

自電池及充電、馬達與驅動觀點 探討電動車之未來發展

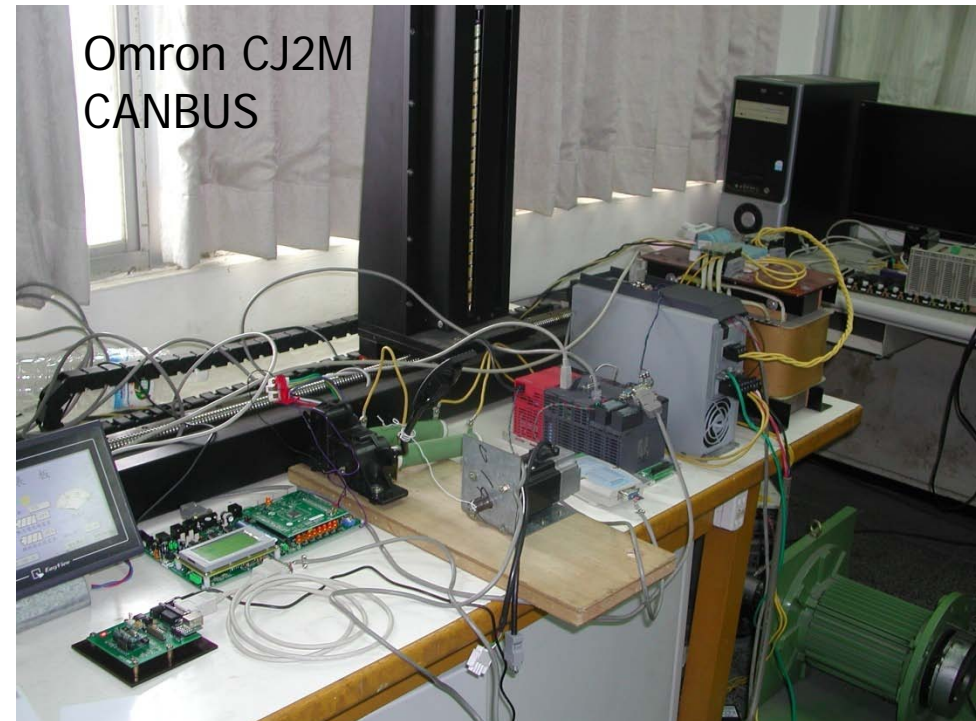


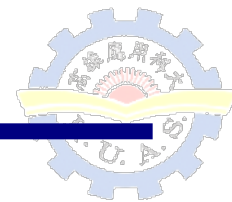
國立高雄應用科技大學
電機系
葛世偉

中華民國一百一十一年 四月二十日

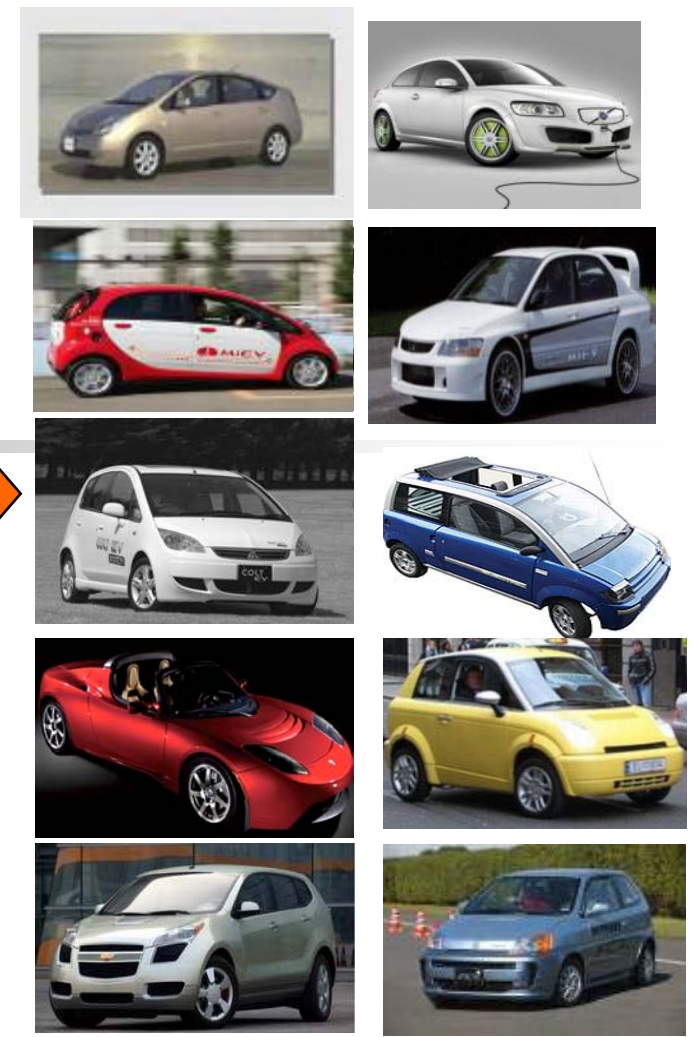
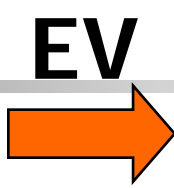
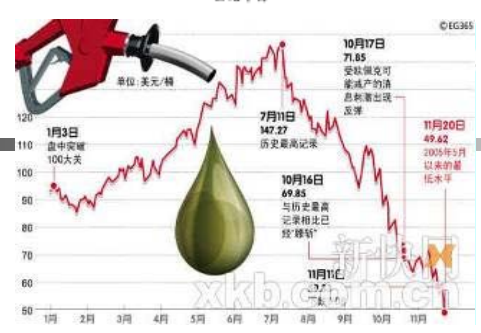
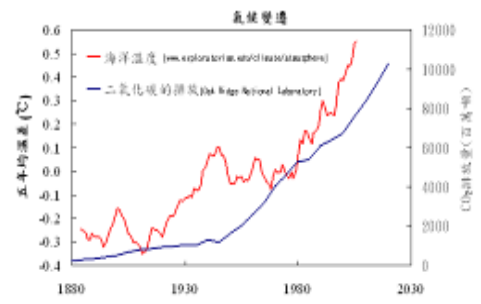
大綱

- 電池、馬達爬坡(馬達與驅動器)、效率、MOTOR (sr)、散熱
- 電池能量管理：殘電量估測機制-混合式殘電量估測法、充放電
- 充電站國外現況—借鏡
- 車載網路系統監控





- 1. 環保
- 2. 節能
- 3. 油價高漲
- 4. 綠色車輛
- 5. 法規



• 歐盟現訂定汽車CO2排放低於130g/km.

• 歐洲汽車製造協會(ACEA)要求2015年CO2排放平均需達到90g/km以下, 2015年生產的車輛, 至少有80%可符合目前綠

色車輛(Green Vehicle)的標準

緒論-全球能源需求預測

■ 石化能源(Fossil Fuel)

- 溫室氣體(Greenhouse Gas, GHG) → CO₂(55%)

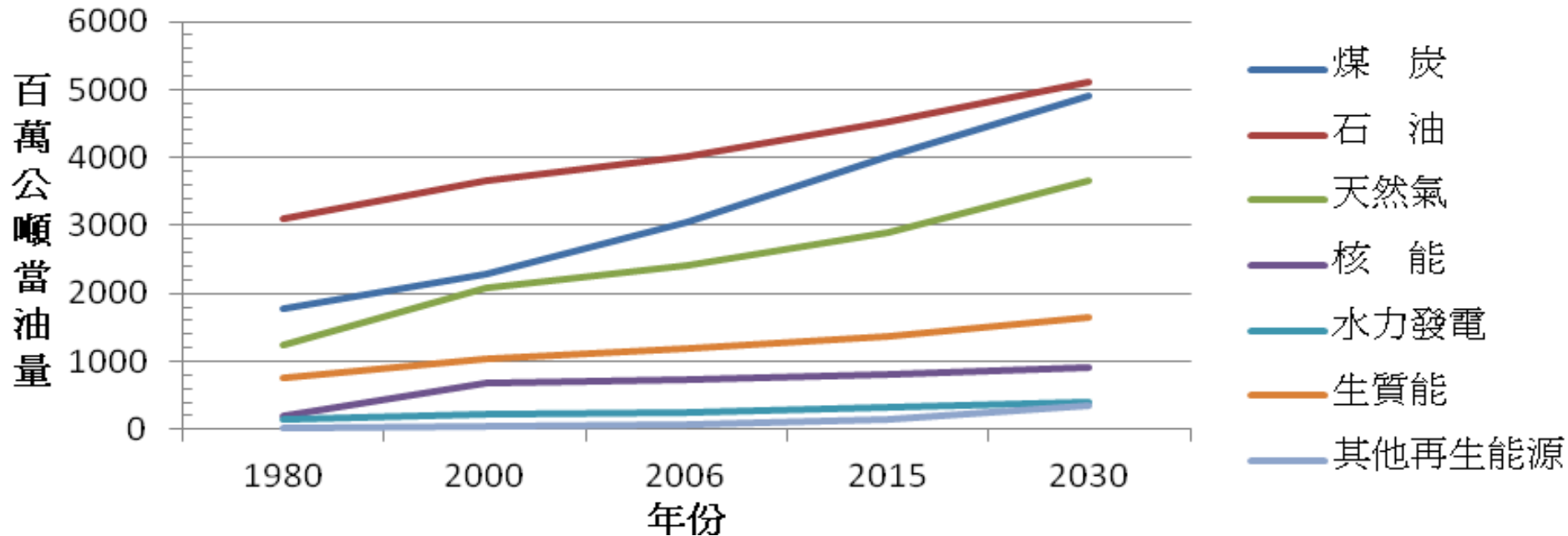
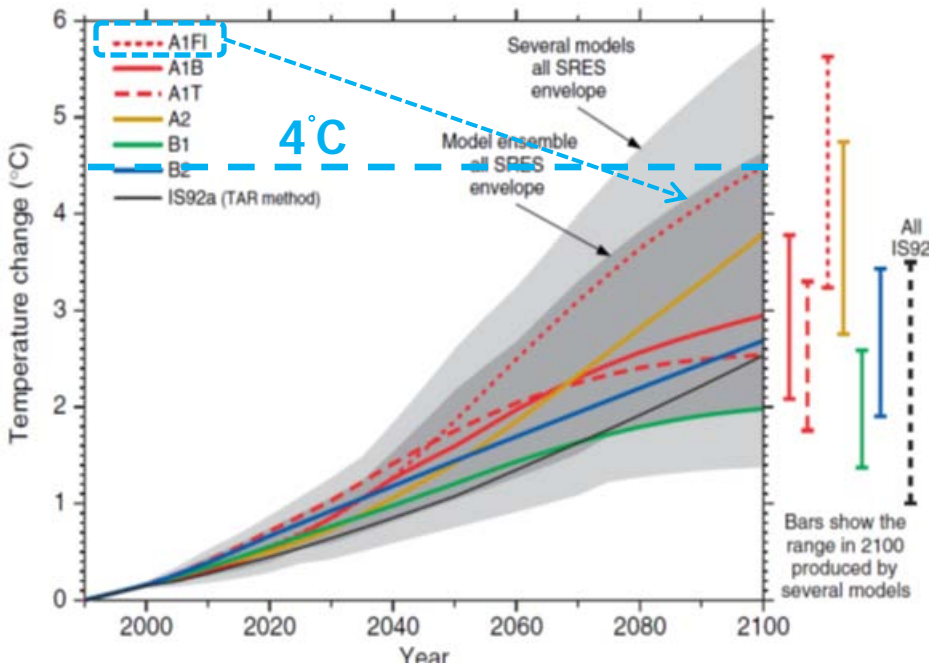
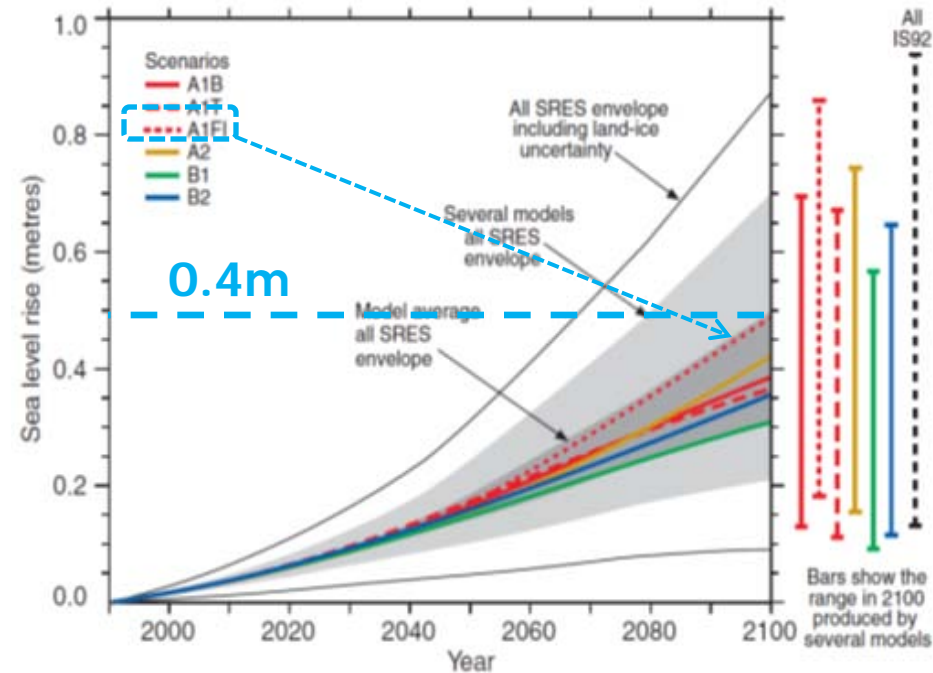


