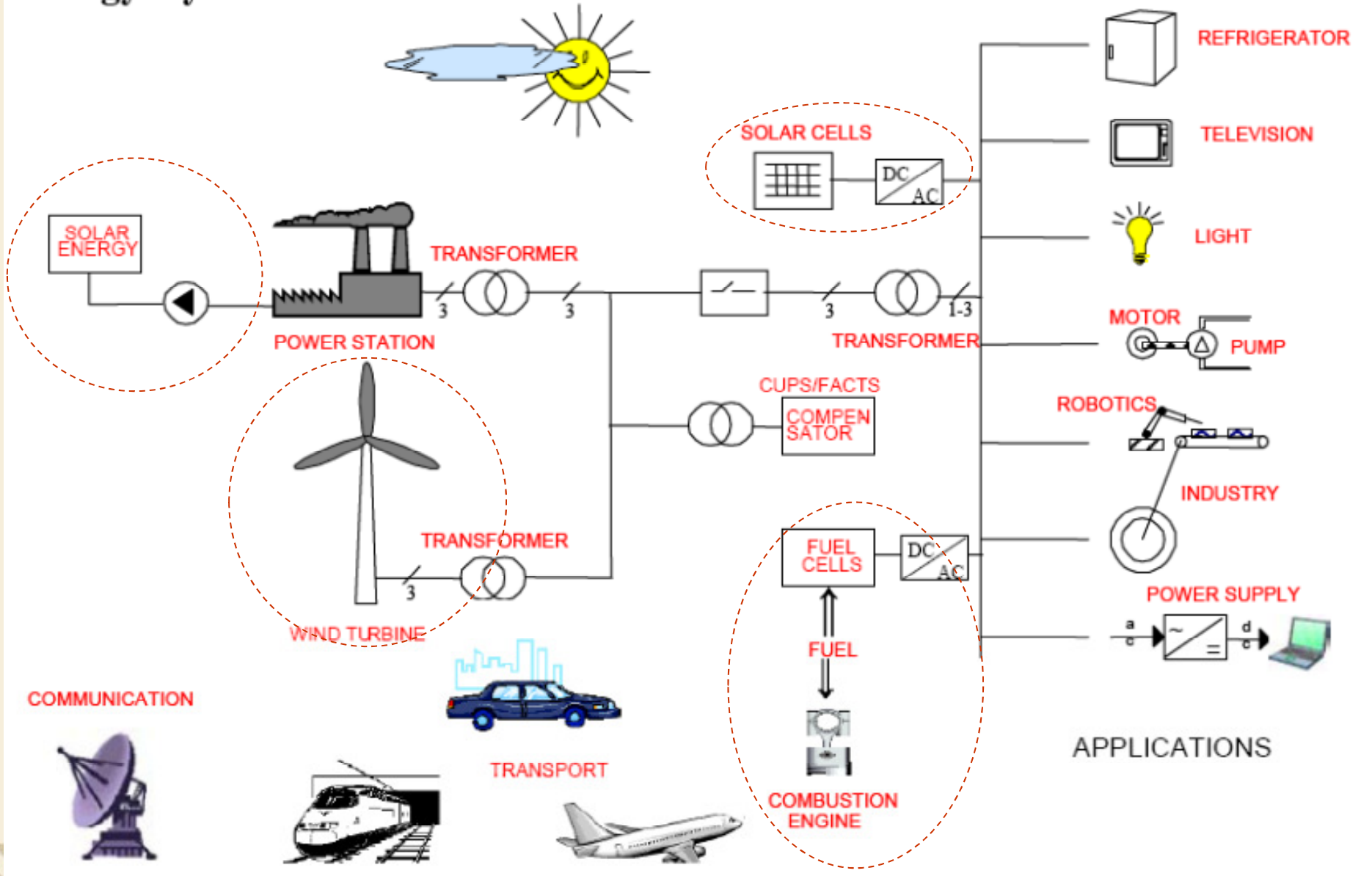


Wind-electric systems.



