



Design and Development of DC-Distributed System with Grid Connection for Residential Applications

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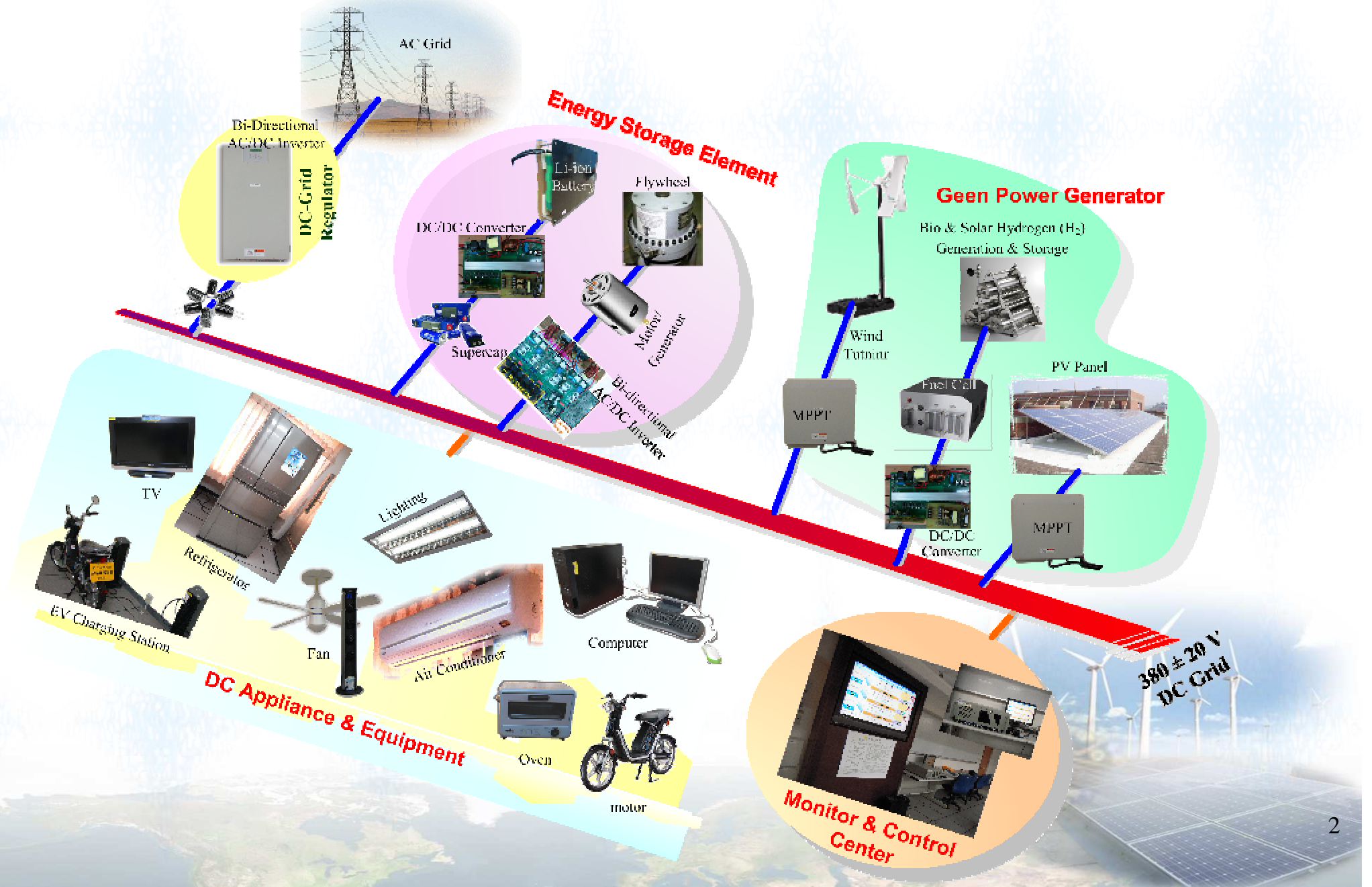
Outline



-  **System Configuration**
-  **Kernel Modules**
-  **Demo. House**
-  **Conclusions**



System Configuration

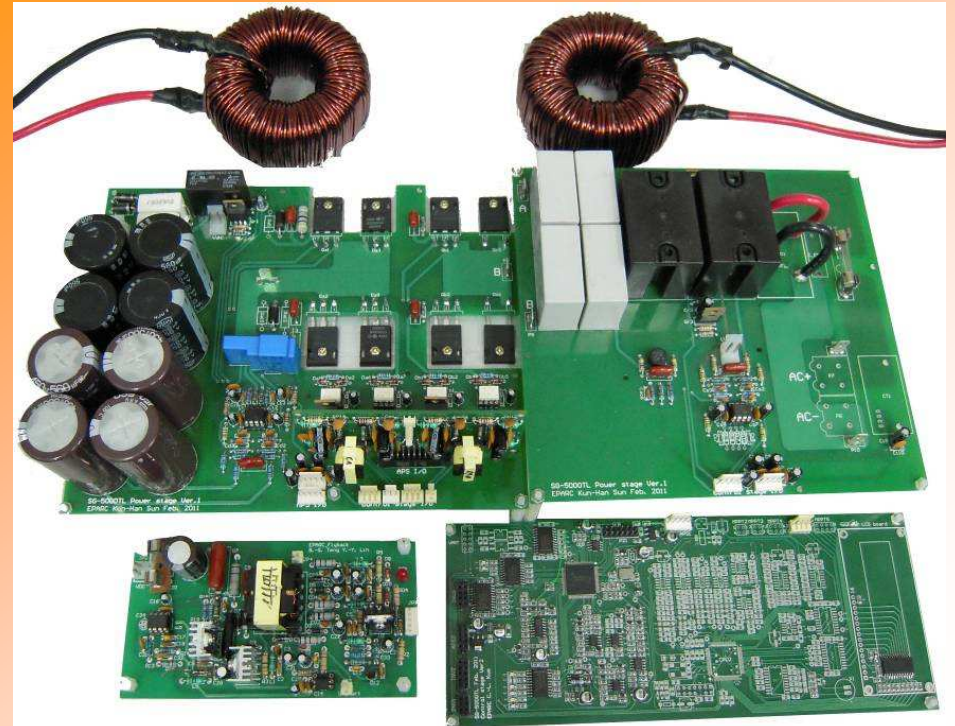
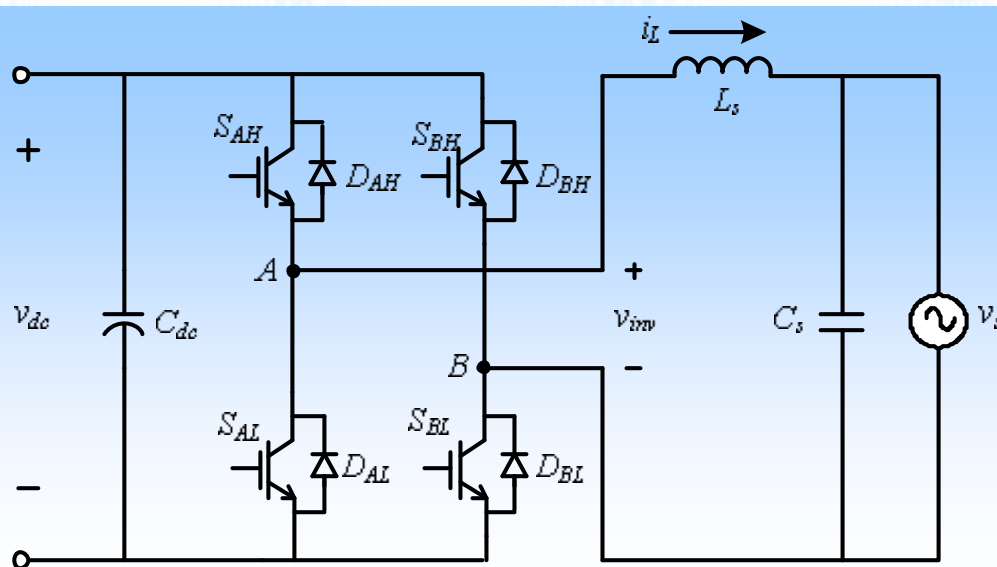




Kernel Modules

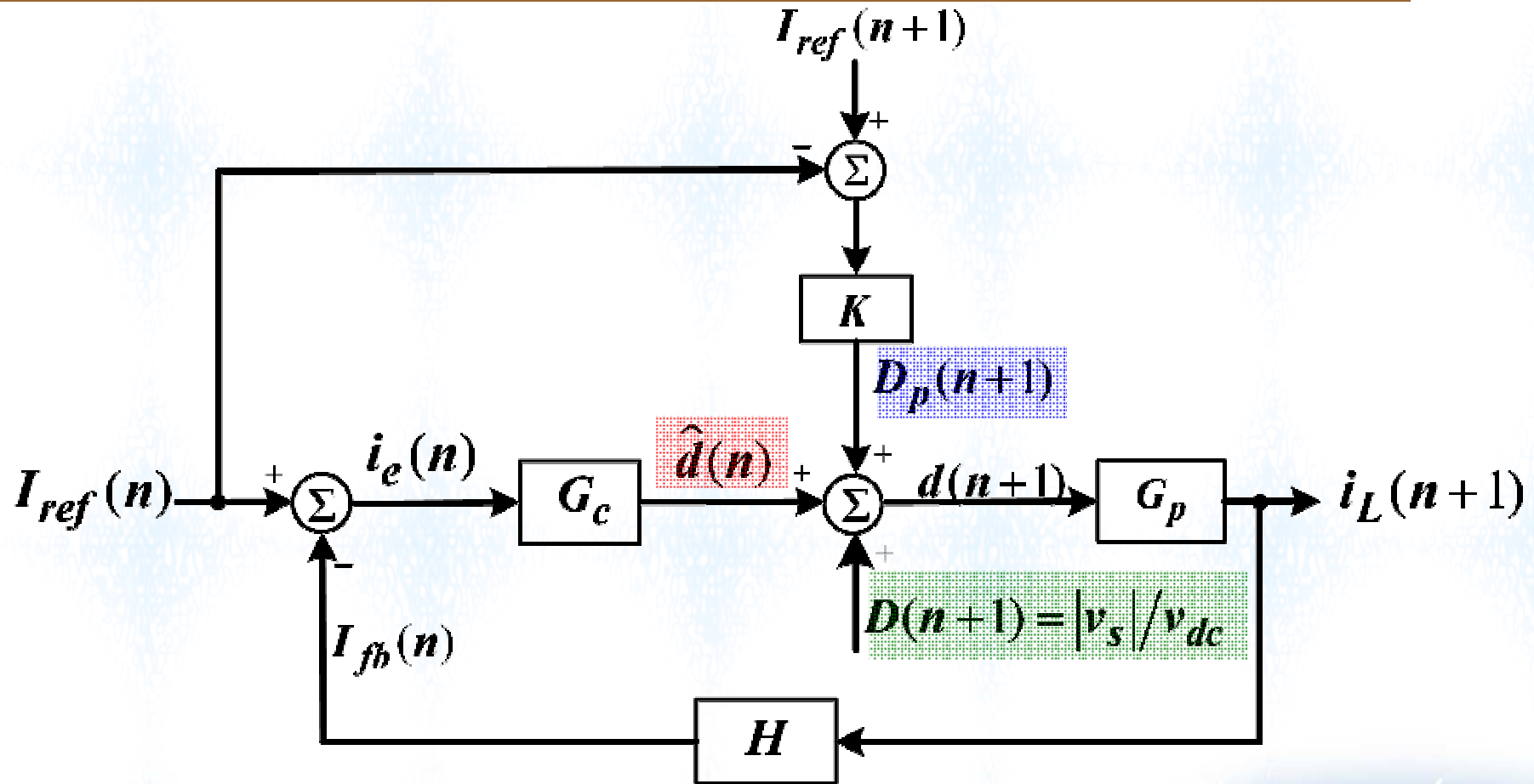
✚ *Bi-directional Inverter*

➤ Single-phase Bi-directional Inverter





Kernel Modules



Take G_C as an instance

$$d = \frac{\Delta i_L \cdot L_s(i)}{v_{dc} T_s} + \frac{|v_s|}{v_{dc}}$$

$$G'_C = G_C v_{dc} T_s / L_s$$

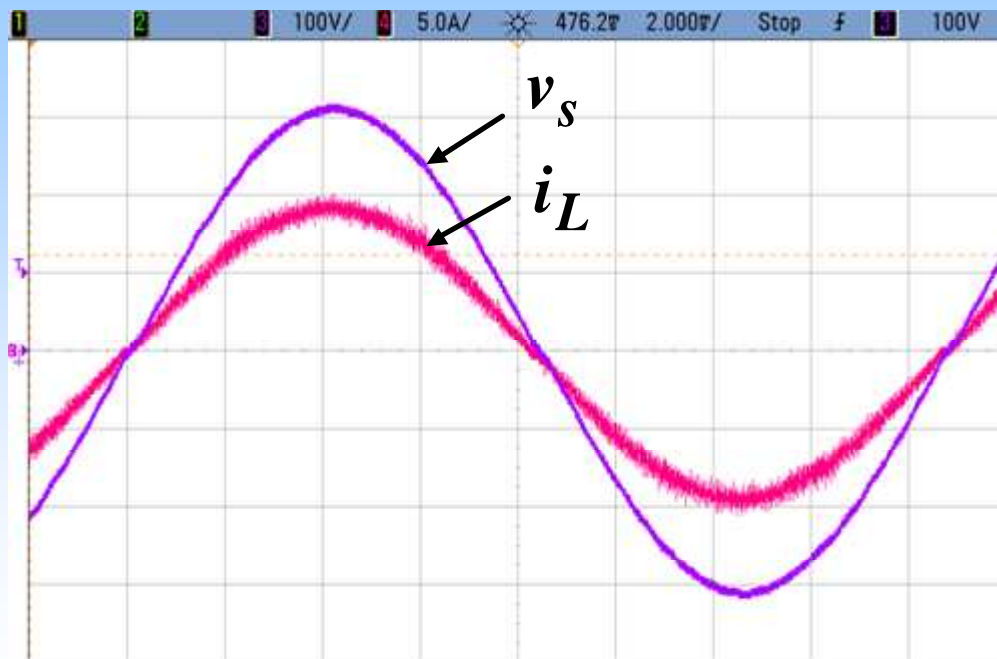
$$\Delta i_L(n+1) = \Delta I(n+1) + G'_C \cdot i_e(n)$$