圖1 全球初級能源需求預測

緒論-全球氣候預測圖



(a) 溫度預測曲線圖



(b) 海平面上升預測曲線圖

圖2 21世紀全球氣候預測圖

緒論-台灣各部門CO₂排放量

- 運輸工具佔我國排碳量的**14.4%**

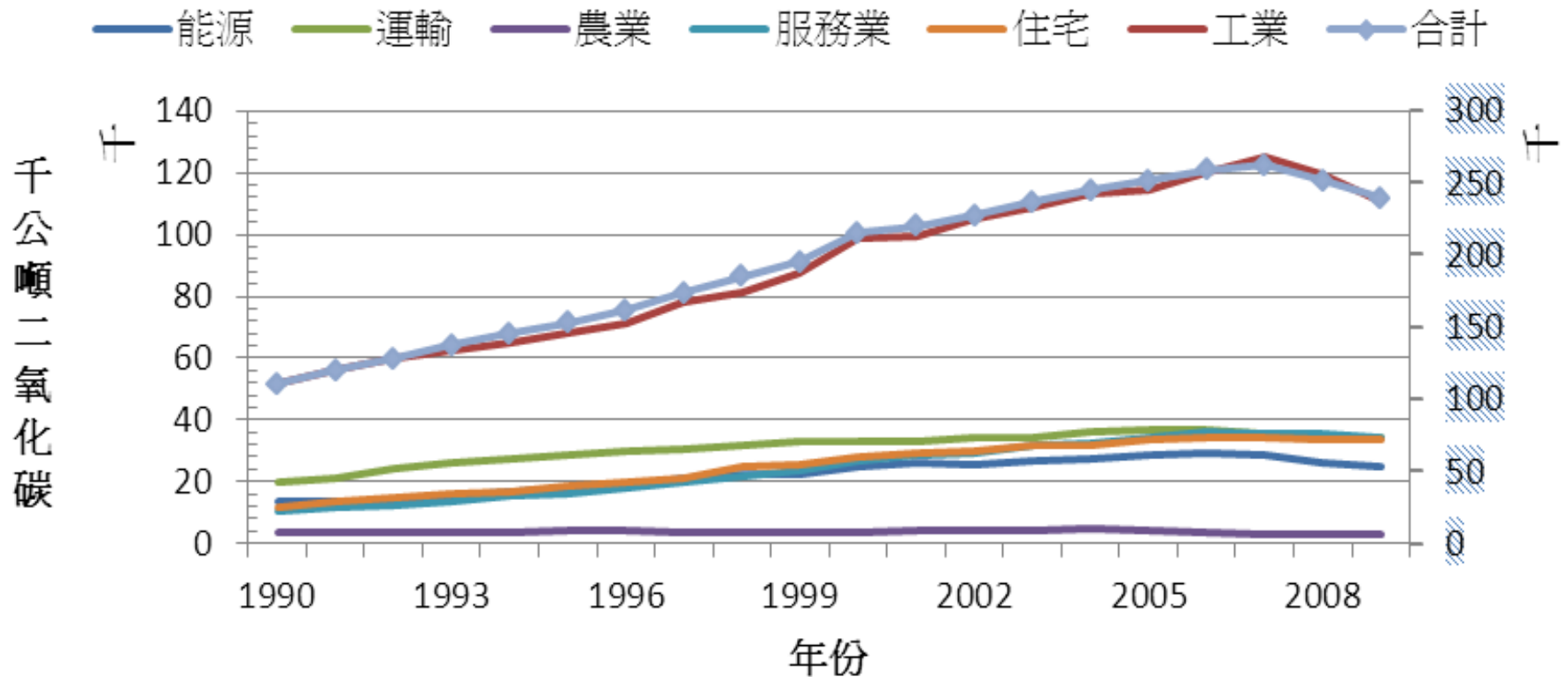
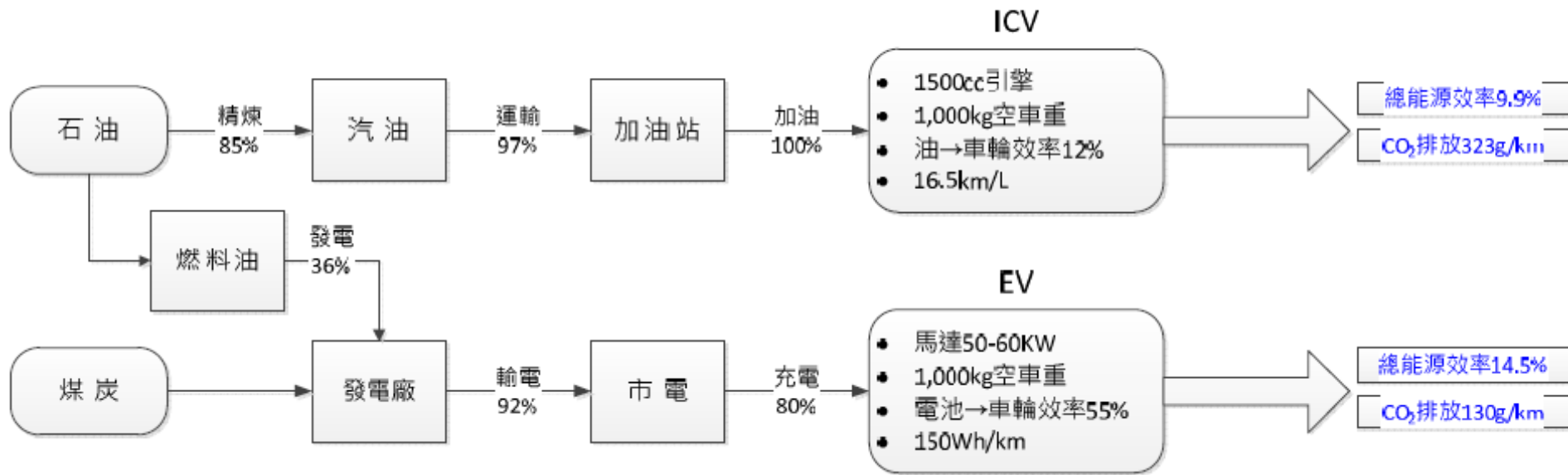


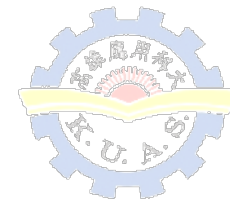
圖3 台灣各部門燃料燃燒CO₂排放量趨勢(各部門包括電力消費排放)

緒論-EV效能及未來發展

■ EV與ICEV之總體能源轉換效率比較



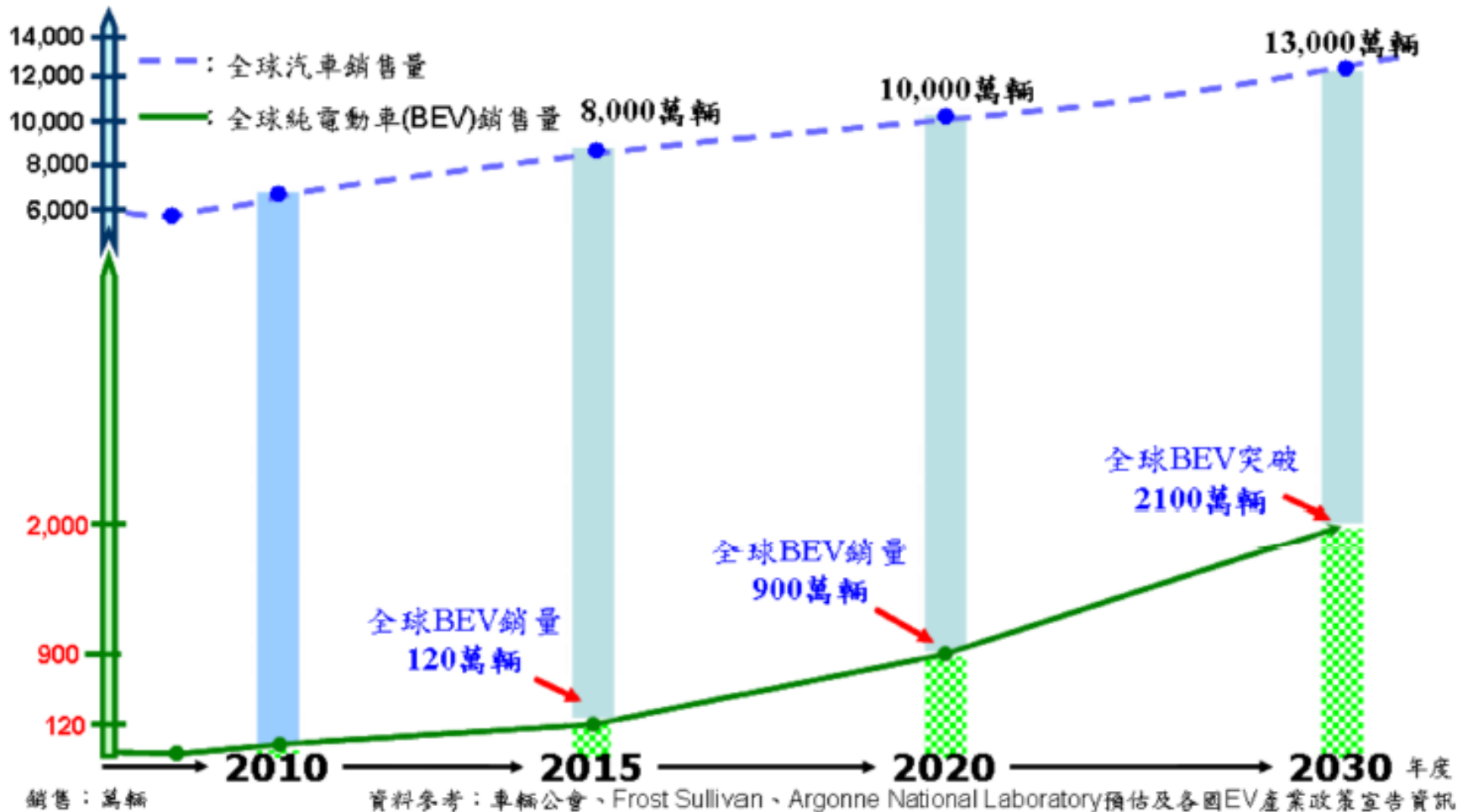
Electric vs Gasoline a few comparisons



| Vehicle | Cost/Mile | Cost/kwh | Annual Fuel Only Cost (11,000 mi.) | Savings Compared to 93 Corolla | Savings Compared to Fleet Prius |
|--------------------------------|-----------|----------|------------------------------------|--------------------------------|---------------------------------|
| 93 Toyota Corolla | \$ 0.150 | N/A | \$ 1,650.42 | N/A | N/A |
| HECO Fleet Toyota Prius | \$ 0.087 | N/A | \$ 959.96 | \$ 690.45 | N/A |
| Leaf Sch. R | \$ 0.080 | \$ 0.33 | \$ 880.49 | \$ 769.93 | \$ 79.48 |
| Leaf Sch. EV-R off-peak | \$ 0.065 | \$ 0.27 | \$ 709.85 | \$ 940.56 | \$ 250.11 |
| Leaf Sch. EV-R on-peak | \$ 0.085 | \$ 0.36 | \$ 940.27 | \$ 710.15 | \$ 19.70 |
| Leaf Sch. TOU-EV off-peak | \$ 0.067 | \$ 0.28 | \$ 731.76 | \$ 918.65 | \$ 228.20 |
| Leaf Sch. TOU-EV priority peak | \$ 0.093 | \$ 0.39 | \$ 1,022.42 | \$ 627.99 | \$ (62.46) |

Copy by Hawaii Electric Company

緒論-全球汽車預估銷售狀況



緒論-各種動力車之示意圖

- 內燃機引擎車 (ICEV)
- 混合動力 (HEV)、
可充電-混合動力電動汽車 (PHEV)
 - 馬達、引擎、混和及制動模式
- 純電動車 (Electric Vehicle, EV)