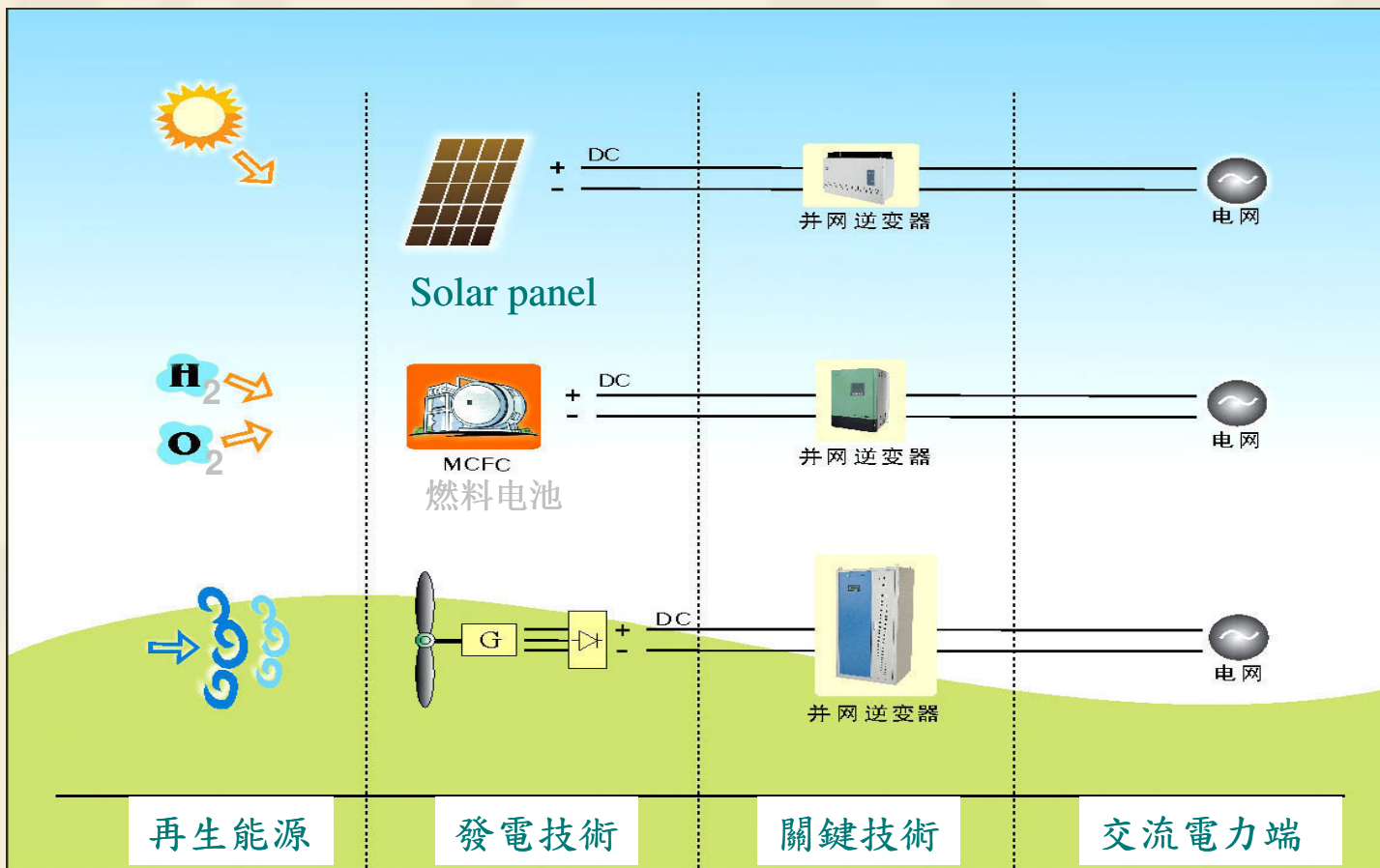
# 分佈式電力系統

## Energy System



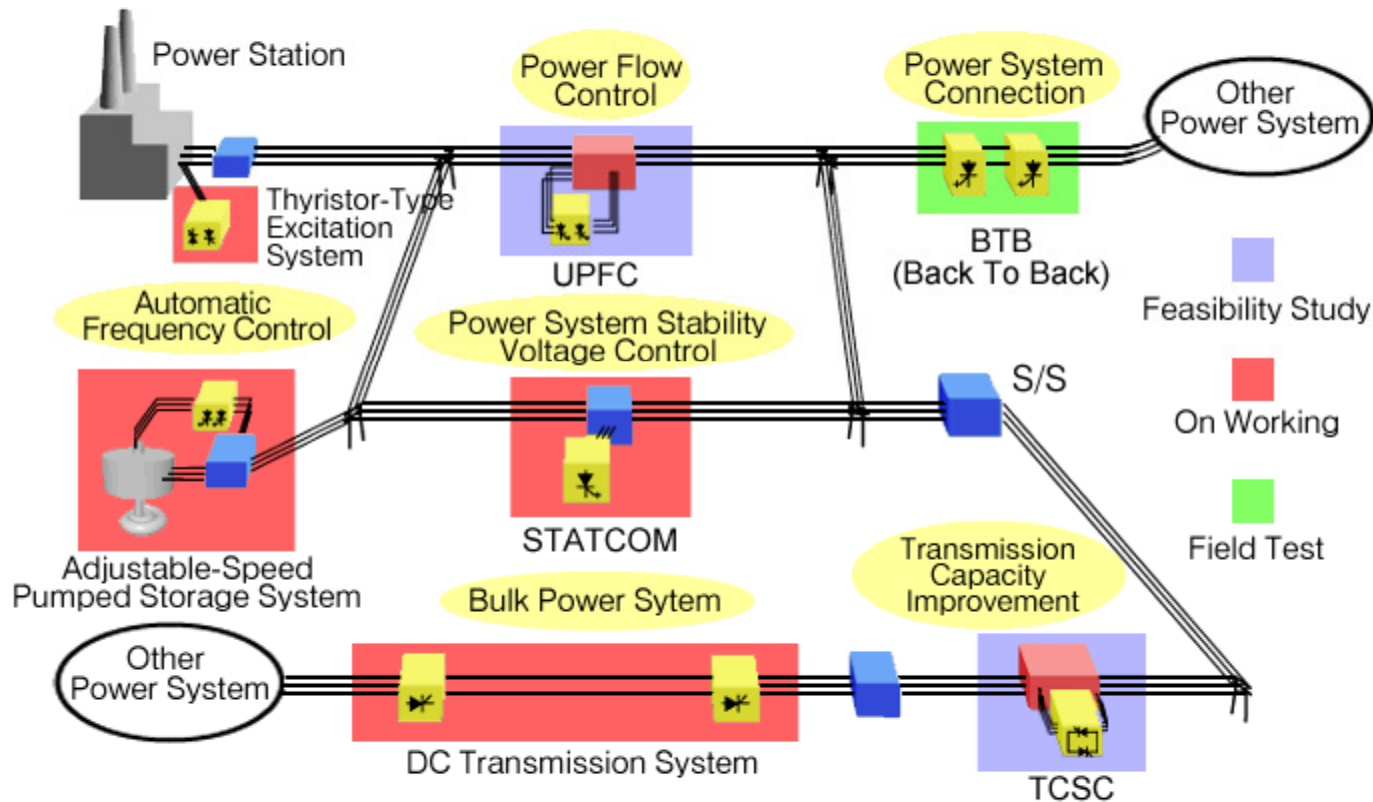
# 系統架構說明

## 再生能源發電應用的背景

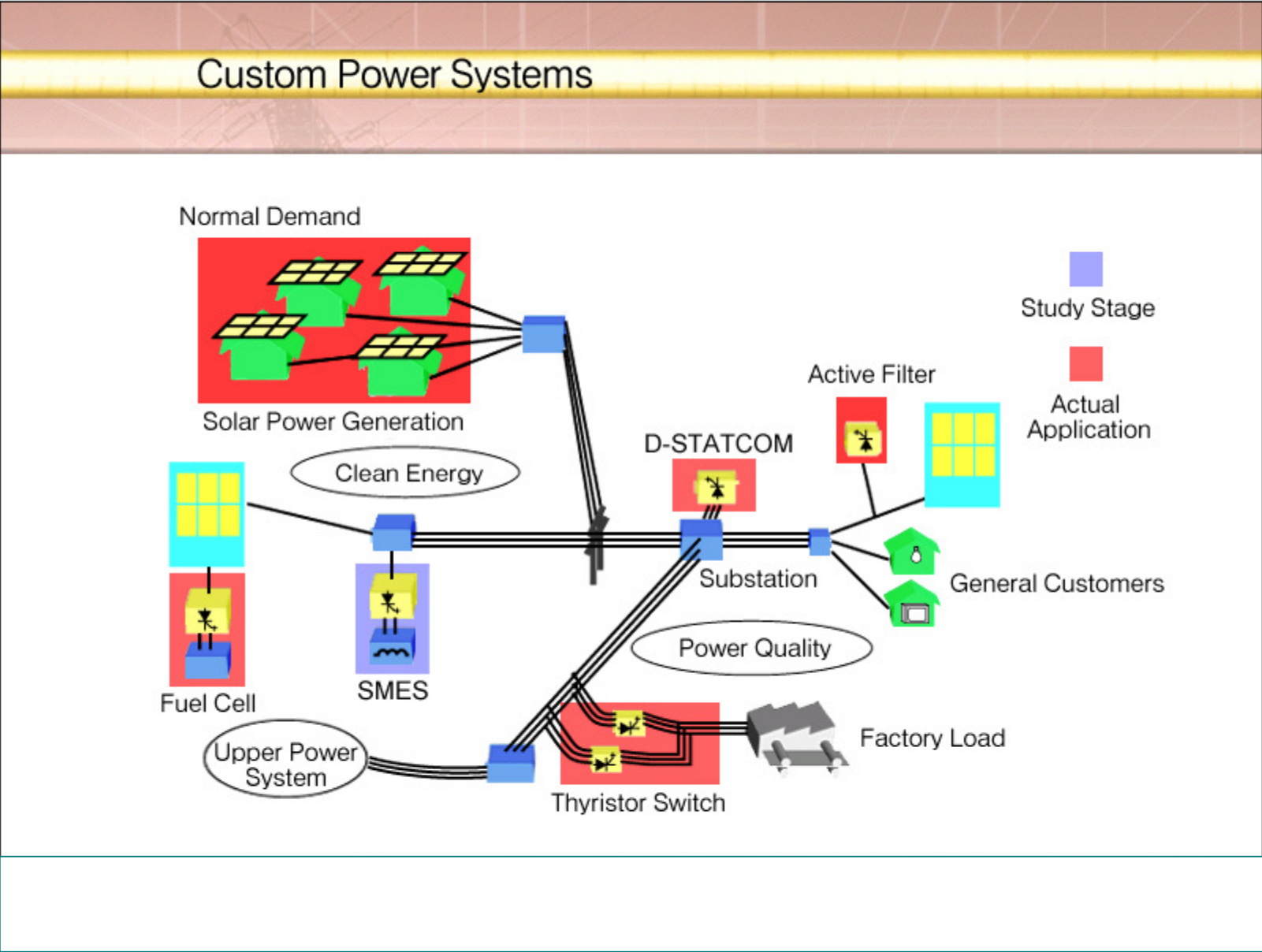


# FACT for Power Quality and Stability

## FACTS(Flexible AC Transmission Systems)



# Active Power Filter Application to Improve Power Quality



## **Conclusions:**

- **High Efficiency Power Supplies for Consumer Products**
- **High Efficiency Power Topologies**
- **Component Analysis**
- **Magnetic Components**
- **Mathematic Analysis**