Kernel Modules

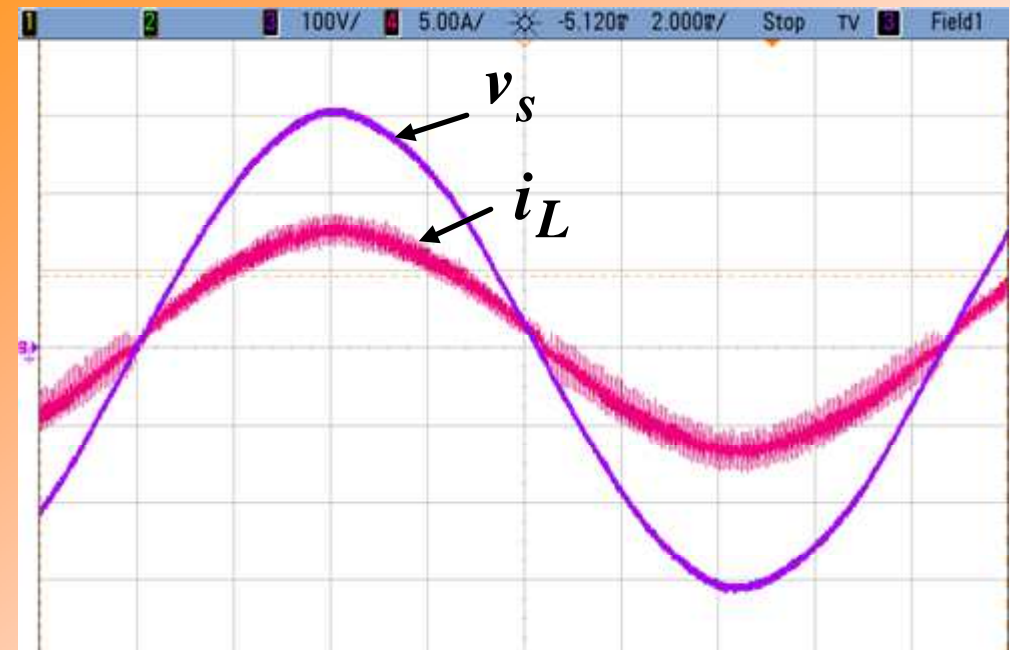
Measured Waveforms ($P_o = 1 \text{ kW}$)

Grid Connection



(v_s : 100 V/div, i_L : 5.0A/div, 2ms/div)

Rectification



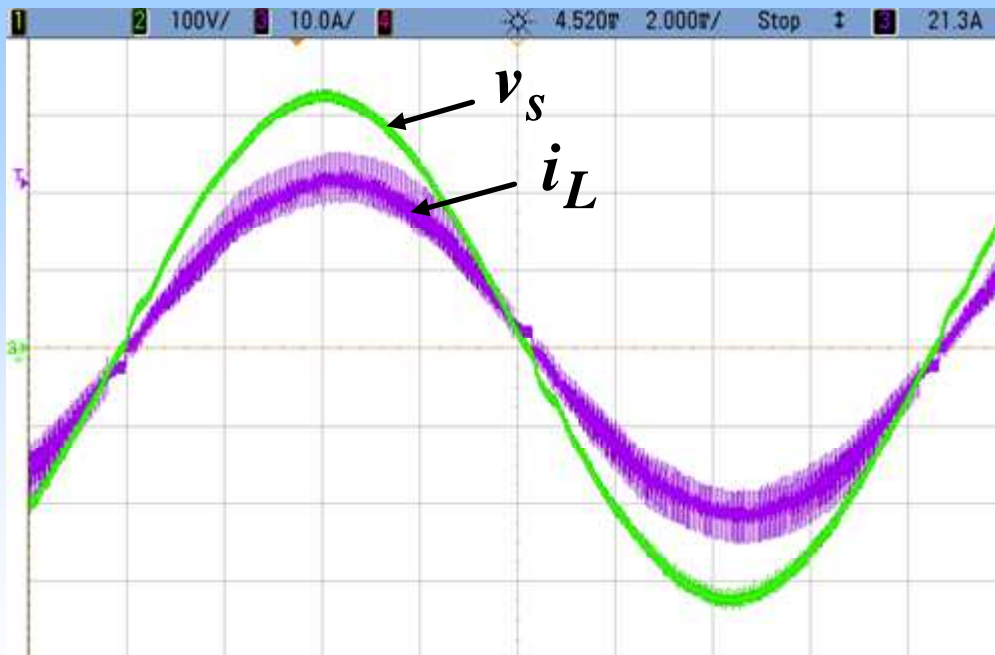
(v_s : 100 V/div, i_L : 5.0A/div, 2ms/div)



Kernel Modules

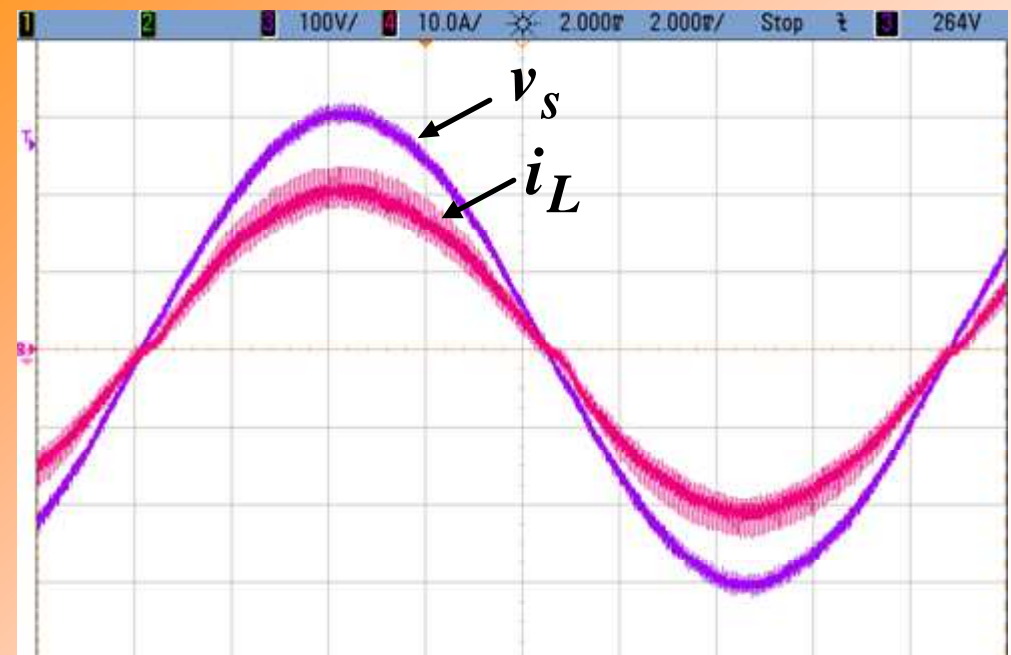
Measured Waveforms ($P_o = 3 \text{ kW}$)

Grid Connection



(v_s : 100 V/div, i_L : 10.0A/div, 2ms/div)

Rectification



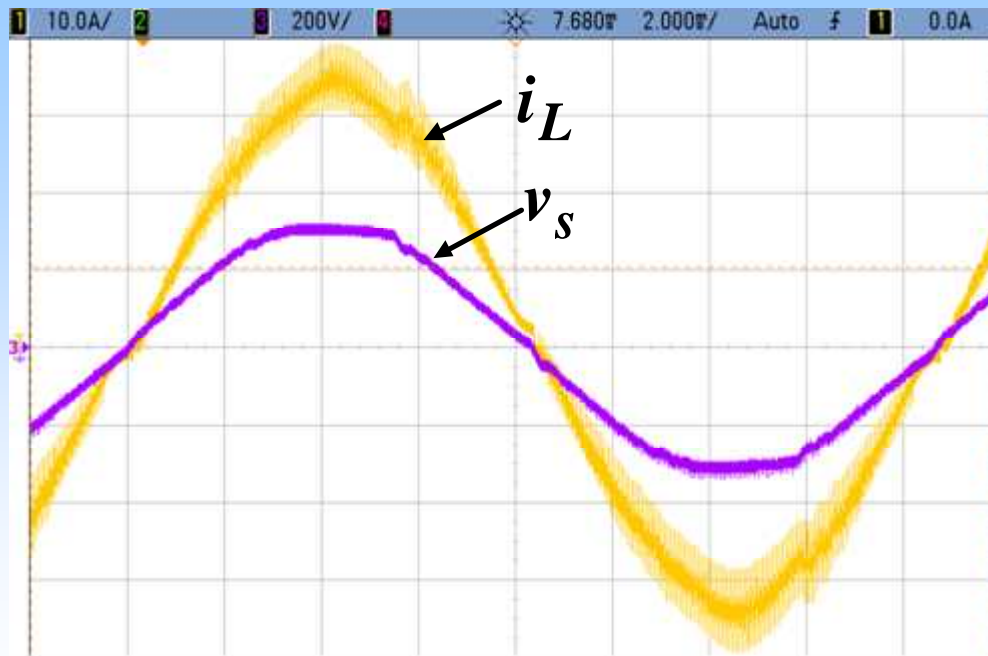
(v_s : 100 V/div, i_L : 10.0A/div, 2ms/div)



Kernel Modules

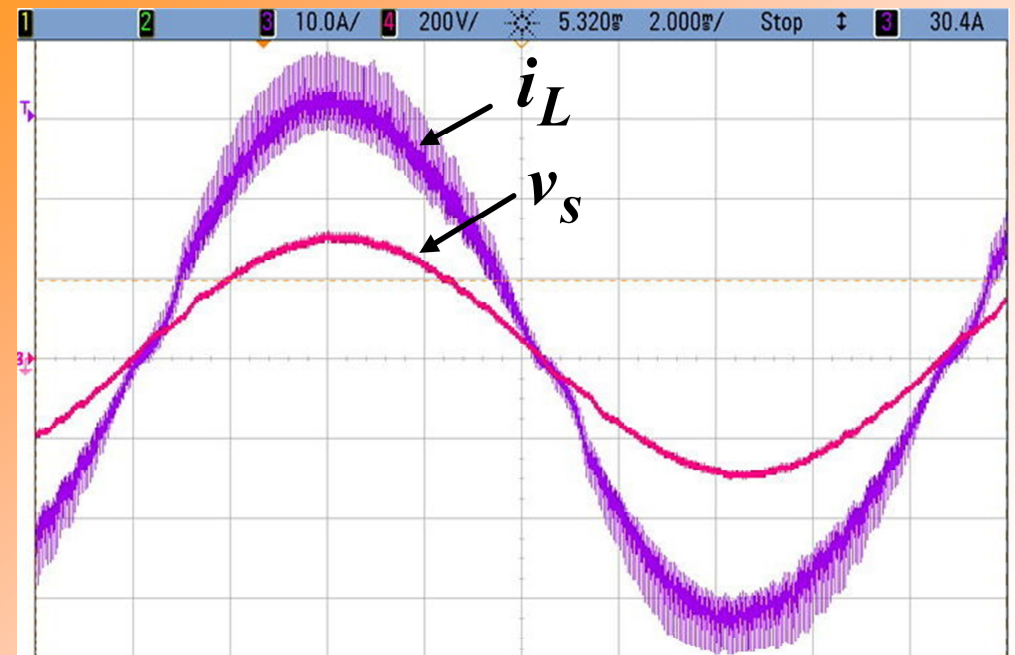
Measured Waveforms ($P_o = 5 \text{ kW}$)

Grid Connection



(v_s : 200 V/div, i_L : 10.0A/div, 2ms/div)