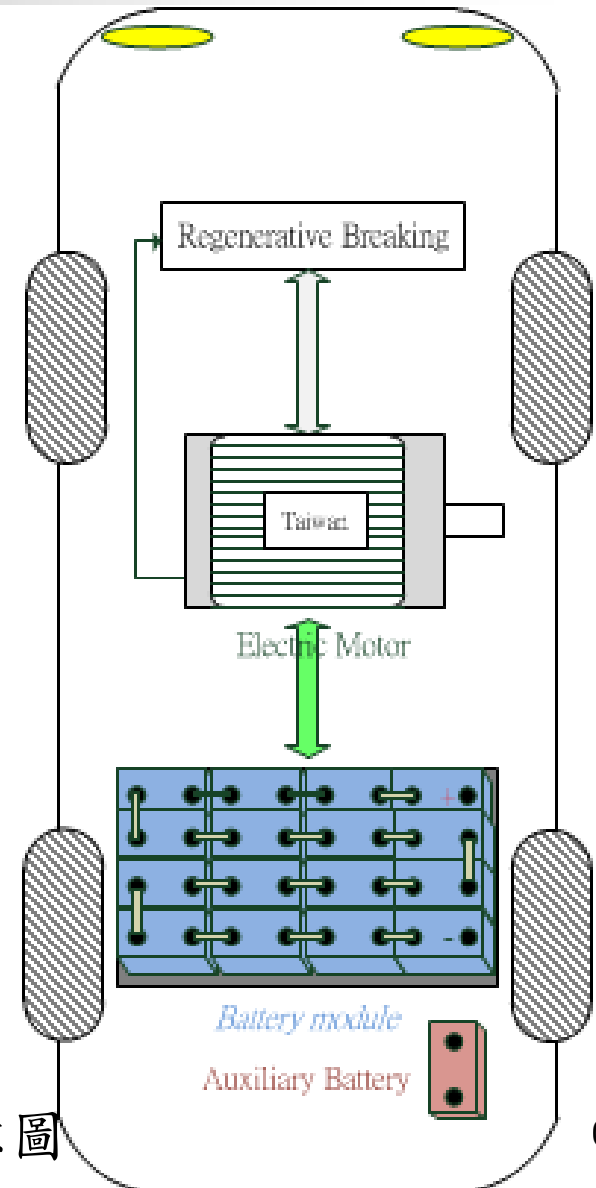
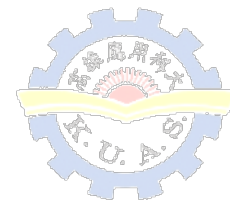
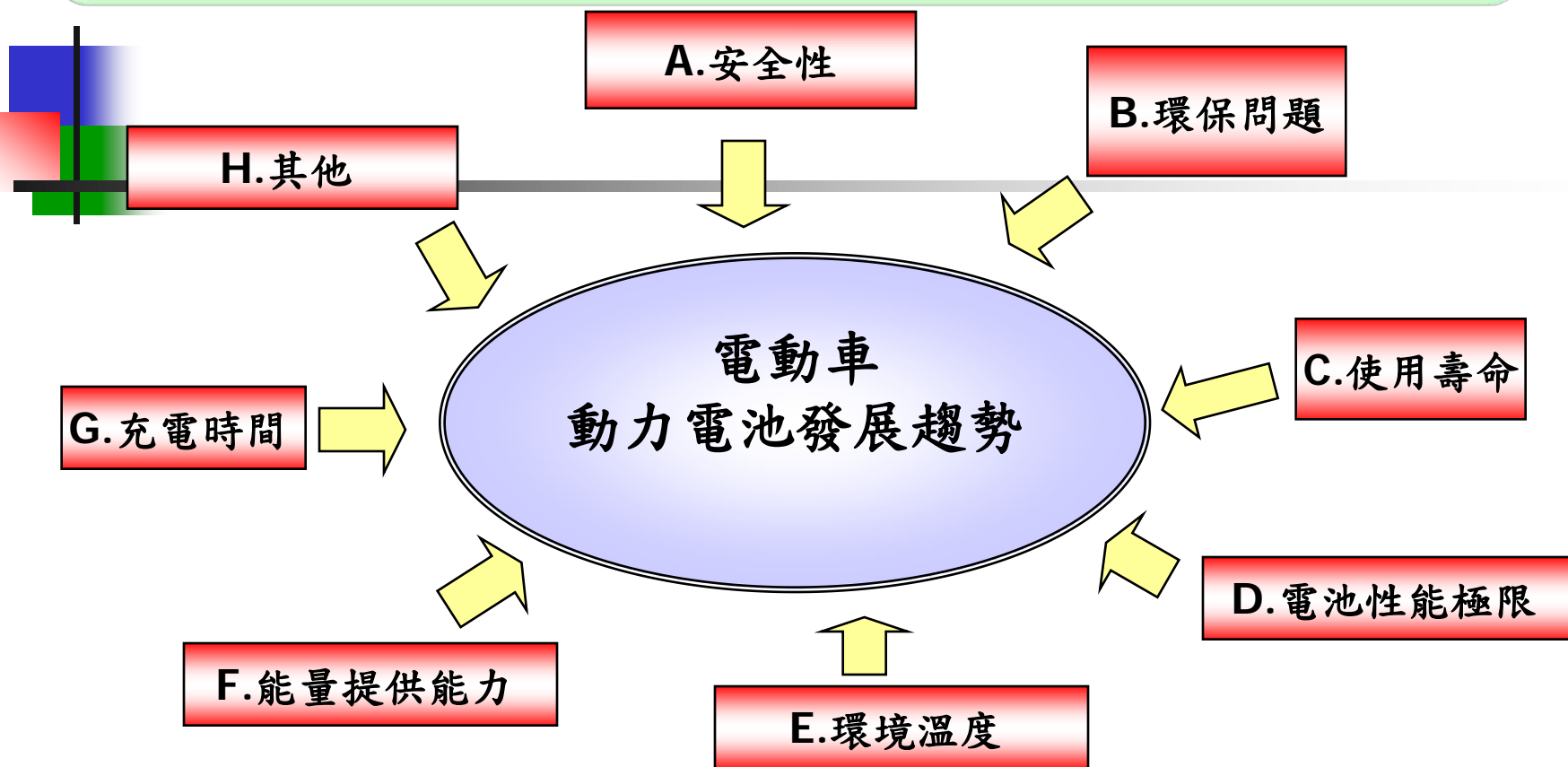


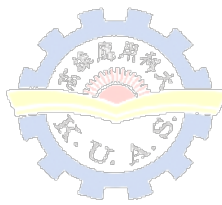
圖4 各種動力車之示意圖



動力電池發展趨勢

電動車輛是否能真正取代目前汽油車輛，除了馬達驅動技術外還有絕大部份是取決於電池技術的重大發展，而應用於電動汽車上之電池類型需考量許多因素。



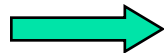


電池術語與規格說明

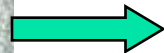
- 能量=電壓×電流×時間=VAh=Wh
 - 能量密度(Energy Density)：指電池單位質量或單位體積所能提供之總功率(瓦時數)，以Wh/kg(Specific Energy) 或Wh/l(Energy Density)表示之。
- 電池容量=電流×時間=Ah(mAh)
 - 電池容量(Capacity)一般是以安培小時(AH)為單位，用以表示電池儲存電力的能力。即電池放電時端電壓到達設定之截止電壓時，電池所提供之總電量(AH)，而電池充(放)時電流之大小通常以C 來表示，1C 就表示1小時可將電池充電或放電至標稱容量之電流量。
- 循環壽命(Cycle Life)：在固定之充放電及靜置條件下，電池反覆充放電後，電池容量下降至初期值特定比例(例如80%或60%等)之反覆充放電循環次數。
- 內阻：指電池內部材料所生成的阻抗，內阻愈小，電池的充放電性能愈好。



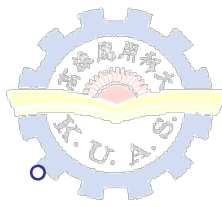
Cell



Module



Pack



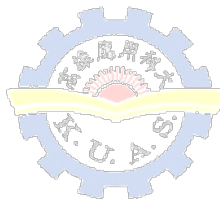
電池快速充電是電動車發展的關鍵因素之一。

- 稀土鋰鈮電池：稀土鋰鈮電池品質能量密度每公斤150到190瓦時，非常安全，生產過程中也非常環保。20分鐘恒流充電。
- 稀土鋰硫電池：這個品質能量密度每公斤可以做到1200瓦時，這個電池非常安全，目前商化產品1200瓦時，同樣的重量充電5分鐘可以跑到2000公里。

■ 稀土戰爭

爬坡角度較大的坡，需要大電流產生大轉矩，這將會引起以下嚴重後果：

1. 大電流將對蓄電池產生衝擊，影響其循環壽命，嚴重者電池使用數個月後性能改變，達不到原有之要求。這表面看來似乎是電池的問題，但其根源在馬達與驅動器、控制器。
2. 大電流對控制器的要求提高，若不增加電力電子功率元件的電流量，則控制器易被燒壞，造成故障，降低了可靠性，若增加電流量，控制器成本增加。
3. 減小了充電一次續駛里程。
4. 馬達損耗增加，易引起永磁體的熱退磁和電流衝擊退磁。



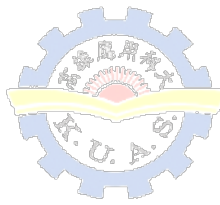
若汽車之總重量為G，則車速為 v_0 時的爬坡度為

$$i = \frac{3600\eta}{Gv_0} [P_t - \frac{1}{\eta}(P_f + P_w)]$$

爬坡所需轉矩=(爬坡度%)(車胎半徑m)(車重+載重kg)

如18" (0.228m正新高速胎)

約21.256%(12°) 、 26.8%(15°) 、 36.4%(20°)



緒論-EV相關電池探討

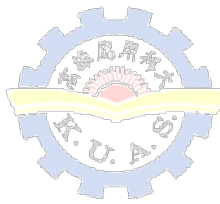
動力電池

- 功率密度高→行駛於高速、爬坡
- 能量密度高→續航力

- 快速充放電
- 體積小、重量輕、耐高溫
- 成本低、使用壽命長及安全性高
- 可回收，且不造成環境污染
- 須具備良好的**電池管理系統BMS**

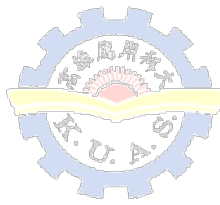
輔助電池auxiliary

- 能夠長時間供應所有車上電器設備。



現有電池探討

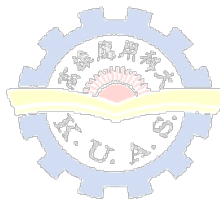
- 燃料電池：路途遙遠。
- 超級電容輔助力有限；
- 磷酸鐵鋰電池：單體電容小於200安時安全，大於200安時爆炸。
- 鉛酸電池：每公斤的能量密度37瓦時。也不可以快充電。生產和使用是污染的，安全是可以。
- 鎳氫電池：每公斤的能量密度是80到90瓦時。一般來說在65度的溫度下是安全的。但是生產使用過程中還是有污染。
- 硅能電池：品質能量密度每公斤40瓦時，非常安全，但是沒有可以快充電的機會。
- 鈉硫電池：每公斤品質密度39瓦時，非常安全，但是充電時間太慢，使用的時候要高溫才能放電。



- 鈷酸鋰電池：現在品質燃料密度是160瓦時，它不安全，單體50安時就可能引起爆炸，也不可以快充電。
- 錳酸鋰：140瓦時，單體大於200安時不安全，永遠不可能快速充電。
- 鎳鈷錳：150瓦時，單體大於200安時爆炸可能性非常高，它的材料永遠不可能快速充電。
- 磷酸鐵電池：150瓦時，大於200安時的單體，世界沒有任何一個國家、科學家可以解決它的安全問題，也不可以快充電。

鋰鈮電池



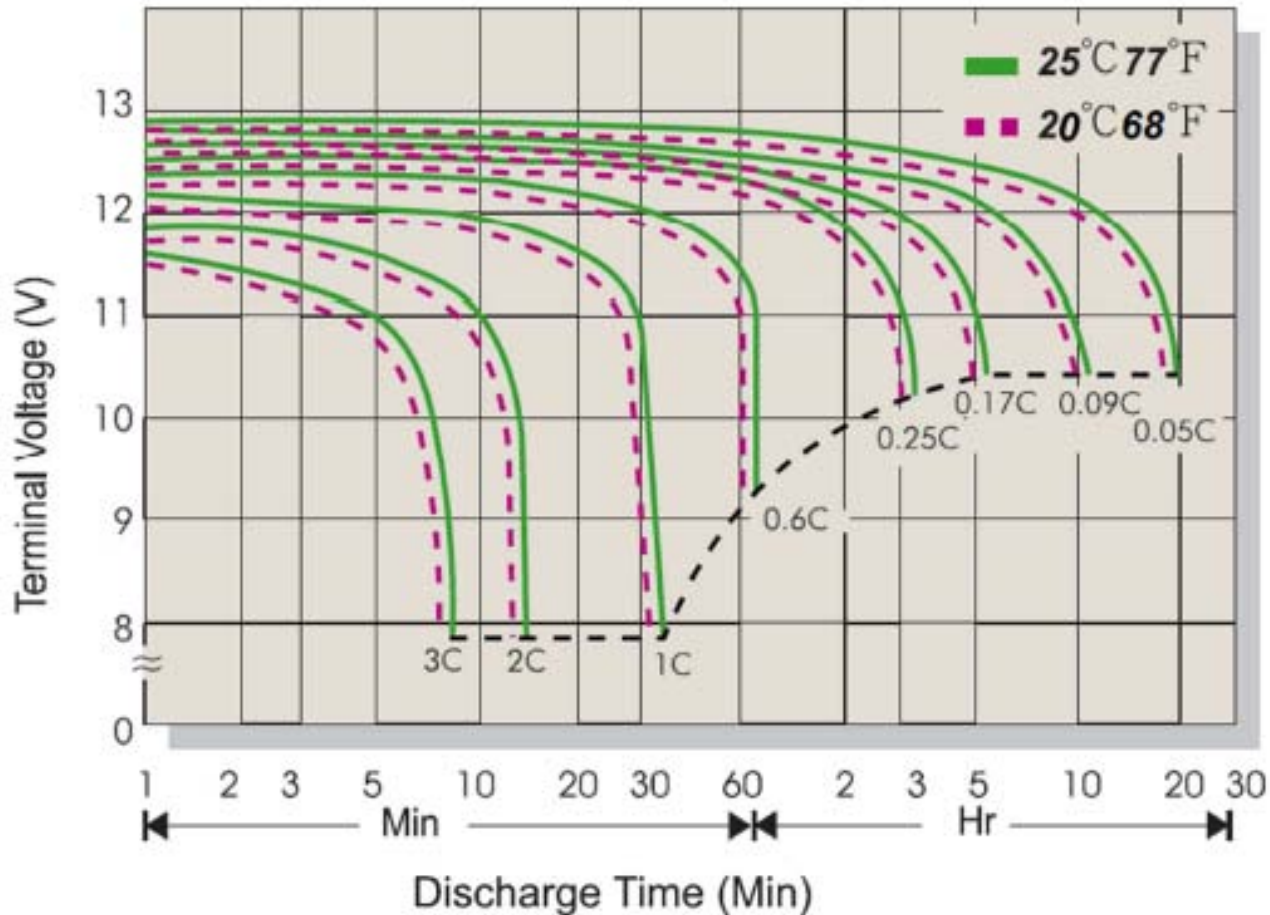


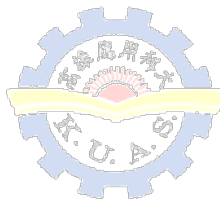
電池快速充電是純電動車的關鍵。

- 稀土鋰鈮電池：稀土鋰鈮電池品質能量密度每公斤150到190瓦時，非常安全，生產過程中也非常環保。20分鐘恒流充電。
- 稀土鋰硫電池：這個品質能量密度每公斤可以做到1200瓦時，這個電池非常安全，目前商化產品1200瓦時，同樣的重量充電5分鐘可以跑到2000公里。
- 稀土戰爭