Rectification



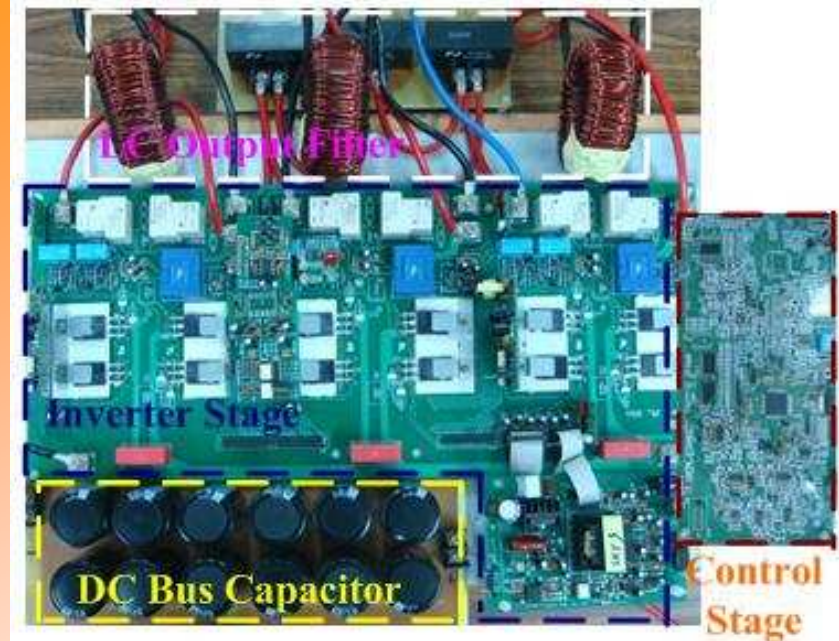
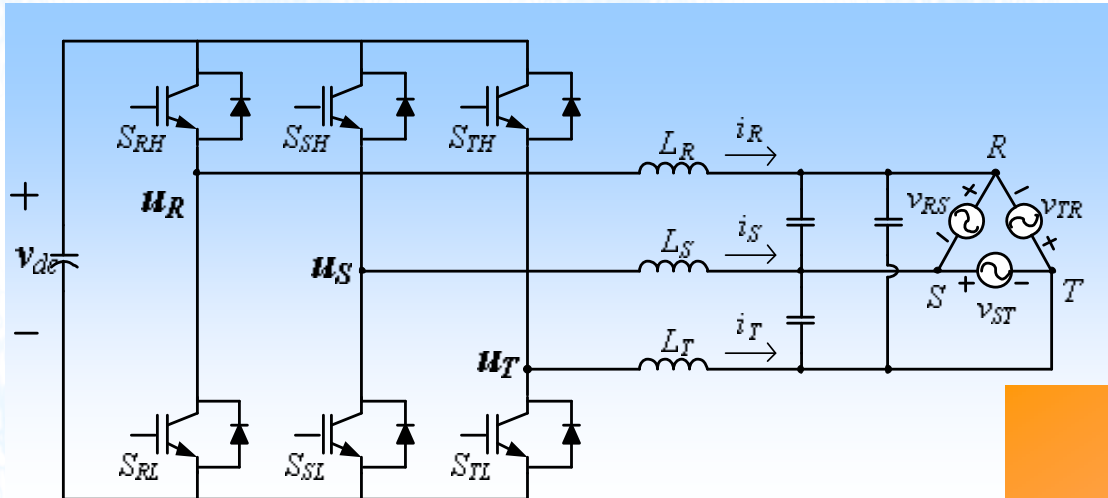
(v_s : 200 V/div, i_L : 10.0A/div, 2ms/div)



Kernel Modules

Bi-directional Inverter

Three-phase Bi-directional Inverter

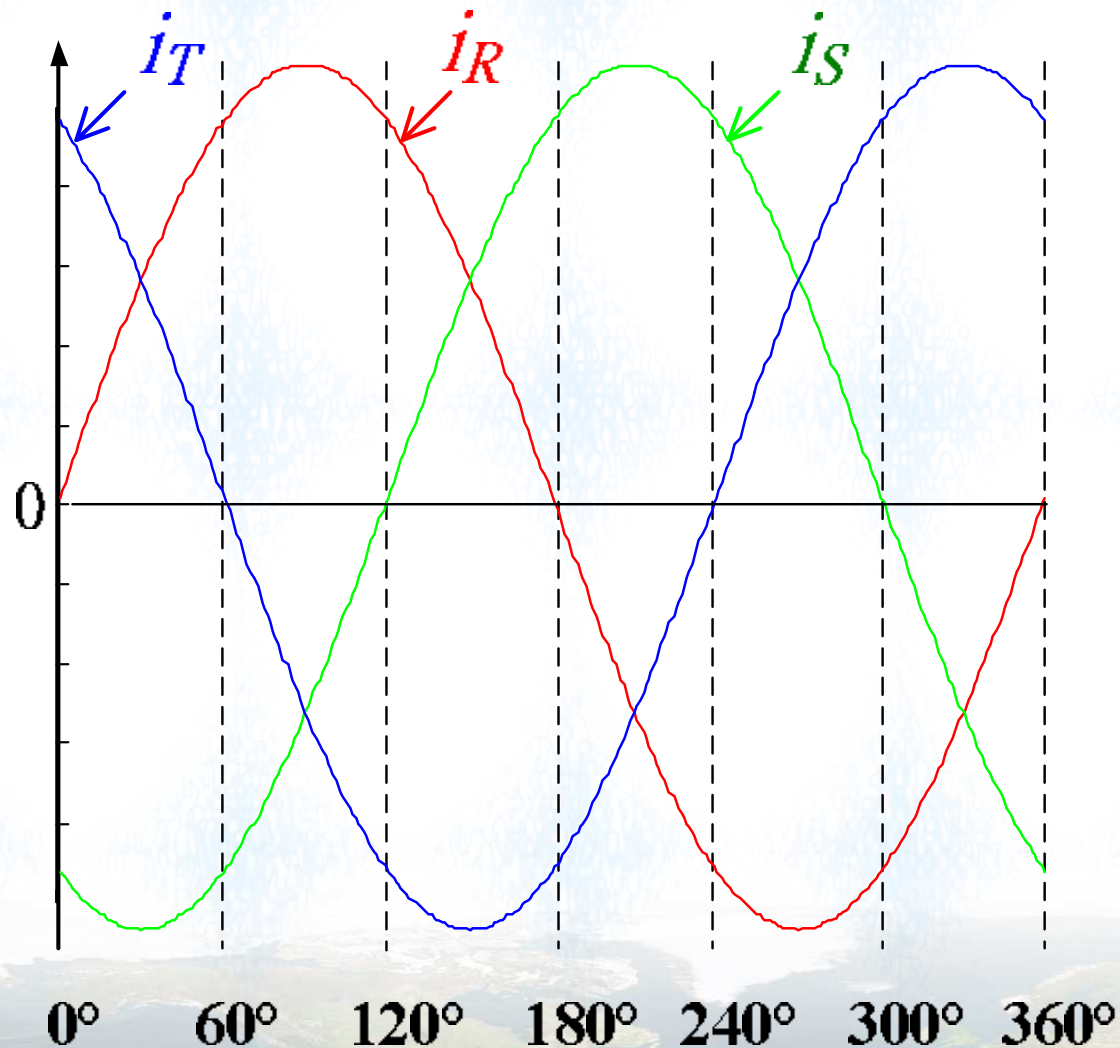




Kernel Modules

Bi-directional Inverter

Three-phase Bi-directional Inverter



A line period is divided into 6 regions.



Kernel Modules

Predictive Current Control

- Duty-Ratio Control Laws — Two Phase Modulation

$$\begin{bmatrix} D_{RH} \\ D_{SL} \\ D_{TH} \end{bmatrix} = \begin{bmatrix} \frac{(L_R + L_S) \Delta i_{v(R)} + L_S \Delta i_{v(T)}}{v_{DC}} \\ 0 \\ \frac{(L_T + L_S) \Delta i_{v(T)} + L_S \Delta i_{v(R)}}{v_{DC}} \end{bmatrix} + \begin{bmatrix} \frac{v_{RS}}{v_{DC}} \\ 1 \\ -\frac{v_{ST}}{v_{DC}} \end{bmatrix}$$

for Region: $0^\circ \sim 60^\circ$

where

$$D_{RH} = \frac{T_2}{T_S}$$

$$D_{TH} = \frac{T_1}{T_S} + \frac{T_2}{T_S}$$

Only phases R and T in switching

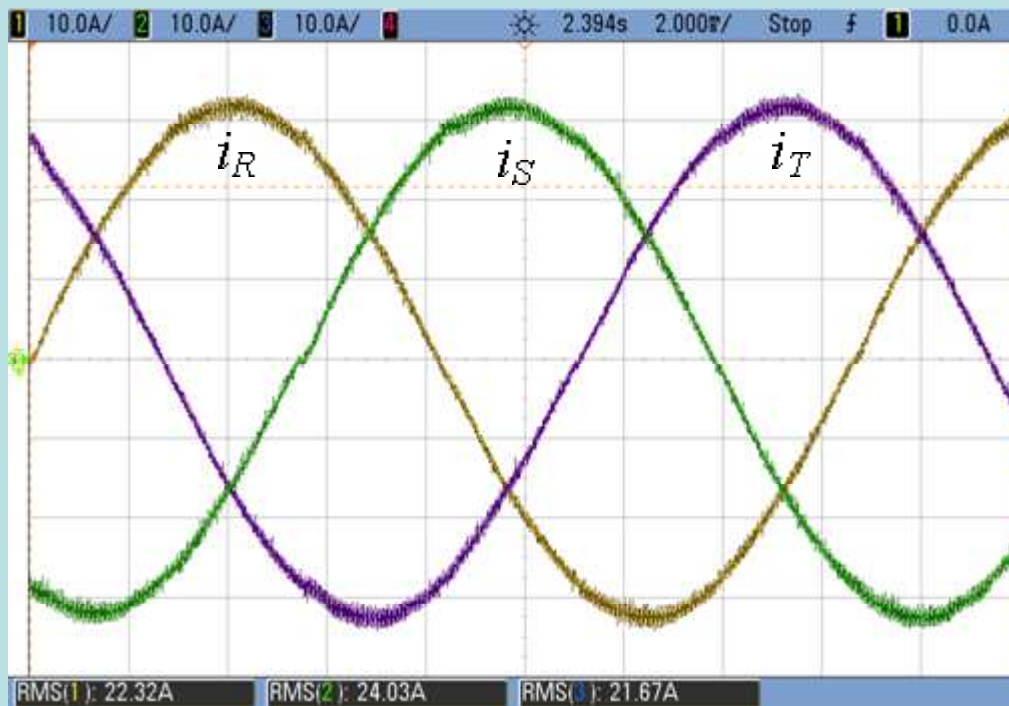


Kernel Modules

Bi-directional Inverter

Three-phase Bi-directional Inverter — 10 kW

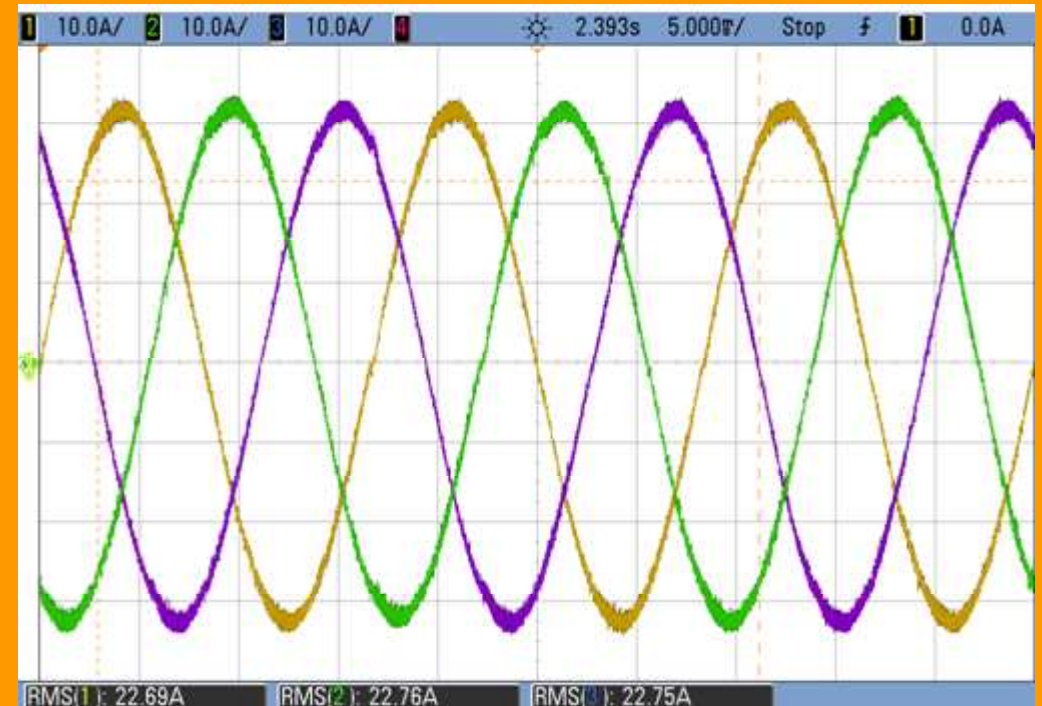
Grid Connection



(i_R , i_S and i_T : 10 A/div; time: 2ms/div)

(a)