殘電量估測機制-電池特性(1)

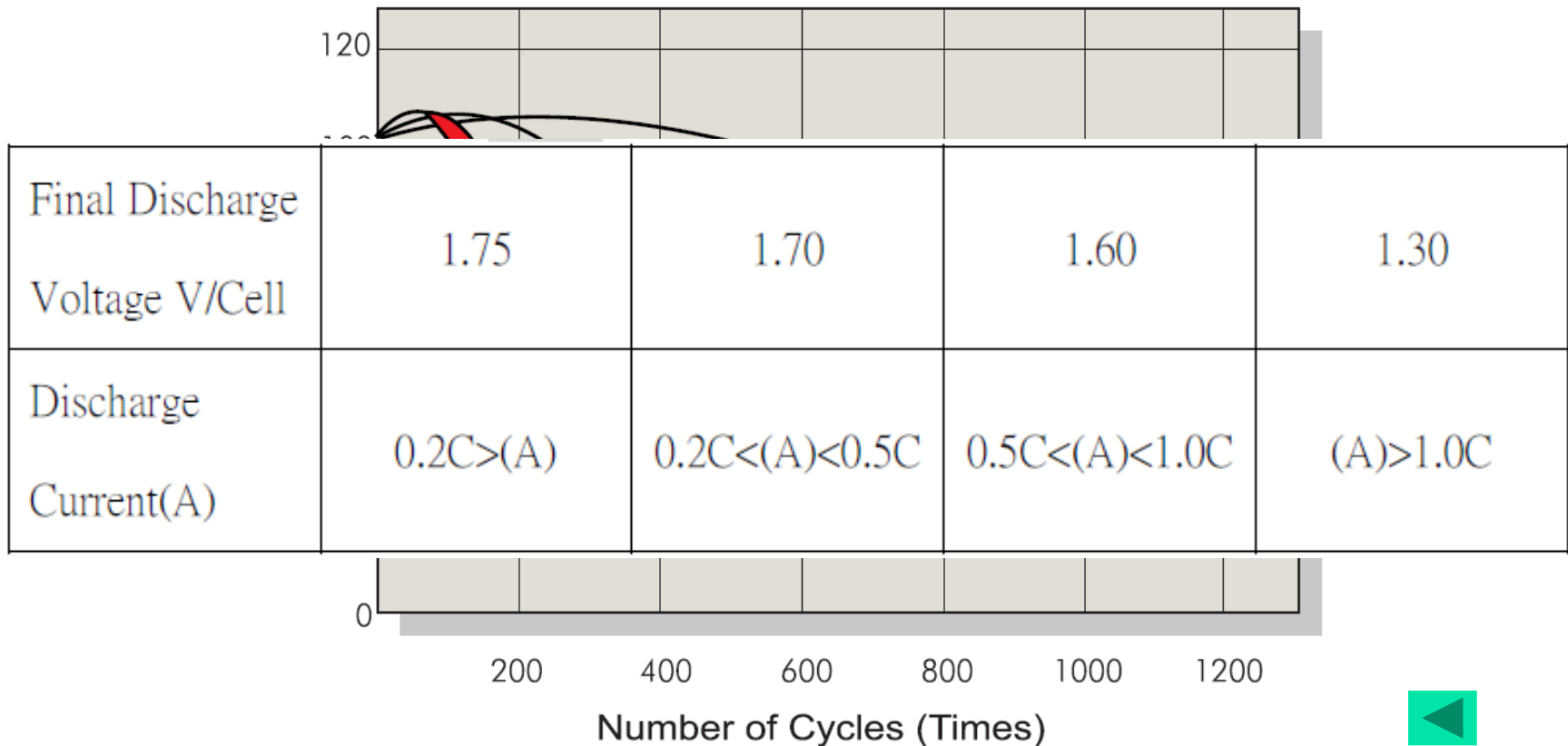
■ 放電電流與截止電壓關係





殘電量估測機制-電池特性(3)

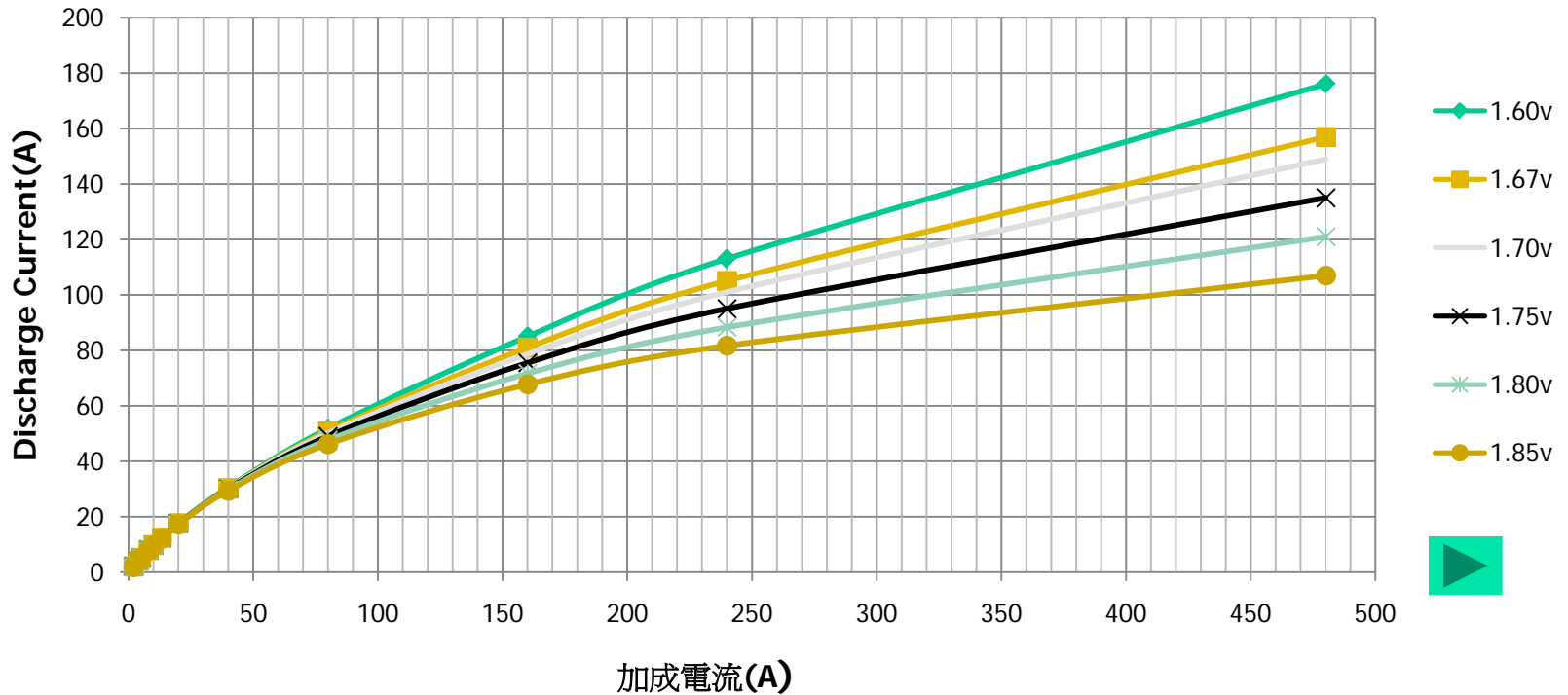
■ 放電深度



電池循環壽命與放電深度關係圖

殘電量估測機制- 改良式庫倫法

不同終止電壓會對應出不同加成效應電流曲線

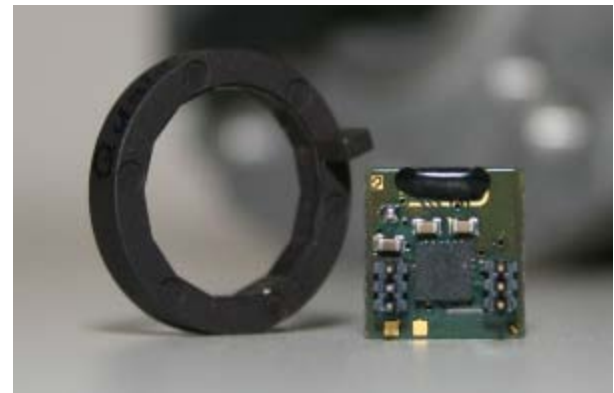
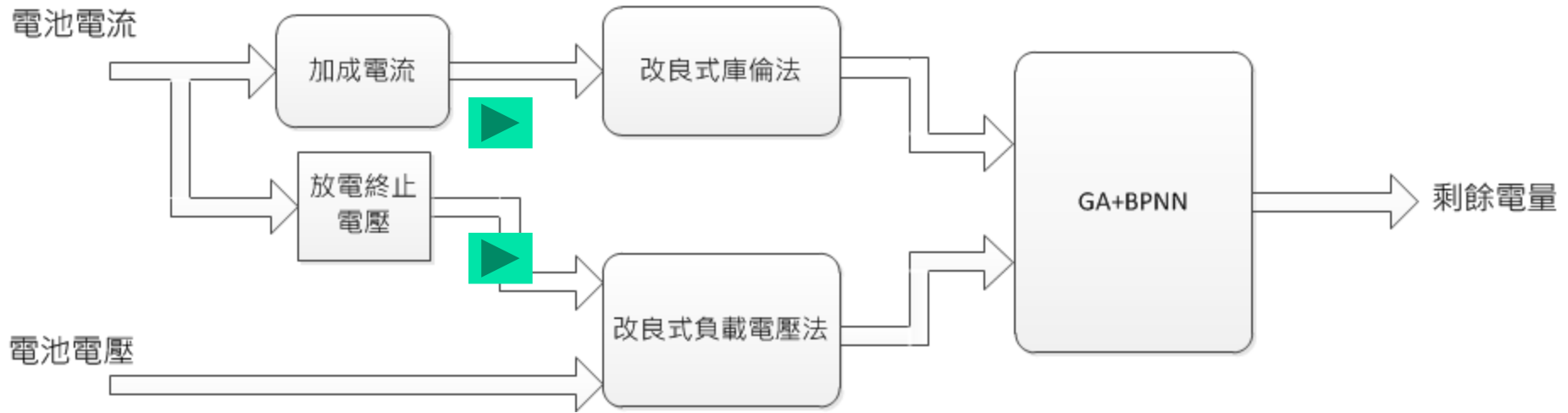


$$Q_{\text{real}}(c) = \frac{\text{額定容量}}{\text{加成效應電流} + \text{目前電流}} \times \text{關斷時間}$$

$$\text{剩餘電量} = \text{額定容量} - (\text{加電流} \times \text{關斷時間})$$

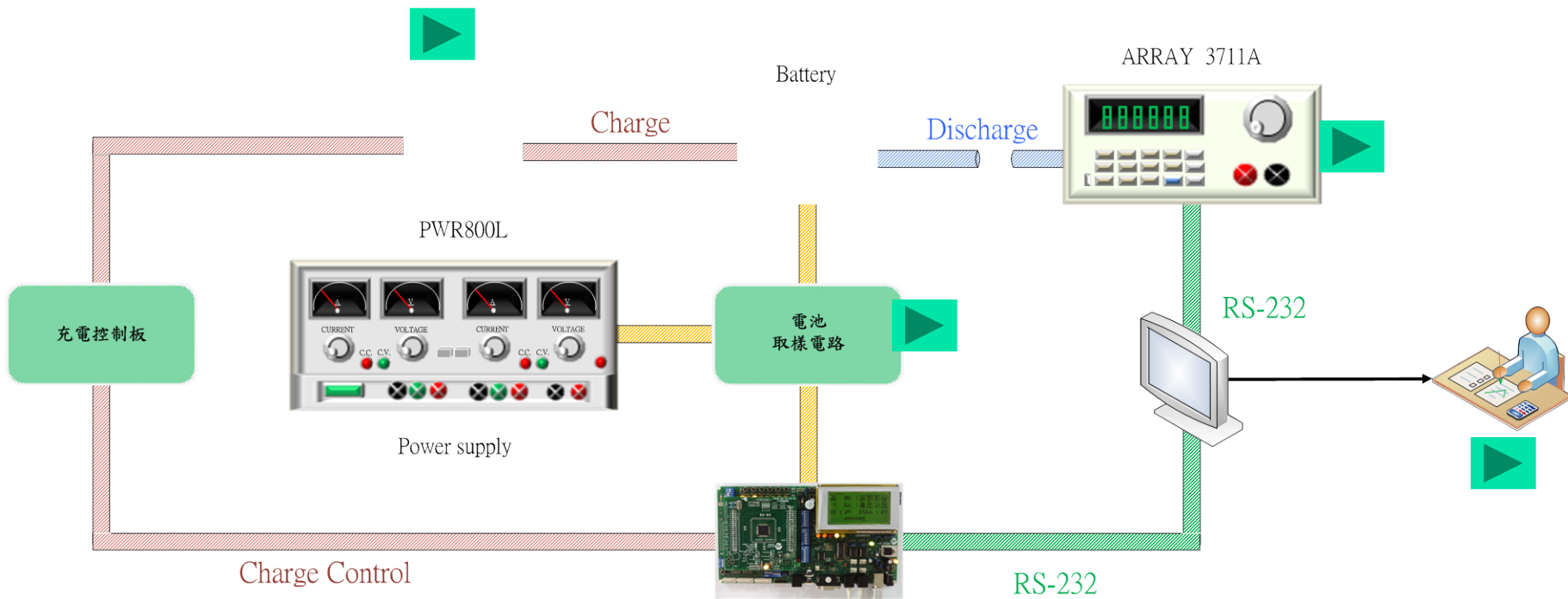
殘電量估測機制

- 混合式殘電量估測法






電池量檢測平台建置- 電池充放電系統架構圖



電池量檢測平台建置- VR Not 監控介面(1)






連線狀態: 連線中...

通訊COM端:

資料傳輸狀況:

0x0016 50 23 40 0C 1D 00

車內資訊
電池管理
即時曲線
資料庫



電池即時資料

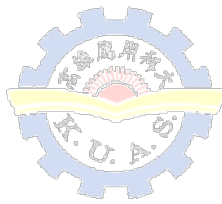
| 即時電壓(V) | 平均電壓(V) | 最大電壓(V) | 電池電量(%) | 平均室溫(C) | 儀板溫度(C) |
|----------|----------|----------|---------|---------|---------|
| 13.22267 | 12.23787 | 13.25338 | 52 | 27.6 | 29 |
| 即時電流(A) | 平均電流(A) | 最大電流(A) | | | |
| 6.057415 | 3.174112 | 8.290315 | | | |

充電控制

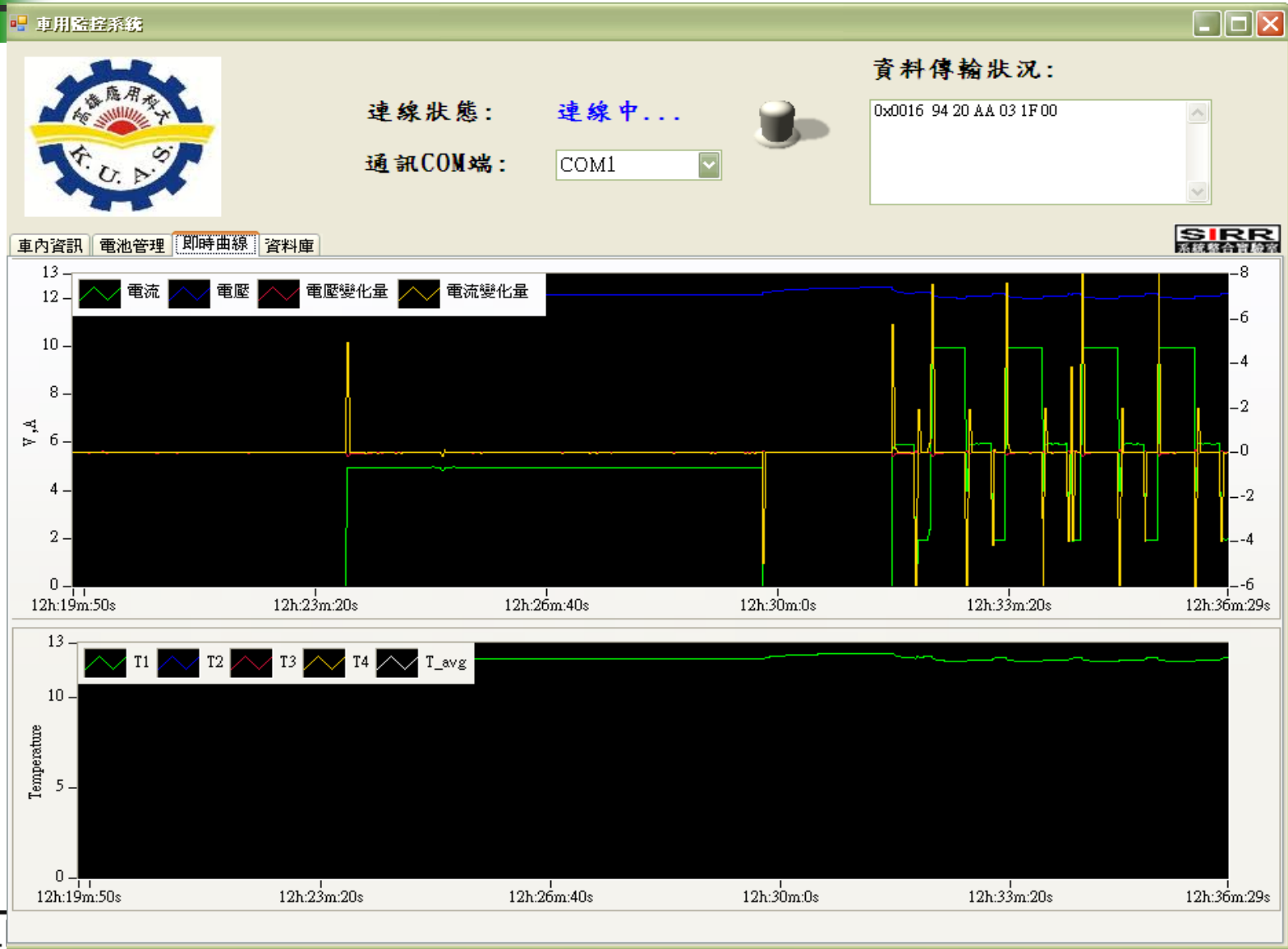
手動充電

| | | | | | | |
|-----------------------------|-----------------------------|-----------|-----------|-------------|-------------|---|
| <p>充電電壓 (V)</p> <p>14.5</p> | <p>充電電流 (A)</p> <p>0.00</p> | <p>開始</p> | <p>重置</p> | <p>自動充電</p> | <p>緊急停止</p> | <p>PWR800 STATE</p> <p>CV</p> <p>CC</p> <p>output</p> |
|-----------------------------|-----------------------------|-----------|-----------|-------------|-------------|---|

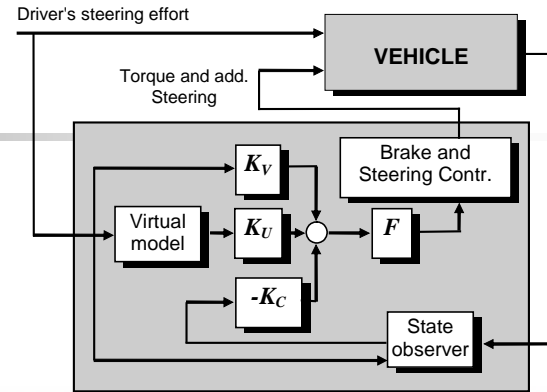




電池量檢測平台建置- VB.Net 監控介面(2)-及時曲線



車載網路系統建置



中央監控系統

車載網路系統

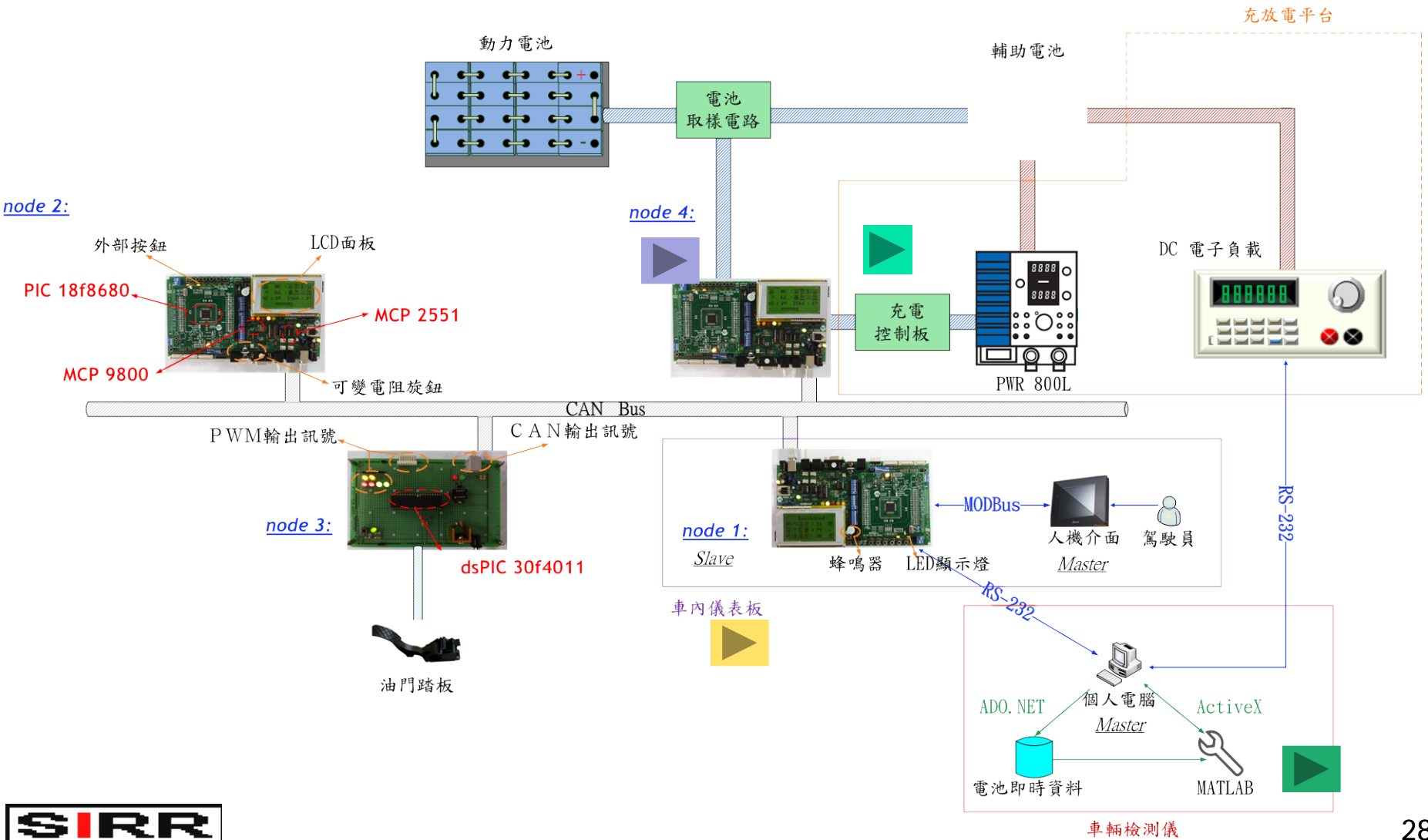
輔助單元

電源管理單元

車輛控制單元

電力驅動單元

車載網路系統CANBUS建置- 車載系統架構圖



車載網路系統建置- 車載資訊



車用監控系統

資料傳輸狀況:
0x0016 30 20 8C 03 1F 00

連線狀態: 連線中...
通訊COM端: COM1

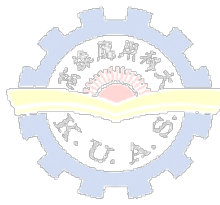
車內資訊 電池管理 即時曲線 資料庫

馬達轉速 (RPM): 0 to 1800, needle at ~1000
時速 (km/hr): 0 to 240, needle at ~40

動力電池電壓: 0 to 350, needle at ~100
輔助電池電壓: 0 to 15, needle at ~10
電池電量: 0 to 100, gauge at 74
車內溫度: 0 to 100, thermometer at ~20