Rectification



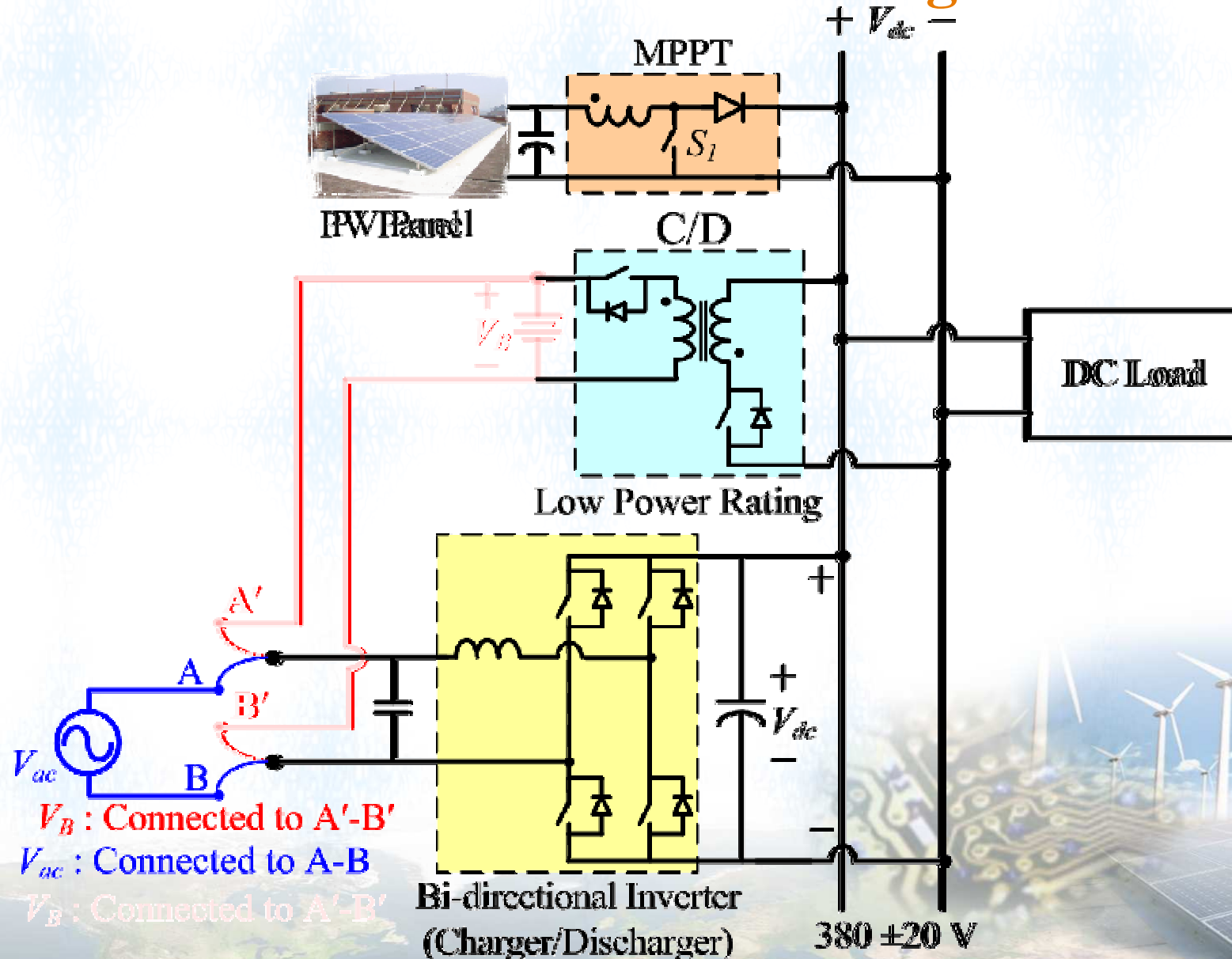
(i_R , i_S and i_T : 10 A/div; time: 2ms/div)

(b)



Kernel Modules

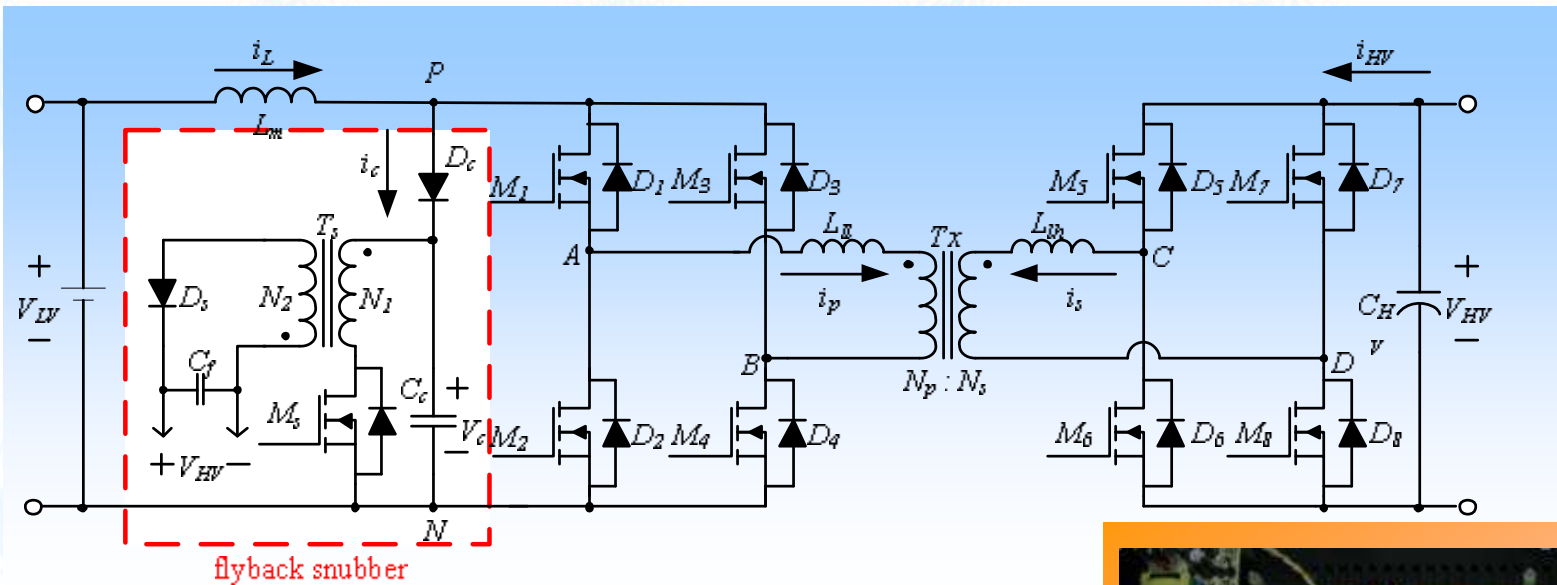
➤ Bi-directional Inverter – Charger/Discharger





Kernel Modules

Bi-directional Charger / Discharger (I)

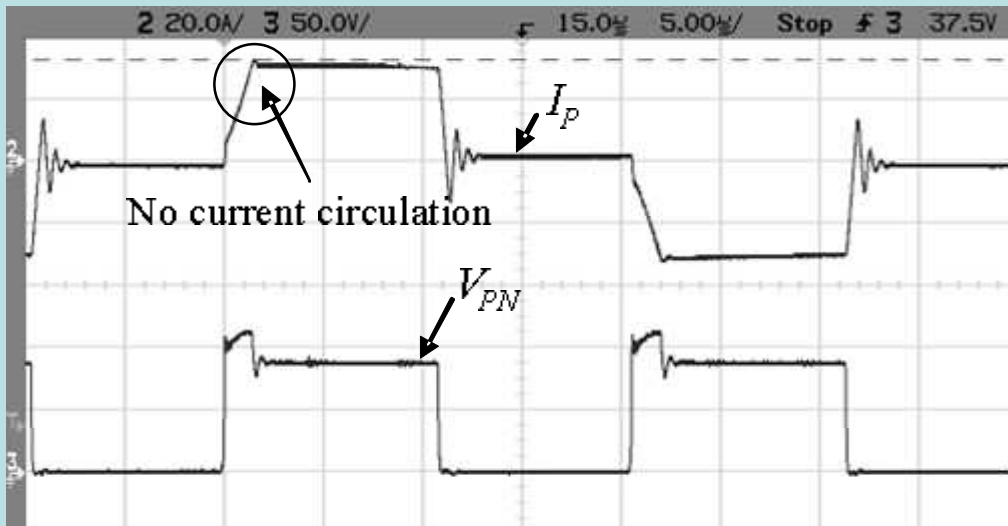




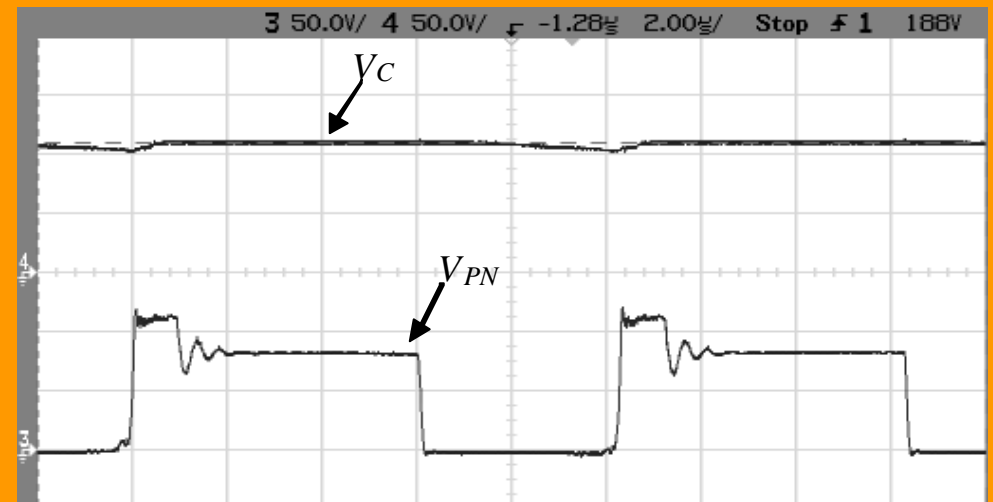
Kernel Modules

Bi-directional Charger / Discharger (I)

transformer & switch currents



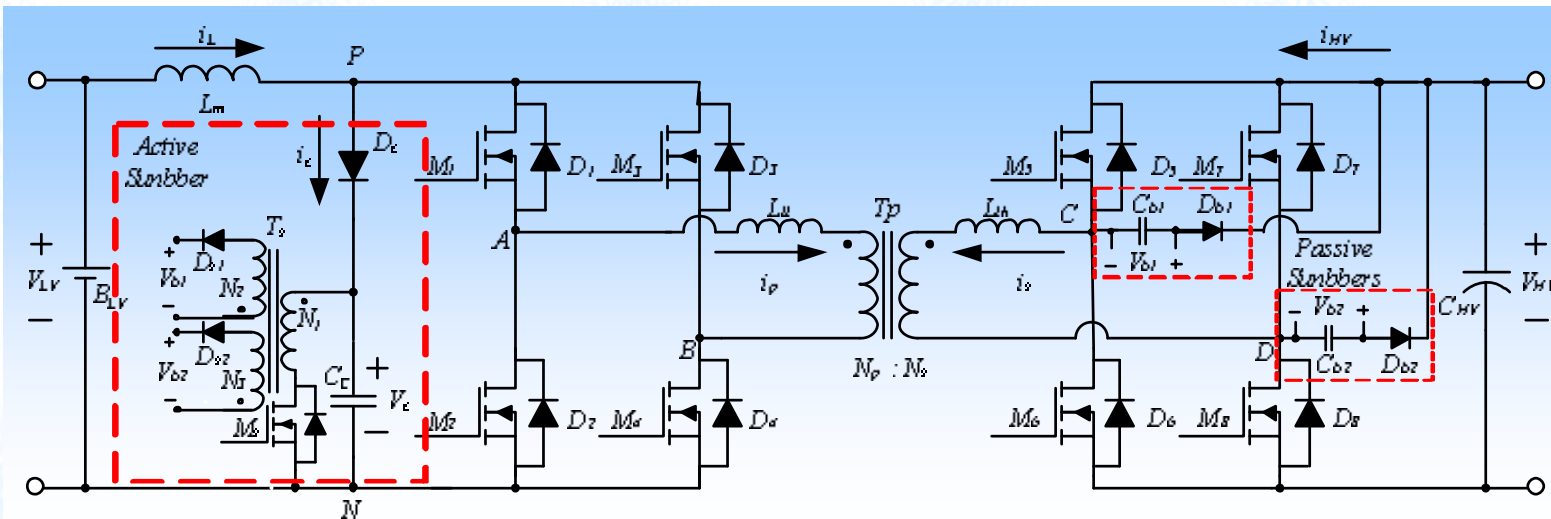
Rail voltage V_{PN} and clamping voltage V_C





Kernel Modules

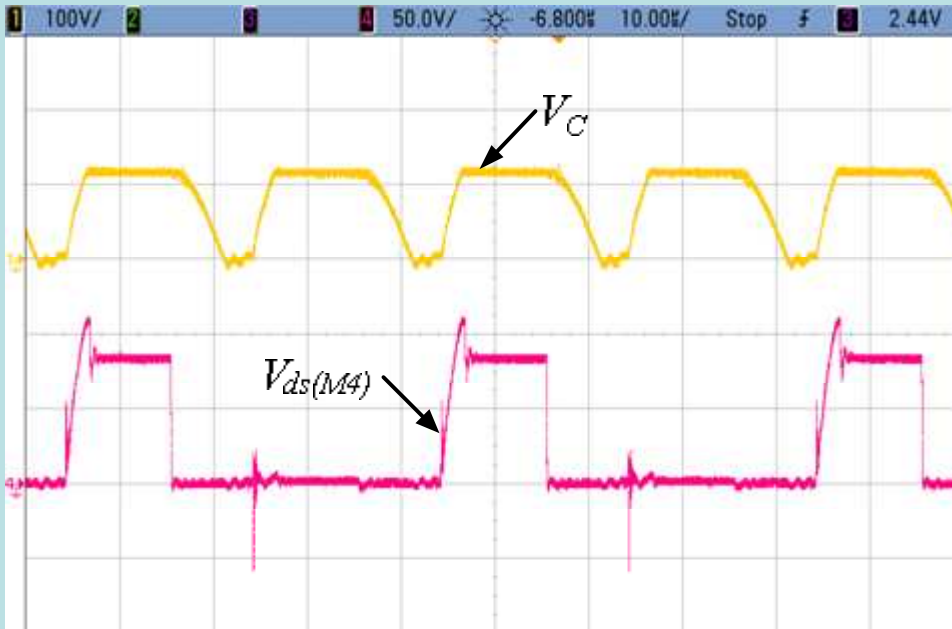
Bi-directional Charger / Discharger (II)





Kernel Modules

clamping capacitor and switch voltages



(V_C : 100 V/div, $V_{ds(M4)}$: 50 V/div, Time: 10 μ s/div)

Near ZVS turn-on

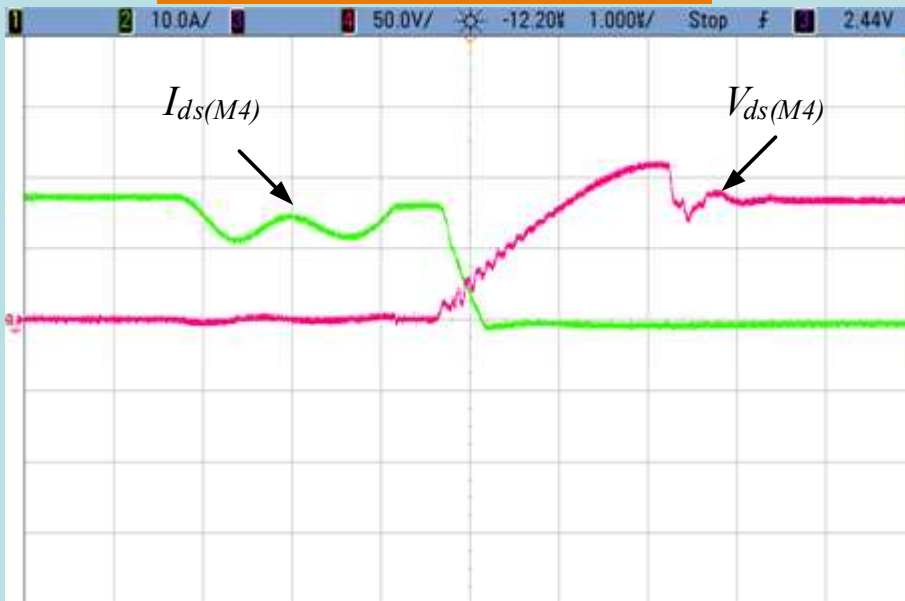


($V_{ds(M4)}$: 50 V/div, $I_{ds(M4)}$: 10 A/div, Time: 1 μ s/div)



Kernel Modules

Near ZCS turn-off



($V_{ds}(M4)$: 50 V/div, $I_{ds}(M4)$: 10 A/div, Time: 1 μ s/div)

Near ZCS at high-side switch

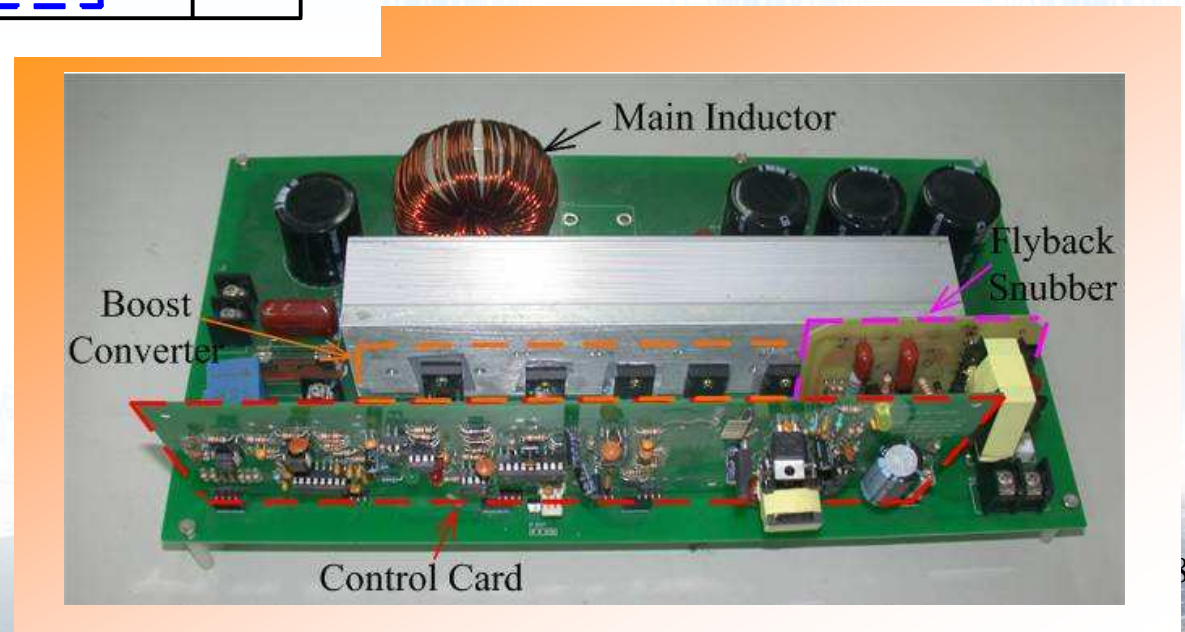
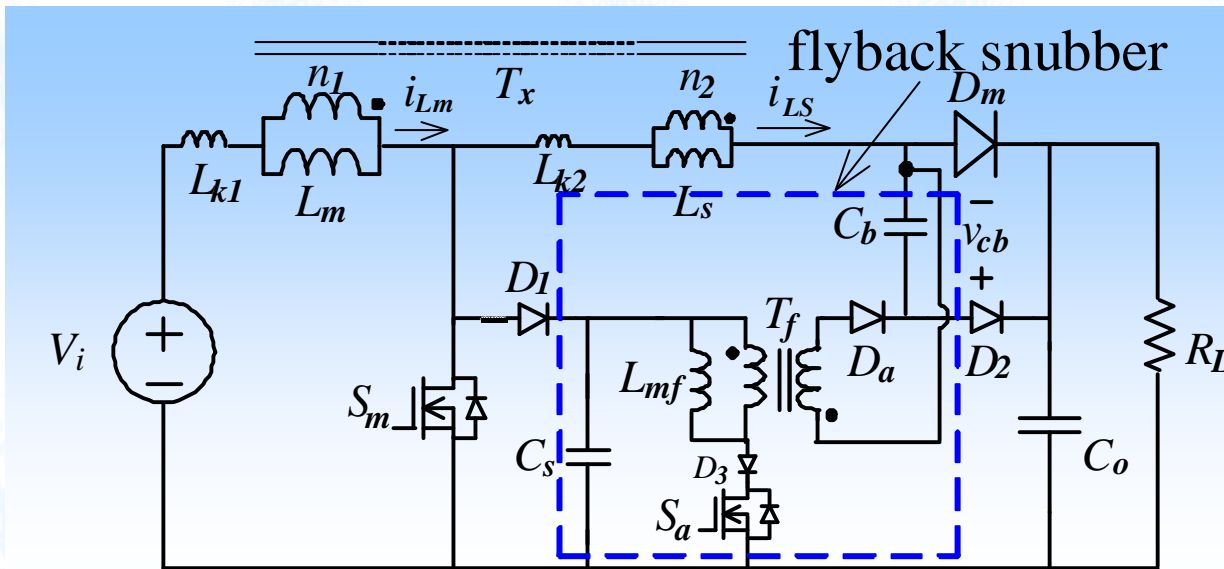


($V_{ds}(M8)$: 100 V/div, $I_{ds}(M8)$: 2 A/div, Time: 50 ns/div)



Kernel Modules

Maximum Power Point Tracker

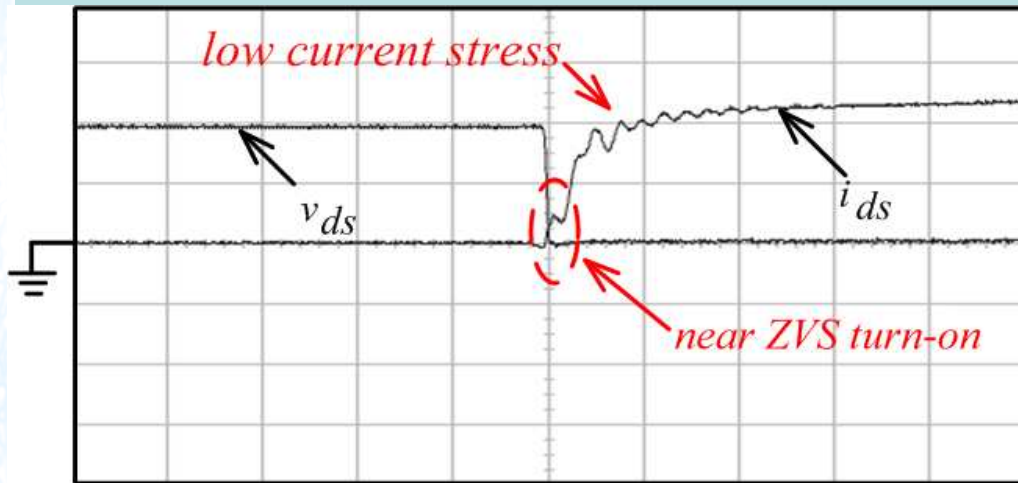




Kernel Modules

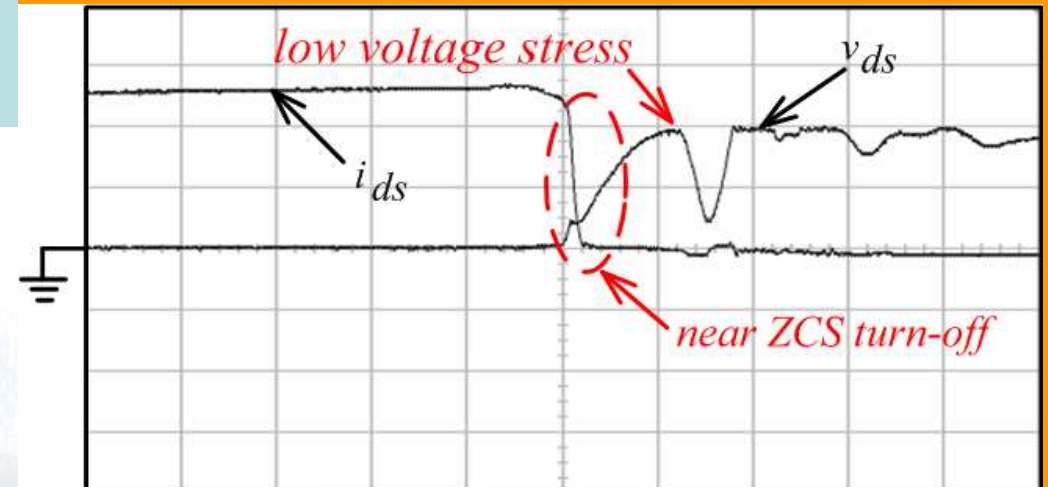
Maximum Power Point Tracker

Near ZVS turn-on



(200 V/div, 10 A/div, 0.5 μ s/div)

Near ZCS turn-off



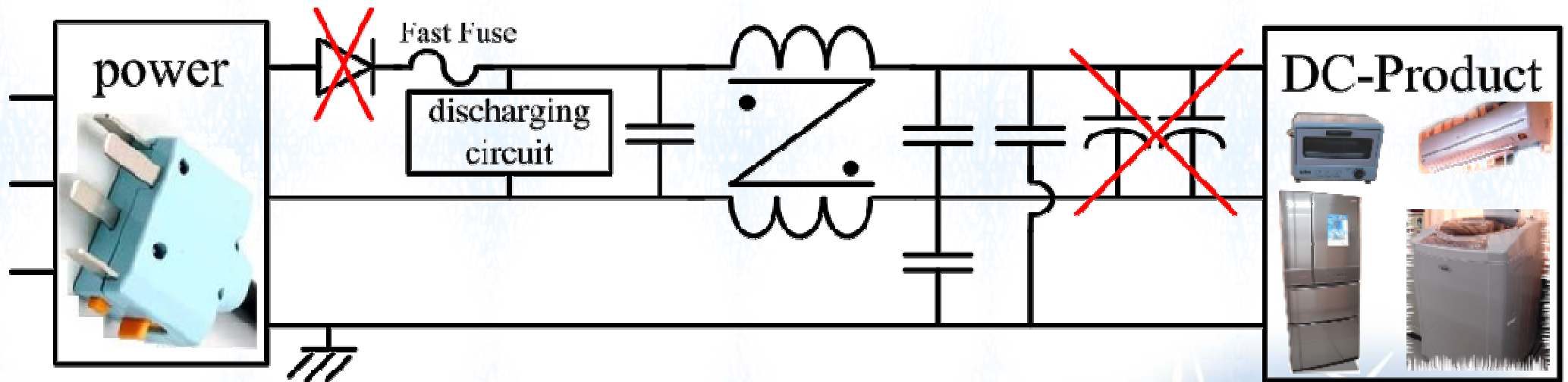
(200 V/div, 10 A/div, 0.5 μ s/div)