車燈控制系統

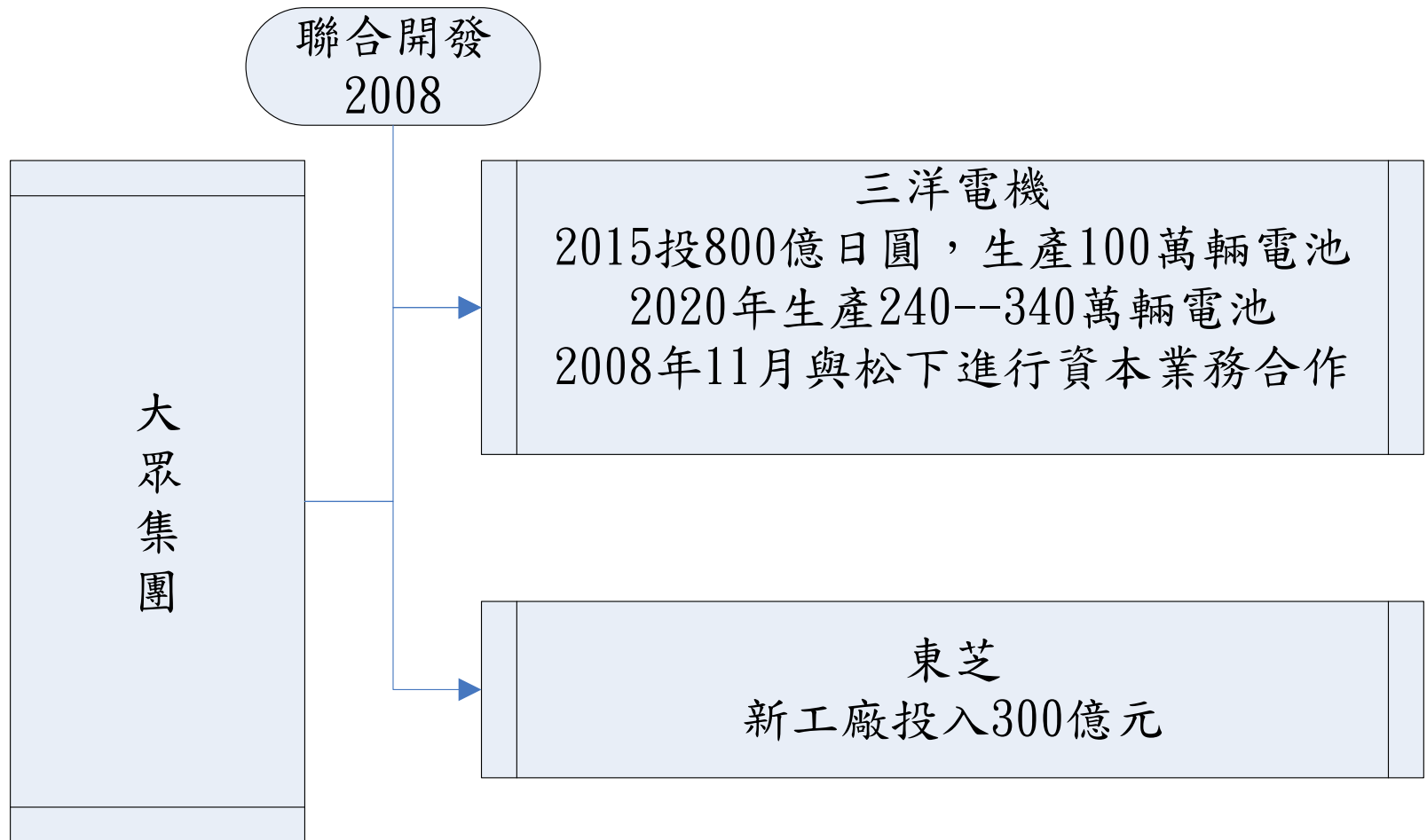
馬達溫度異常 車門警示燈 電量過低 電池溫度異常



Charge

- 1. 現況
- 2. 充電電路
- 3. 電能管理BMS

中國大陸合縱連橫

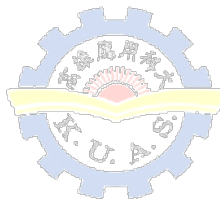




| Charging time | Power supply | Voltage | Max current |
|---------------|------------------------------|---------|-------------|
| 6-8 hours | <u>Single phase</u> - 3,3kW | 230 VAC | 16 A |
| 2-3 hours | <u>Three phase</u> - 10kW | 400 VAC | 16 A |
| 3-4 hours | <u>Single phase</u> - 7kW | | 32 A |
| 1-2 hours | <u>Three phase</u> - 24kW | | 32 A |
| 20-30 minutes | <u>Three phase</u> - 43kW | | 63 A |
| 20-30 minutes | <u>Direct current</u> - 50kW | | 100 - 125 A |

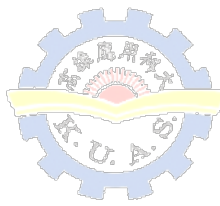


T



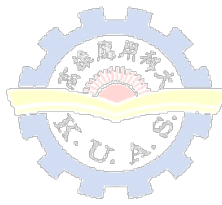
The International Electrotechnical Commission (IEC) “Modes” are similar:

- “Mode 1” - slow charging from a regular electrical socket (single or 3-phase)
- “Mode 2” - slow charging from a regular socket but which equipped with some EV specific protection arrangement (e.g. the Park & Charge or the PARVE systems)
- “Mode 3” - slow or fast charging using a specific EV multi-pin socket with control and protection functions (e.g. SAE J1772 and IEC 62196)
- “Mode 4” - fast charging using some special charger technology such as CHAdeMO.



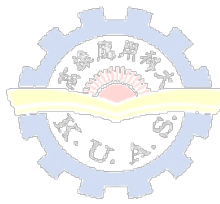
- IEC62196-1是指一般性充電系統，IEC62196-2式將充電系統細分為三類，即TYPE1、TYPE2、TYPE3等三類，其中
- TYPE1：是指電動車單相充電(意為車輛接口或輸入端為單相)，如Yazaki 或 SAE J1772 (日本(Japan)，北美(North America))；
- TYPE2：：車輛之連接口為單相與三相，主插口端連接器無關閉器(WITHOUT SHUTTERS)，如VDE-AR-E 2623-2-2；
- TYPE3：車輛之連接口為單相與三相，主插口端連接器具備關閉器(WITH SHUTTERS)，如SCAME連接器發展系列。





IEC 6185-1標準規範，其規定電動車電源 充電之四種模式：

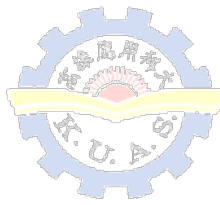
- Mode 1 (AC) - slow charging from a standard household-type socket-outlet
- (MODEL1 AC):標準家電交流插座慢充；
- Mode 2 (AC) - slow charging from a standard household-type socket-outlet with an in-cable protection device
- (MODE2 AC)：標準家電交流插座慢充，但電纜具保護裝置；
- Mode 3 (AC) - slow or fast charging using a specific EV socket-outlet and plug with control and protection function permanently installed
- (MODE 3 (AC)：具備保護固定充電設施，慢充與快充選擇；
- Mode 4 (DC) - fast charging using an external charger
- (MODE4 DC)： 外接裝置直流快充模式
- 充電模式1至3為直接由主電源充電，讓電動車充滿電需要3--10小時，模式4為快充10分鐘充滿，唯須電池外接(OFF-GRID)，所需外接工具昂貴。



LEVEL 1 CHARGING

- • Portable “plug”
- • 120 VAC standard outlet
- • Delivers power from the wall to the vehicle’s on-board charger
- • Time from fully depleted to fully charged: 16-18 hours

LEVEL 2 CHARGING (*OVERNIGHT CHARGING*)

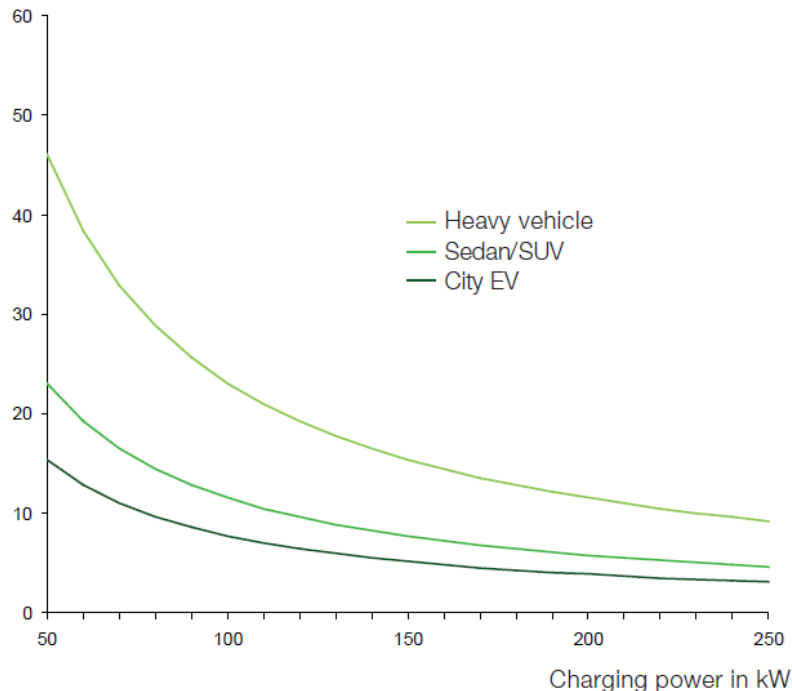


- • Fixed charging station
- • 208-240 VAC fixed installation
- • Delivers AC power from the wall to the on-board charger
- • Time from fully depleted to fully charged: 3-8 hours

LEVEL 3 CHARGING (*DC FAST CHARGING*)

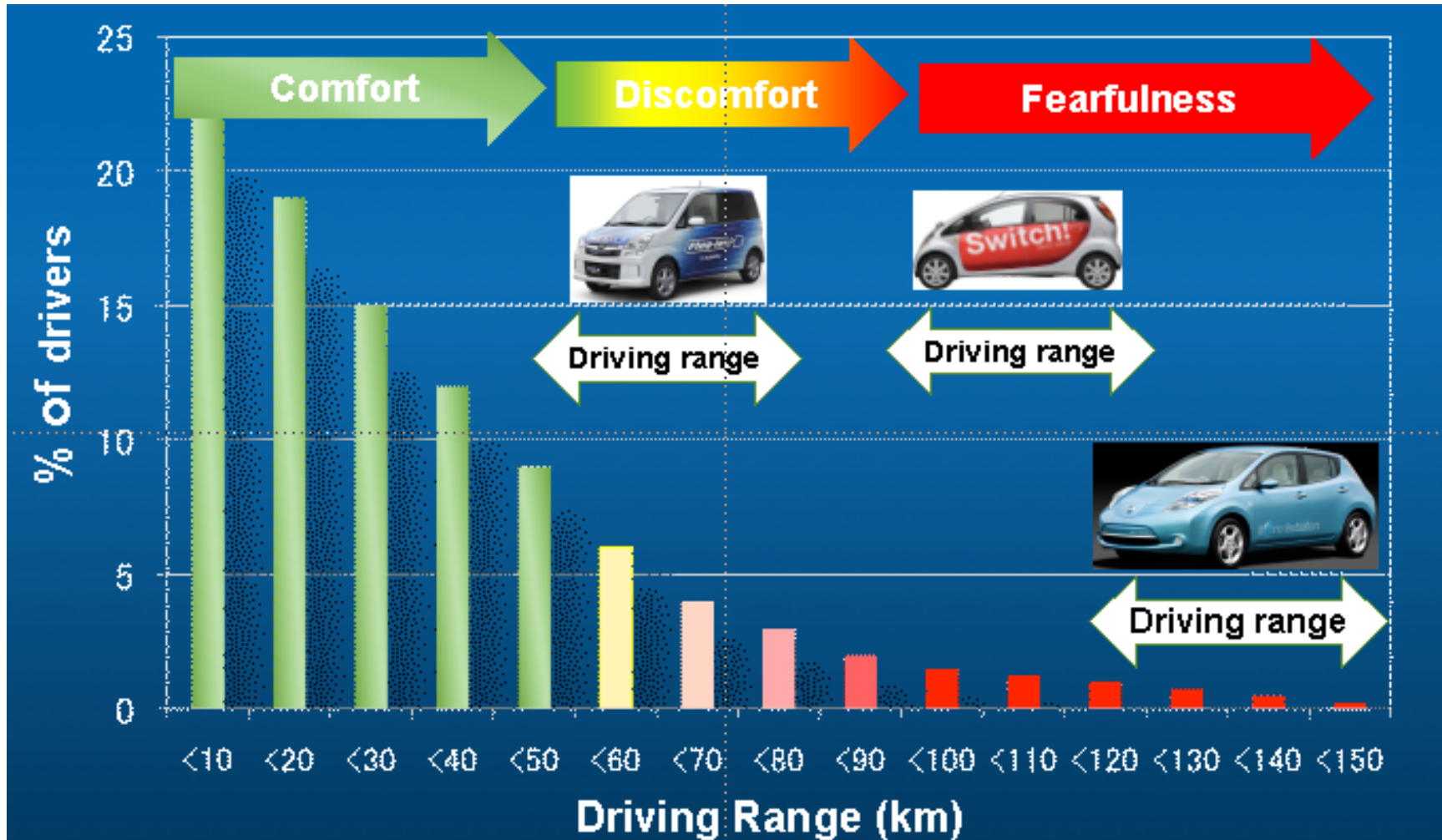
- High powered fast-charge station (like a “gas pump”)
- 400-600 VAC fixed installation
- Delivers DC energy, bypassing the on-board charger
- Time from fully depleted to fully charged: as little as <30 minutes

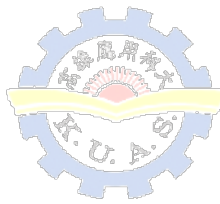
Minutes to charge 80 % capacity



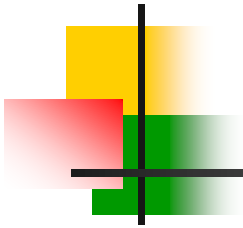
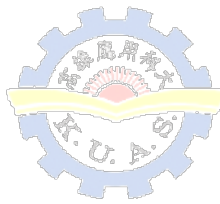
CHAdeMO DCEV50-PS DC EV-50FS

Characteristics of CHAdeMO Quick Charging System



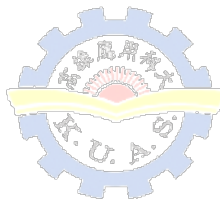


- Tokyo Electric Power Company introduced an EV with a driving range of 80km on a trial basis in 2007. Showed the driving record of the EV in Yokohama in October 2007, the area is compact and the gas vehicle's daily driving distance is around 40km. Then, the EV should be able to cover the area easily. However, the driving distance of the EV in October was 200km and it was not used
- often. The driver had been informed of its performance, but he hesitated to use it, since he was worried in case the battery would be out.