Kernel Modules

✚ *DC-Appliance and Product*

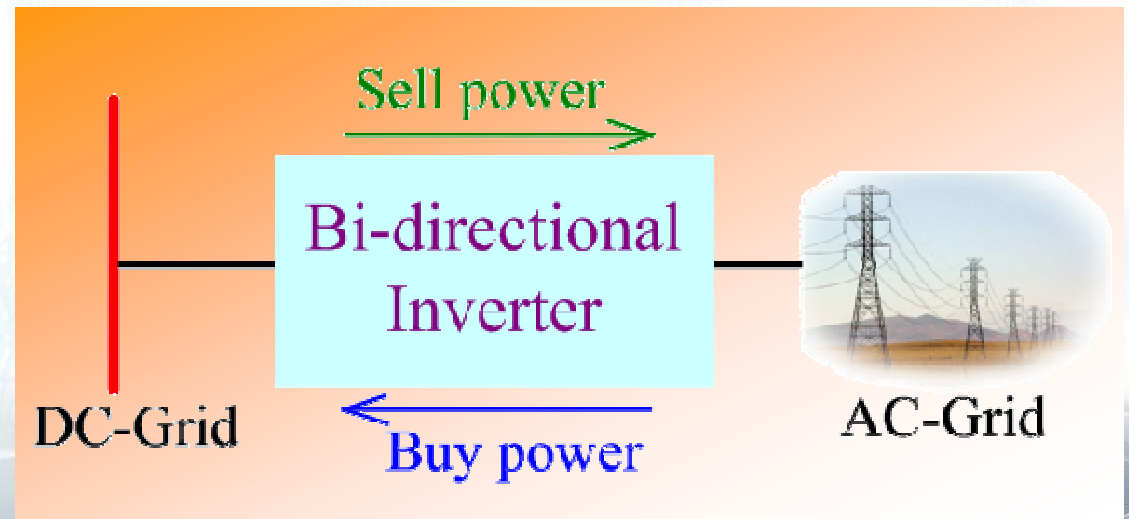
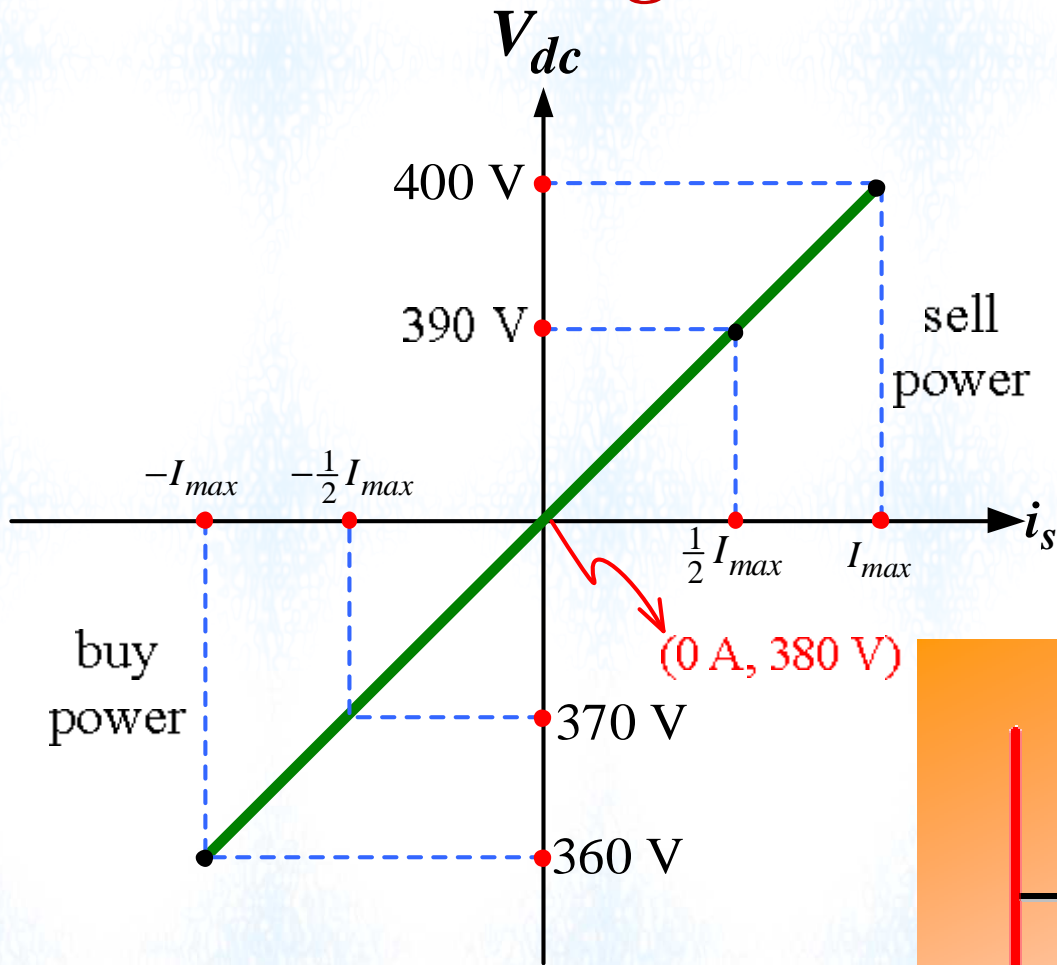
Input stage of a DC product





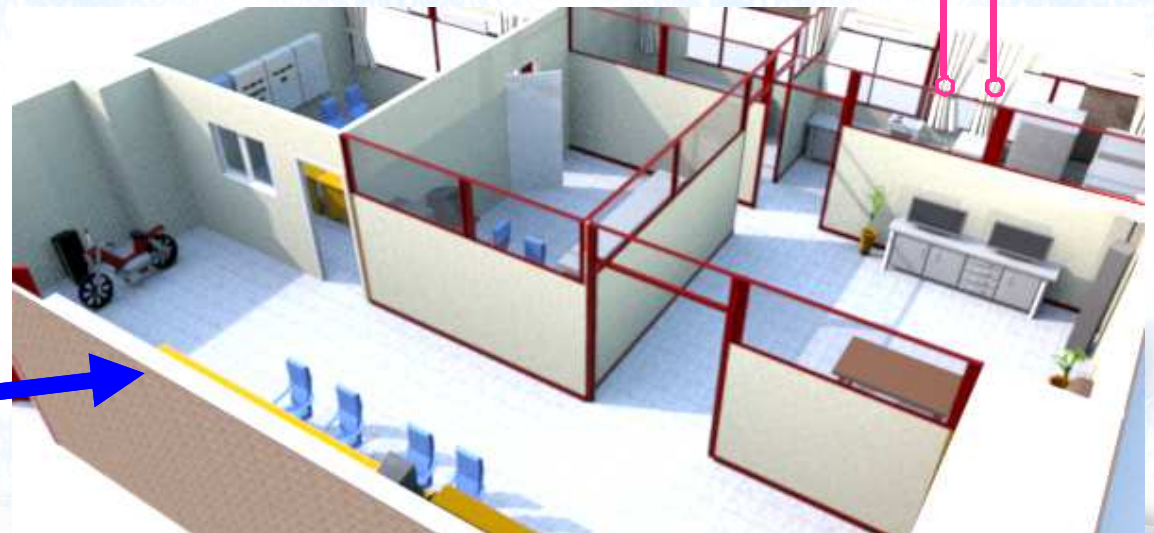
Kernel Modules

✚ *DC-Grid Regulation*



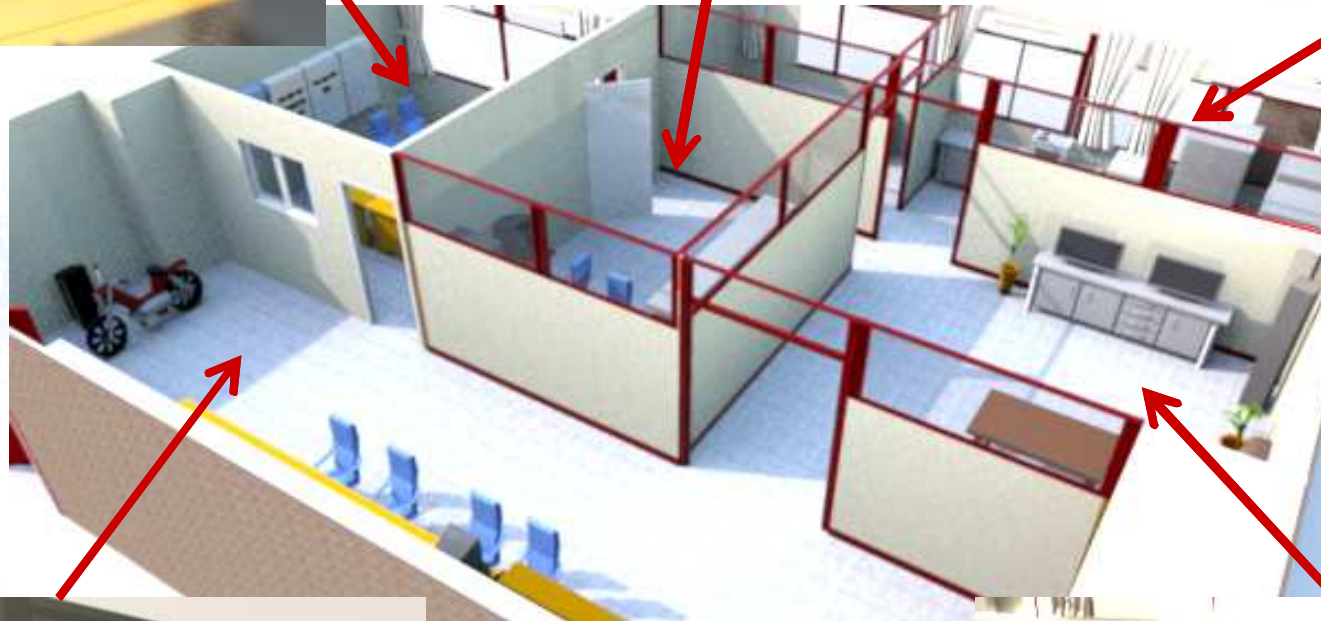
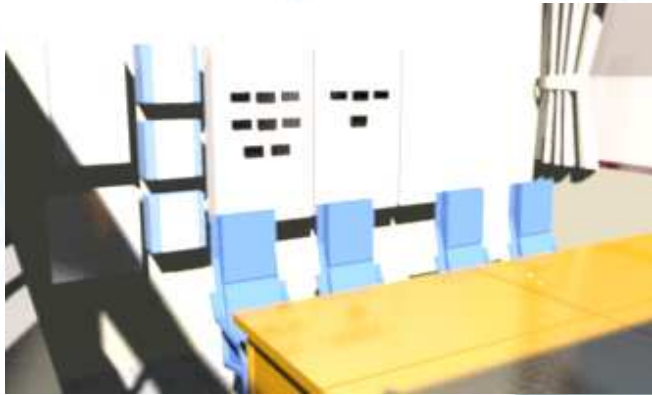