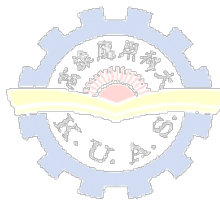


| | Replenishment Rate for Km (miles) driven | | |
|----------------|--|-------------------------|--------------------------|
| Charge Regimen | 50Km / day (30miles) | 100Km(60miles) / day | 150Km(90 miles) / day |
| Level 1(1.4KW) | ~5.5Hrs | ~11Hrs | ~16Hrs |
| Level 2(3.3KW) | ~2.5Hrs | ~4.5Hrs | ~6.5Hrs |
| Level 2(6.6KW) | ~1Hrs | ~2.5Hrs | ~3.5Hrs |
| DC fast charge | <0.5Hrs | ~0.5Hrs | <1Hrs |

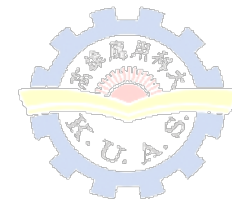
Level 3 charging stations (ac to dc) —fast charge



| specification | EV-30 | EV-60 | EV-125 | EV-250 |
|-----------------------|---|-------|--------|-----------------|
| Power Rating | 30KW | 60KW | 125KW | 250KW |
| Input Power | 480V/3PHASE AC (other inputs available) | | | |
| Input Current | 42A | 84A | 165A | 330A |
| Power Factor | 0.95 | | | |
| Connector | AV or JART /TEPCO | | AV | |
| Voltage | 50VAC to 600VAC | | | 50VAC to 700VAC |
| Current | 100A | 200A | 275A | 550A |
| Frequency | 50Hz/60Hz | | | |
| Efficiency rating | >90% | | | |
| Operating temperature | -30°C -- 50°C | | | |
| Storage temperature | -30°C -- 60°C | | | |



| specification | EV-30 | EV-60 | EV-125 | EV-250 |
|----------------------|--------|-------|--------|--------|
| Power Rating | 30KW | 60KW | 125KW | 250KW |
| Charge shutdown time | 15msec | | | |
| Voltage accuracy | 1% | | | |
| | | | | |
| | | | | |
| | | | | |



| specification | EVSE-RS | EVSE-RS DUAL | EVSE-RS QUAD | EVSE-LS EVSE-CS |
|-----------------------|--------------------|-----------------|-----------------|--------------------|
| Power Rating | 30KW | 60KW | 125KW | 250KW |
| Power Factor | 0.95 | | | |
| Connector | SAE J1772 | | | |
| Voltage | 208VAC to 240VAC | | | |
| Current | 30A MAX | | | |
| Frequency | 50Hz/60Hz | | | |
| Enclosure | NEMA4 | | | |
| Operating temperature | -30°C -- 50°C | | | |
| Cord length | upto 25' available | | | |

EV charging station signs

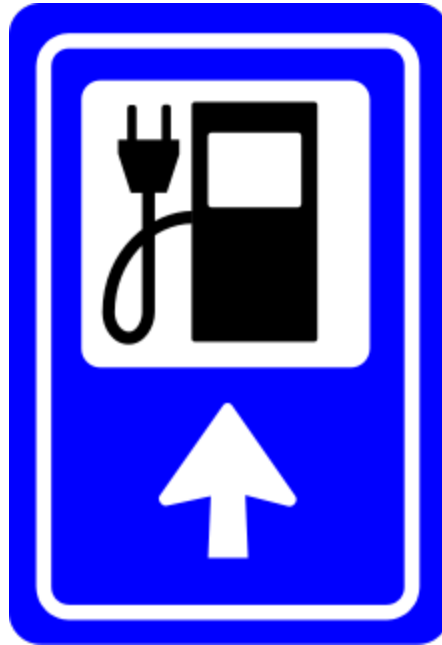


photo :

http://www.nytimes.com/2011/05/08/automobiles/08JAPAN.html?_r=3&ref=world

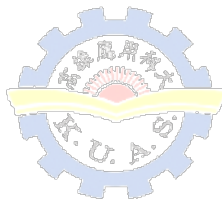


HELPING OUT An electric Mitsubishi i-MiEV in a tsunami-wrecked area of Iwate Prefecture.

By KEN BELSON

Published: May 8, 2011

Renewable electricity and RE charging Stations

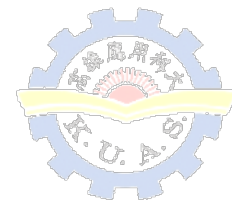




Public charging stations in San Francisco 2009

Level 2 charging station for the Nissan Leaf

辦公大樓地下停車場充電站





Wireless charging station

Zoom in of the wireless inductive charging device

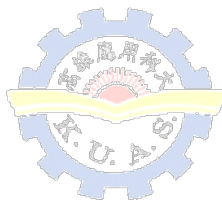


Powermat Wireless Charging System for Samsung Galaxy S 4G/Vibrant

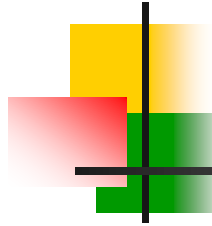


Powermat Wireless Charging System for BlackBerry Torch

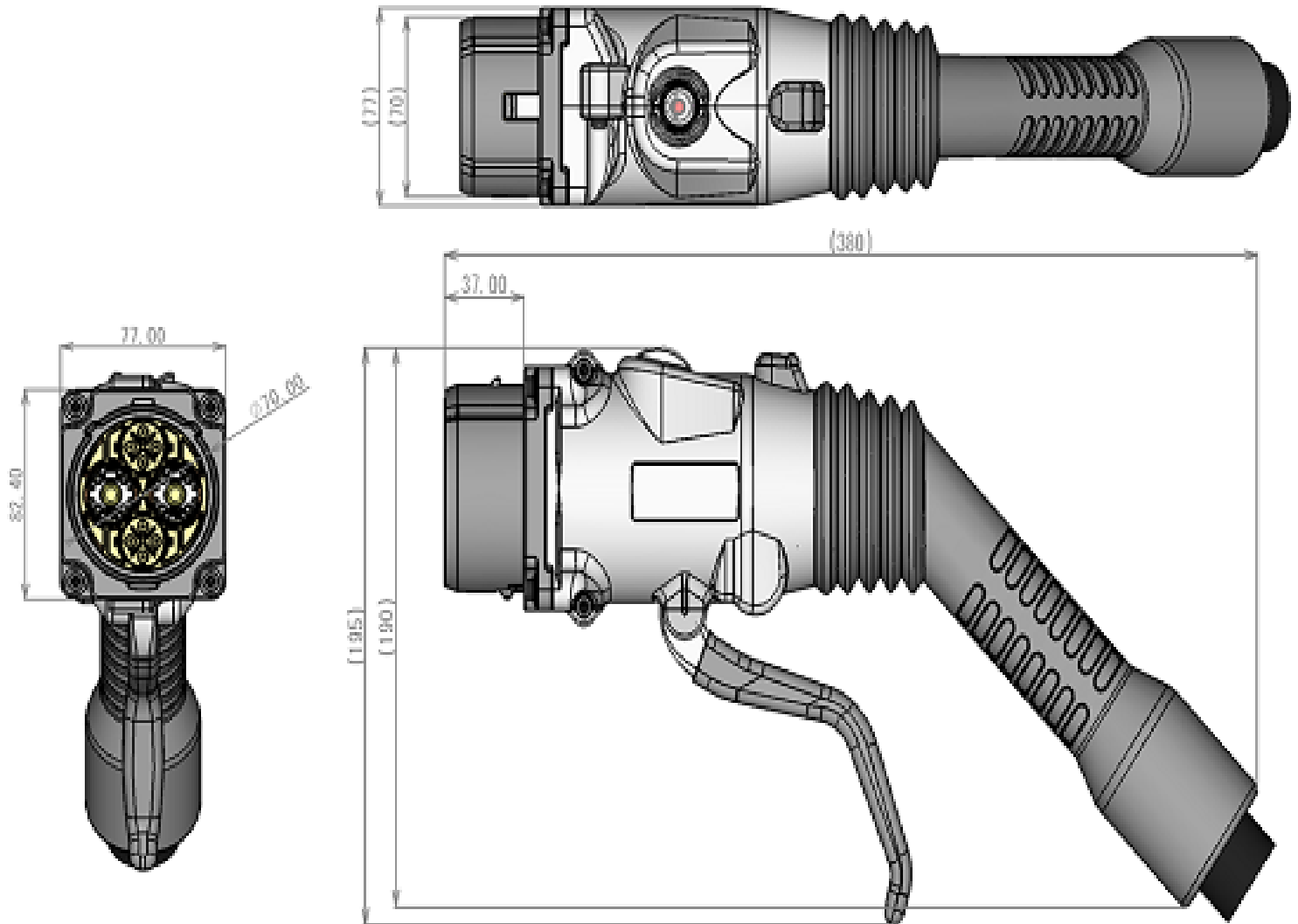
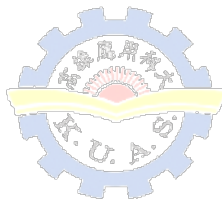




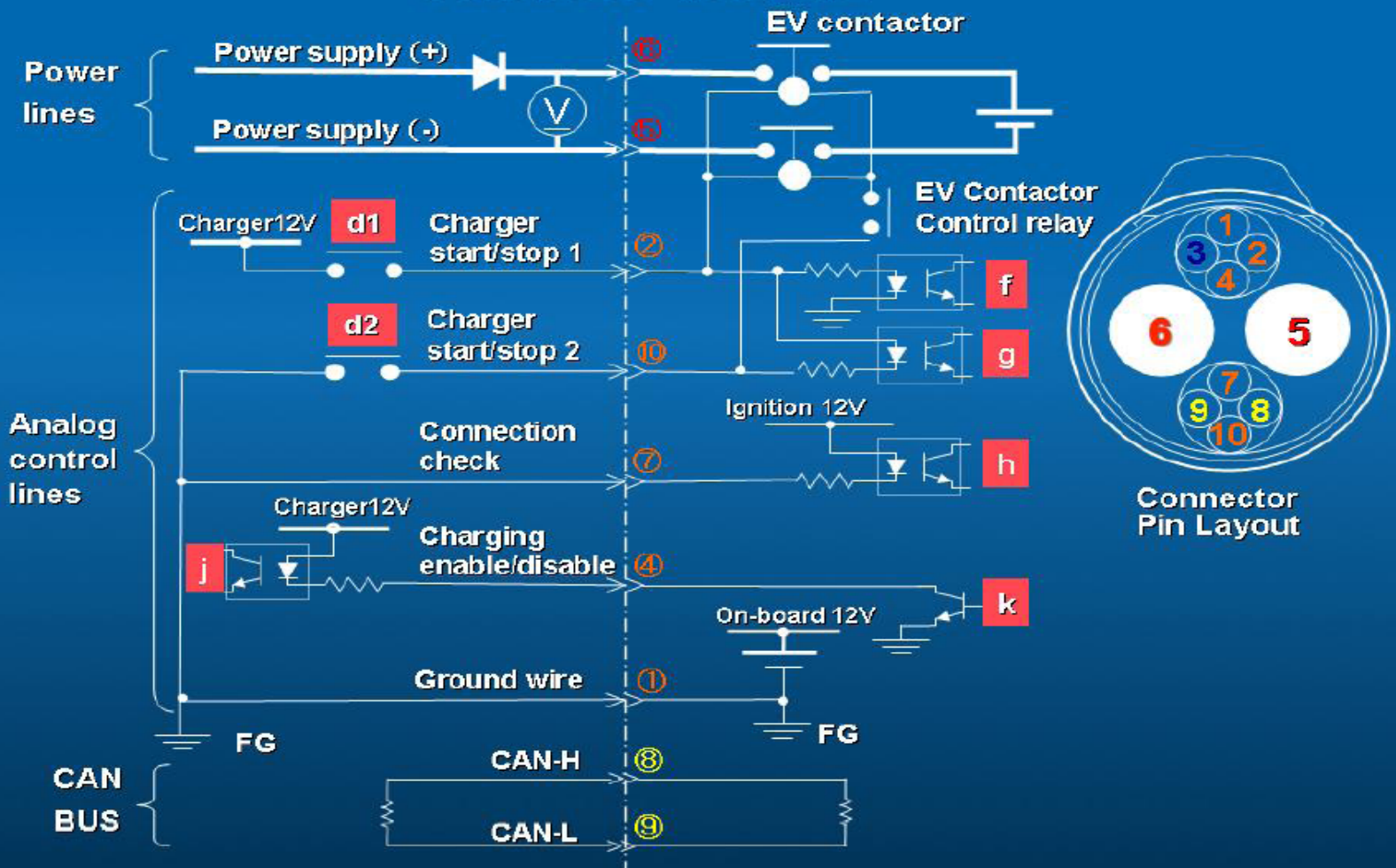
國內示範充電站 artc



CHAdeMO proposing DC Connector (YAZAKI CORPORATION)