Demo. House





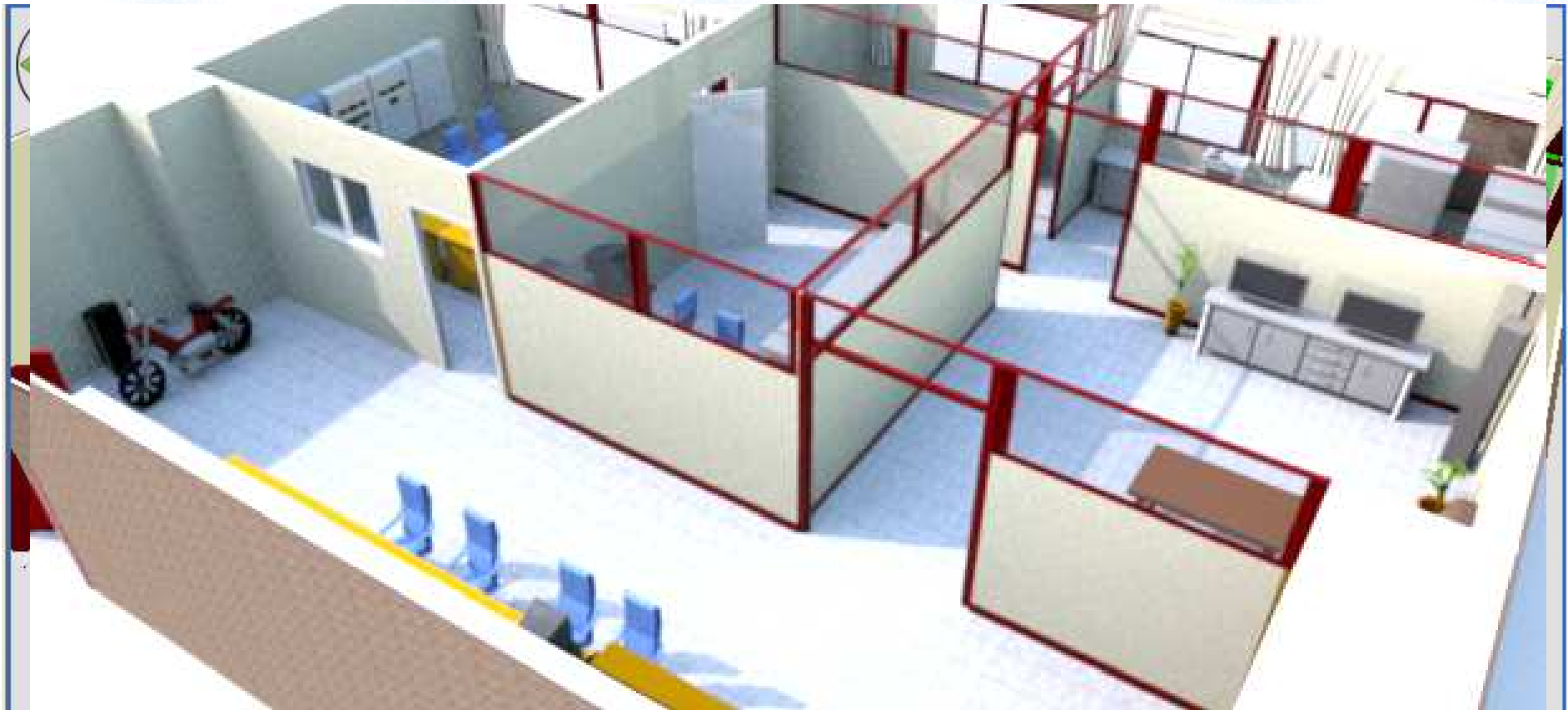
Demo. House





Demo. House

DC AC





Conclusions

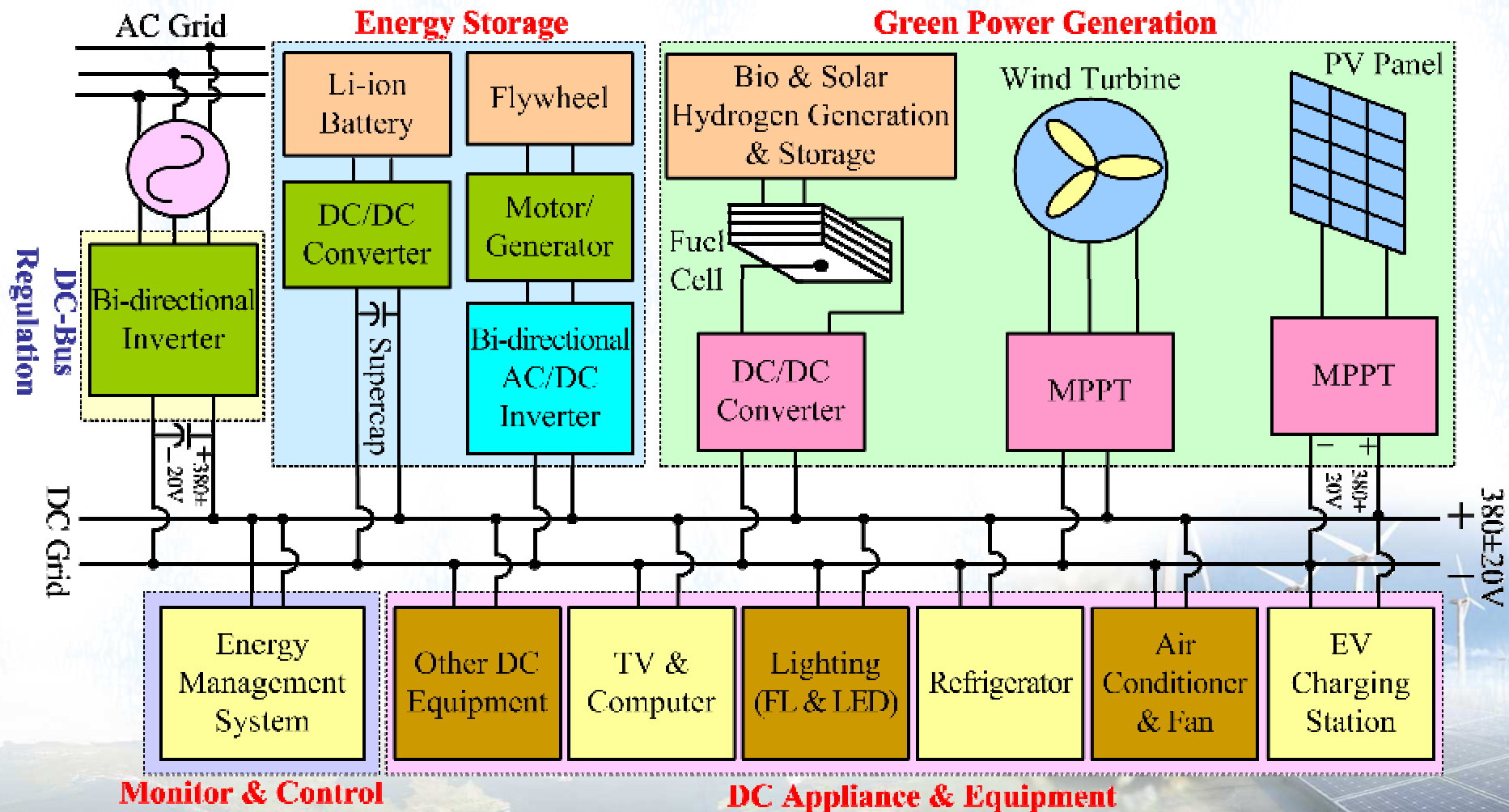
➤ We do need team work





Conclusions

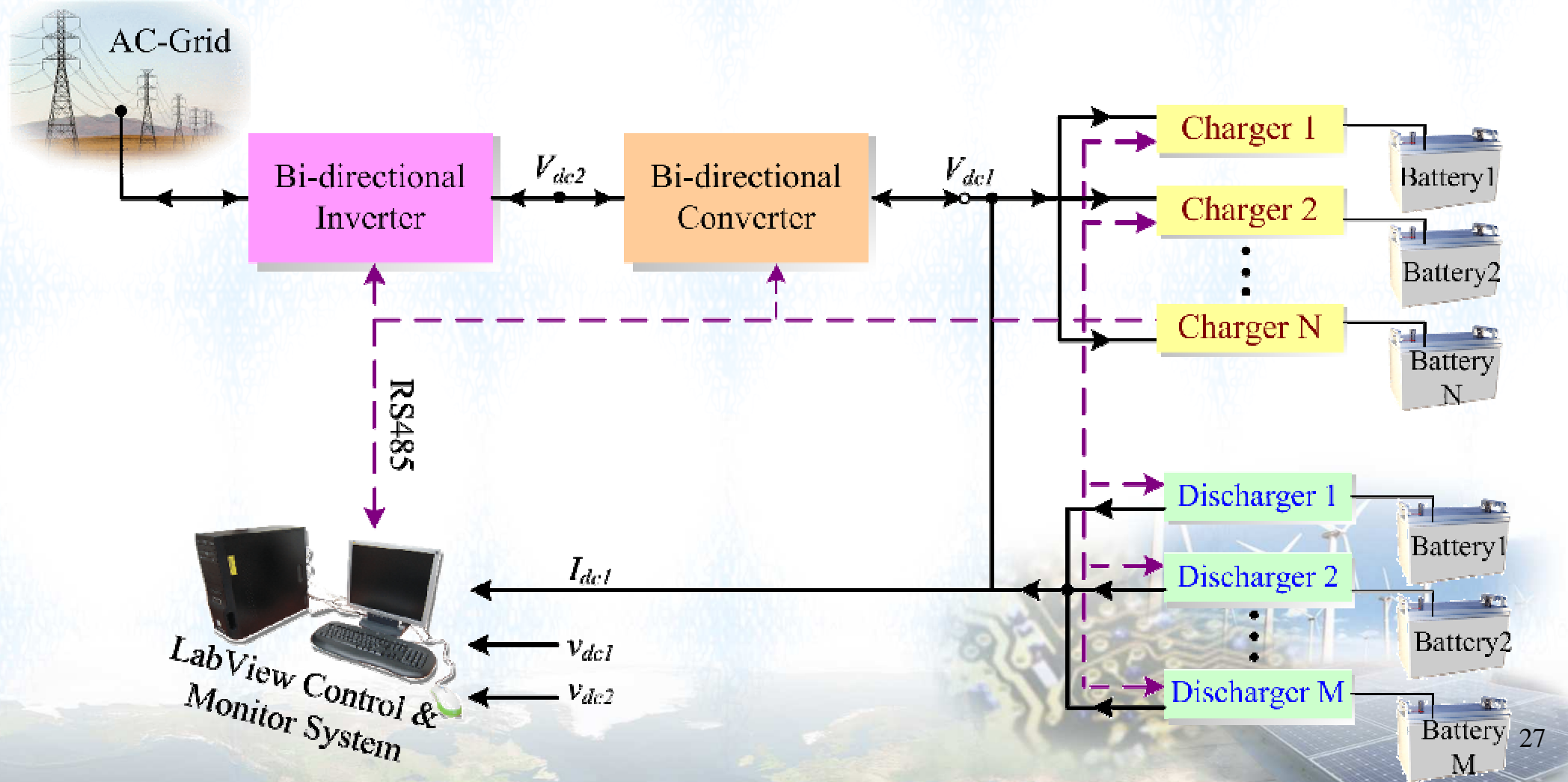
- **Current Applications of the Core Technologies**
 - **DC-distributed Systems with grid connection**



Conclusions

➤ Extended Applications

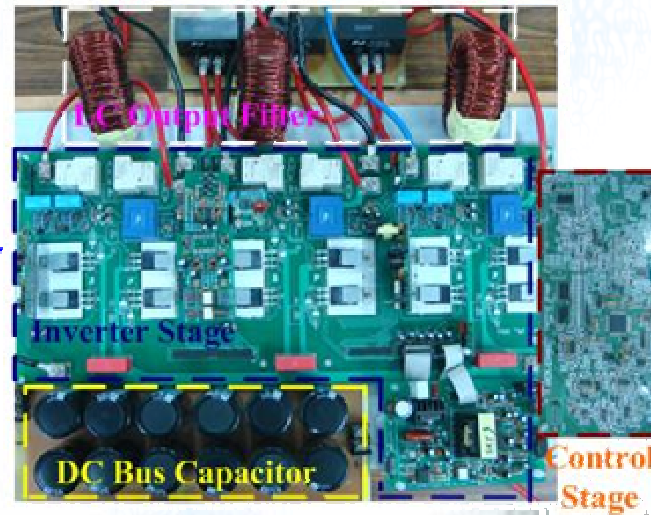
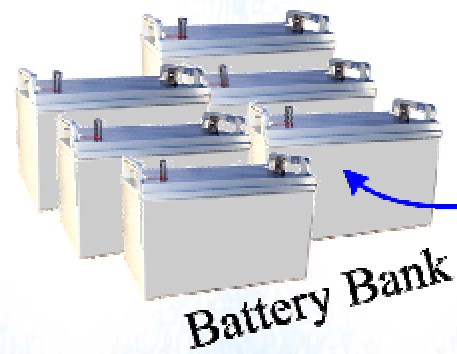
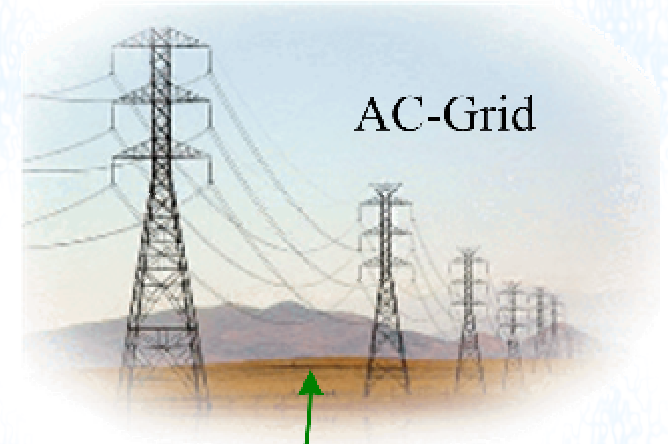
● Battery Testing System





Conclusions

- **UPS-Battery Maintenance System**



Bi-directional Inverter





Conclusions

- **Extended Applications**
 - **Moving Data Center**





Thanks for your attention



DC LED lighting

MCC

DC Charging Station

系統介紹簡介

主要設備	簡介
太陽能發電系統	本系統採用12kWp之太陽能發電系統，由12塊100W之單晶矽太陽能電池板組成，經由MPPT控制器連接至DC/DC轉換器，再連接至DC LED燈具。
DC LED燈具	本系統採用DC LED燈具，其優點為省電、壽命長、無汞污染、無閃光、無熱輻射、無噪音、無電磁干擾等。
併入市電系統	本系統採用併入市電系統，其優點為省電、壽命長、無汞污染、無閃光、無熱輻射、無噪音、無電磁干擾等。
自動功率調整	本系統採用自動功率調整系統，其優點為省電、壽命長、無汞污染、無閃光、無熱輻射、無噪音、無電磁干擾等。
系統監控系統	本系統採用系統監控系統，其優點為省電、壽命長、無汞污染、無閃光、無熱輻射、無噪音、無電磁干擾等。
顯示設備	本系統採用顯示設備，其優點為省電、壽命長、無汞污染、無閃光、無熱輻射、無噪音、無電磁干擾等。
交流系統	本系統採用交流系統，其優點為省電、壽命長、無汞污染、無閃光、無熱輻射、無噪音、無電磁干擾等。
交流轉直流系統	本系統採用交流轉直流系統，其優點為省電、壽命長、無汞污染、無閃光、無熱輻射、無噪音、無電磁干擾等。
直流轉交流系統	本系統採用直流轉交流系統，其優點為省電、壽命長、無汞污染、無閃光、無熱輻射、無噪音、無電磁干擾等。



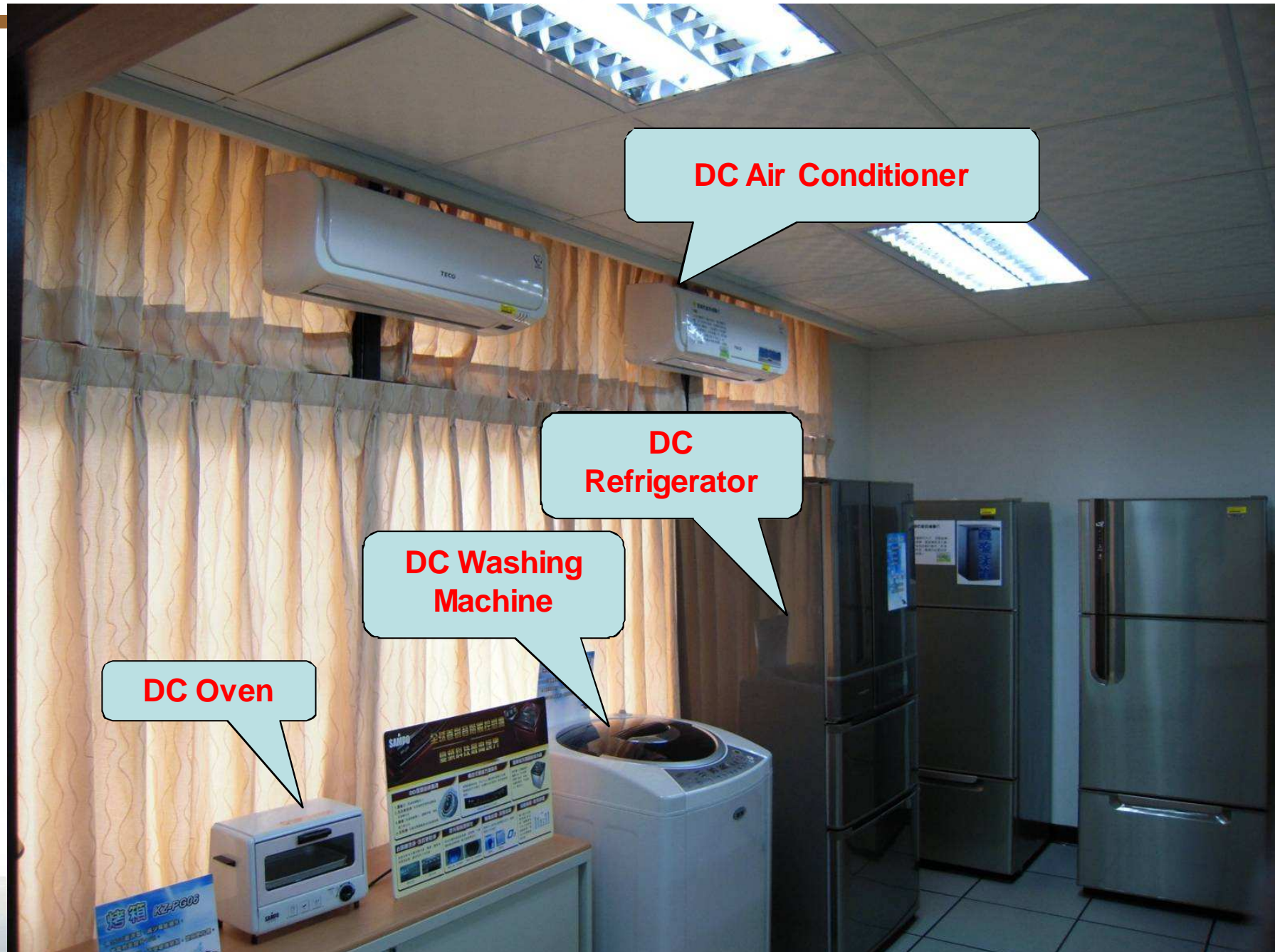
**DC Air
Conditioner**

**DC Electronic
Ballast**

DC Lamp

DC TV

DC Fan

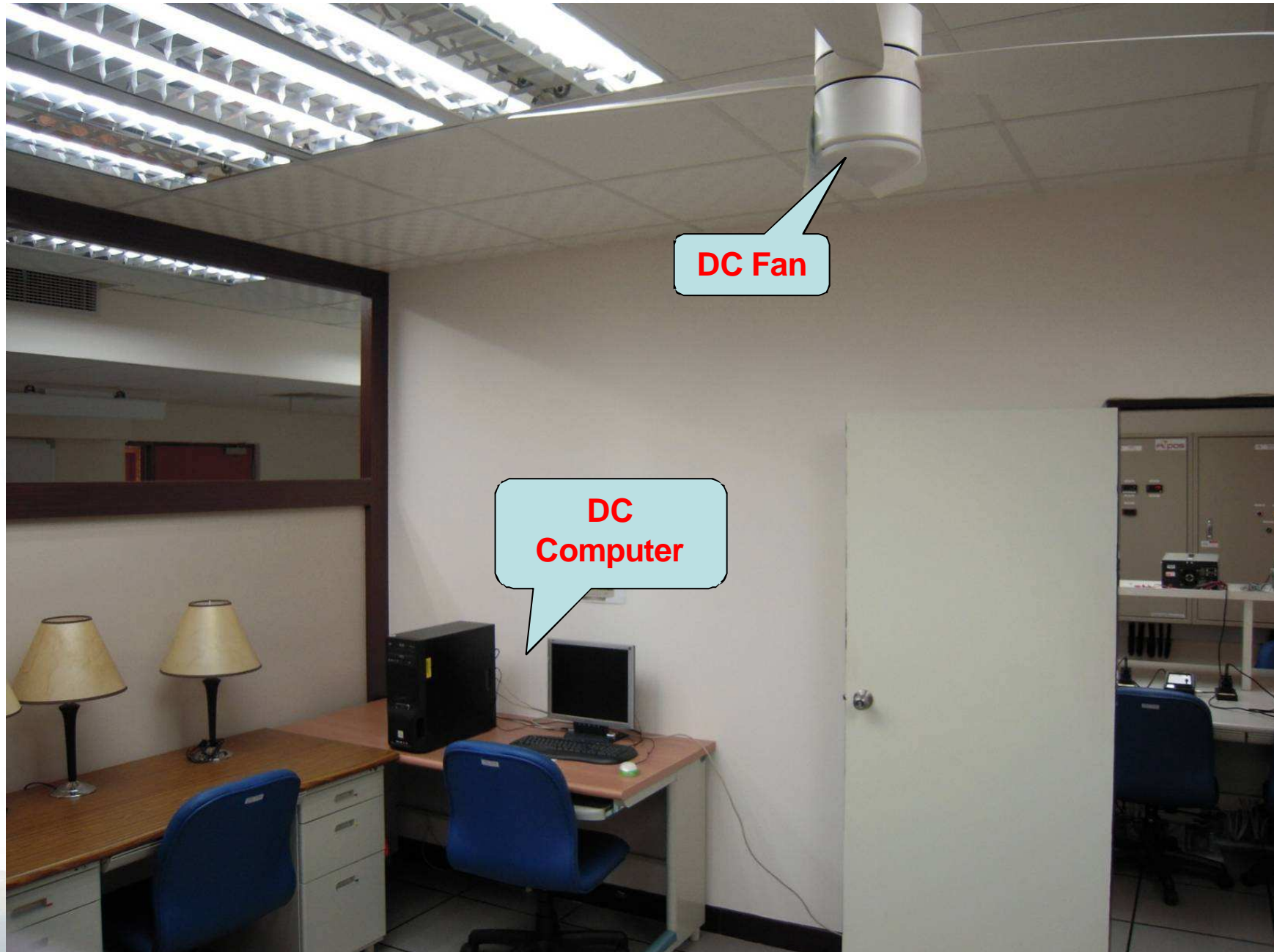


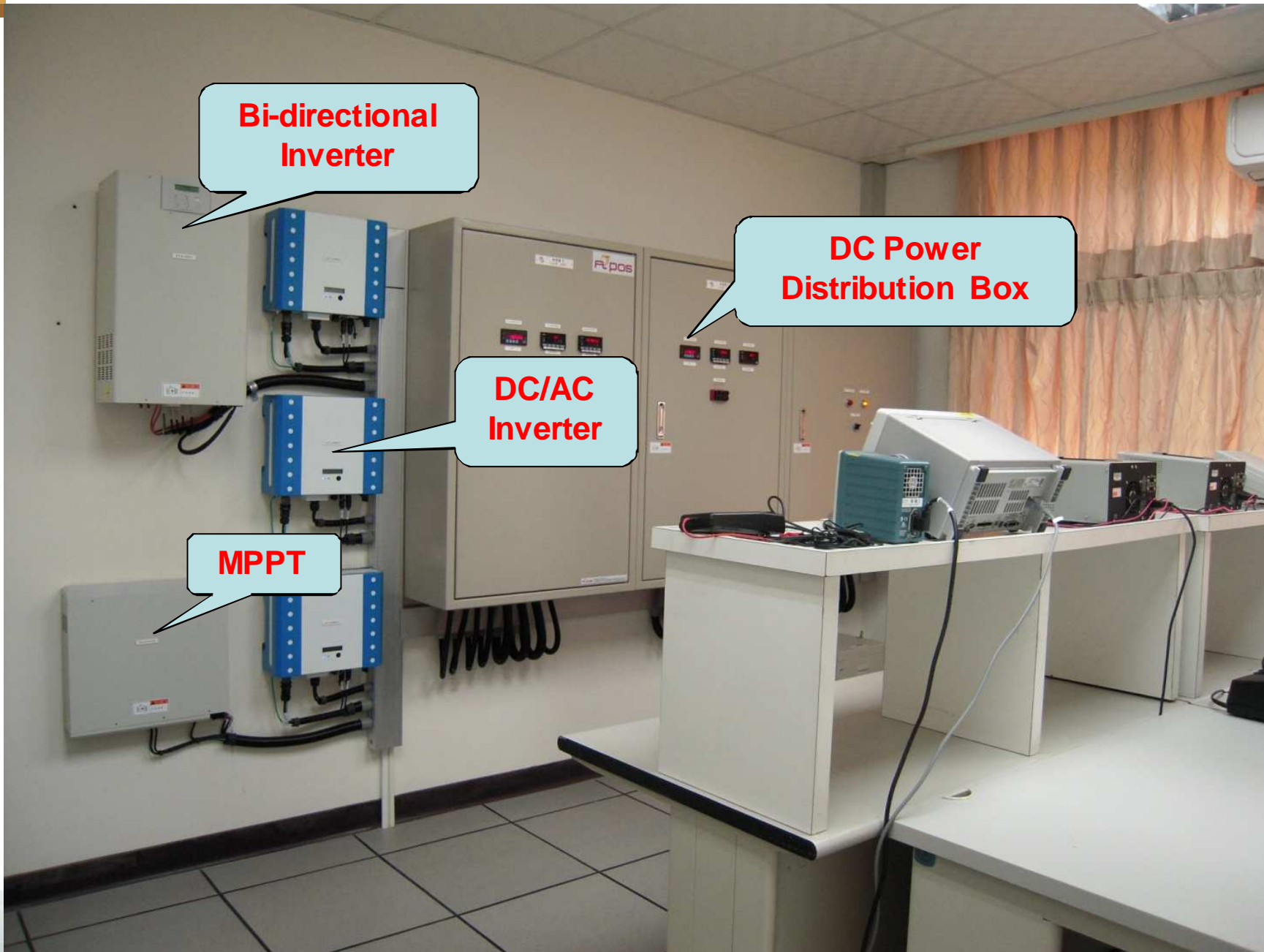
DC Air Conditioner

DC Refrigerator

DC Washing Machine

DC Oven





Bi-directional Inverter

DC Power Distribution Box

DC/AC Inverter

MPPT