Connector interface



National Standard (AC coupler)

L : 400VAC 16—63A

NC1: 400VAC16—63A

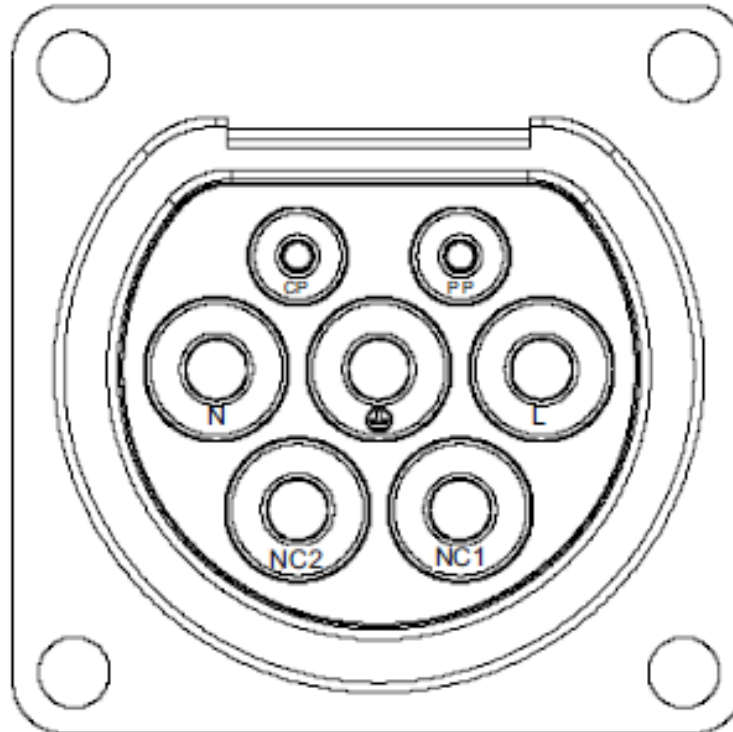
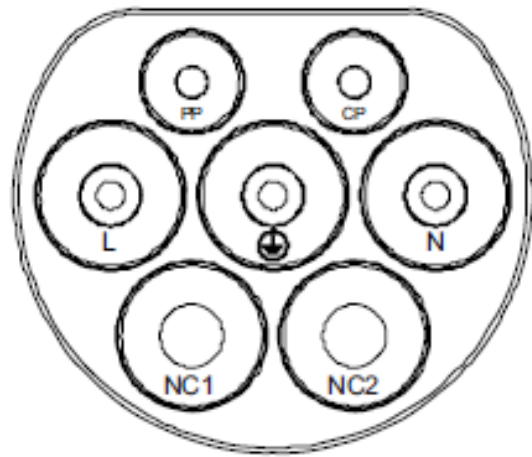
NC2:400VAC16---63A

N :400VAC16---63A(NEUTRA)

PE : Ground / Earth

CP :30V/10A Control Pilot 控制確認1

PP : 30V/10A Plug Presen 控制確認2



Non-National Standard (AC coupler)

L : 400VAC 16—63A

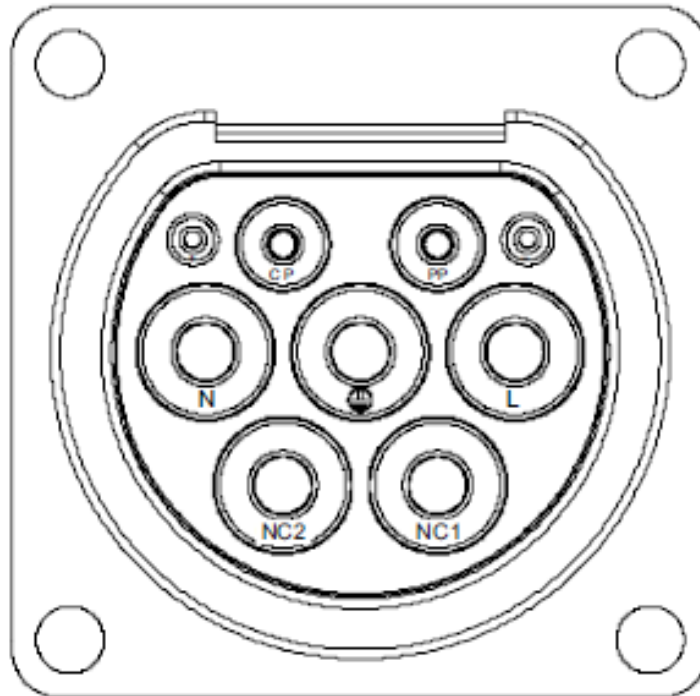
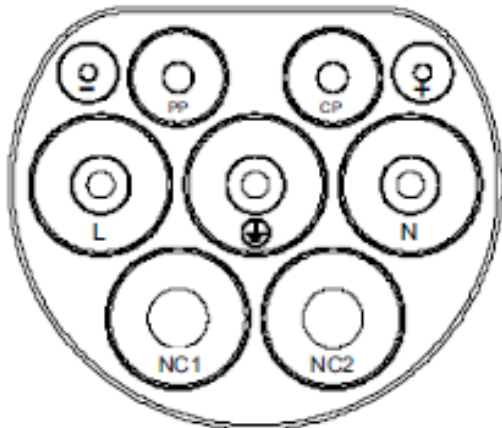
NC1: 400VAC16—63A

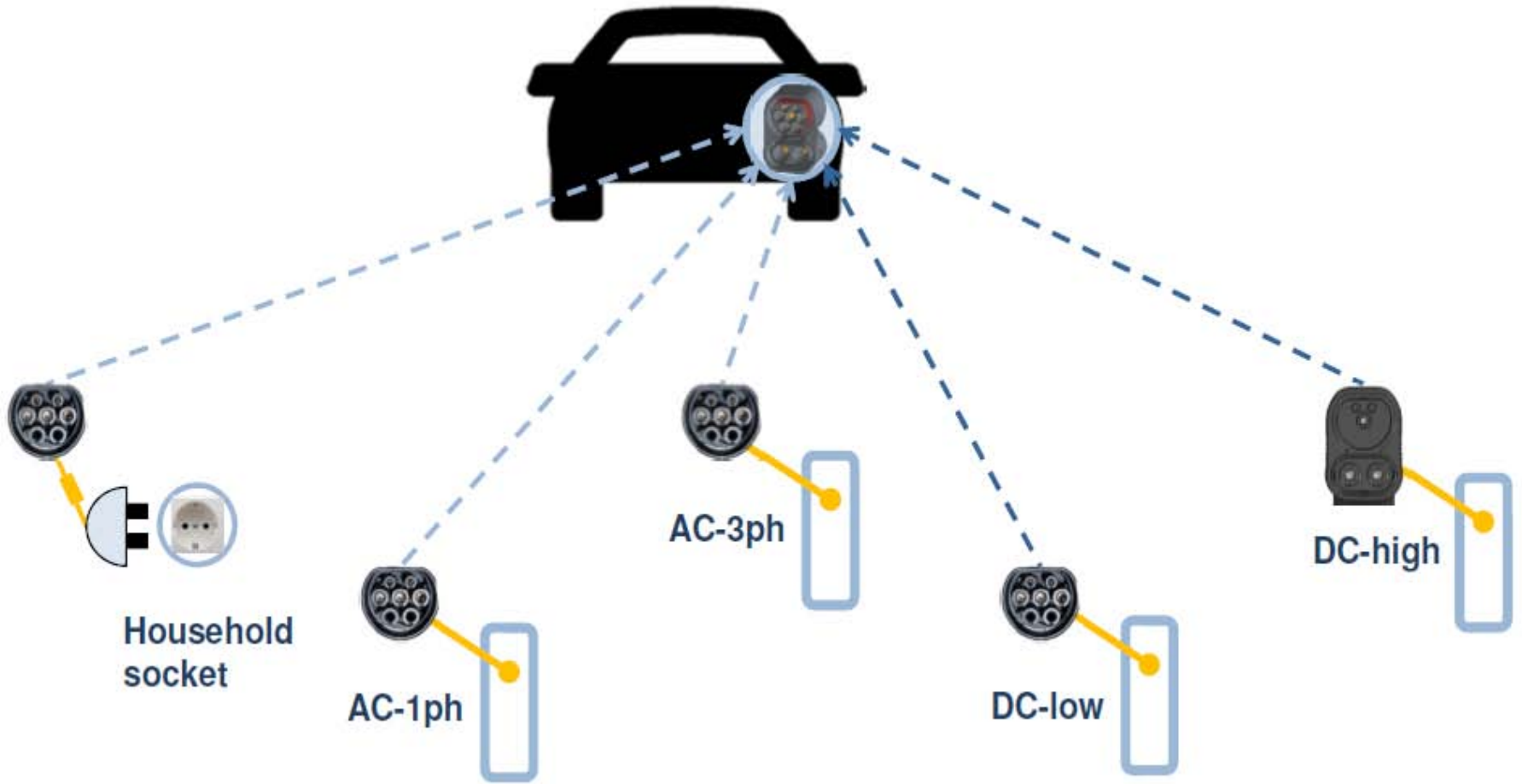
NC2:400VAC16---63A

N :400VAC16---63A(NEUTRA) PE : Ground / Earth

CP :30V/10A Control Pilot 控制確認1 PP : 30V/10A Plug Presen 控制確認2

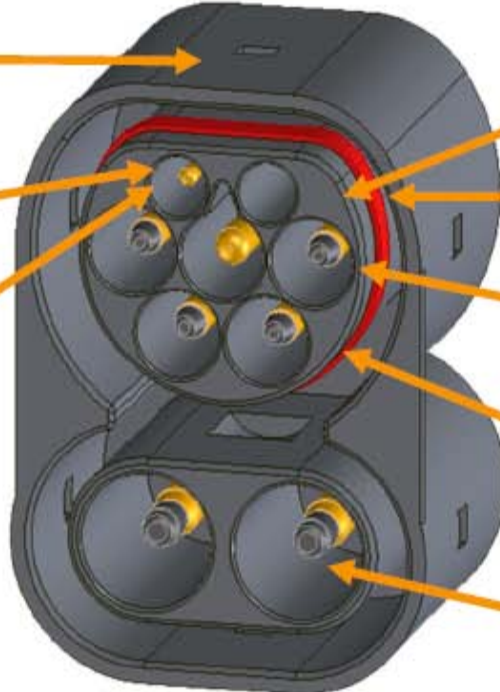
+ : 30V/5A Auxiliary Power or other - : 30V/5A Auxiliary Power or other





Safety features

- 1 Diagnosable lock
- 2 Proximity and control pilot
- 3 Charging control communication with PLC

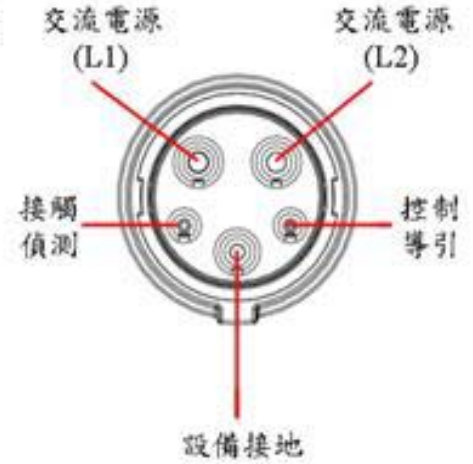
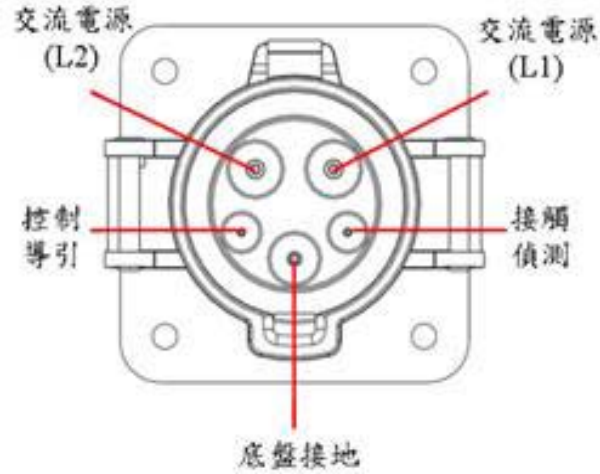


Function

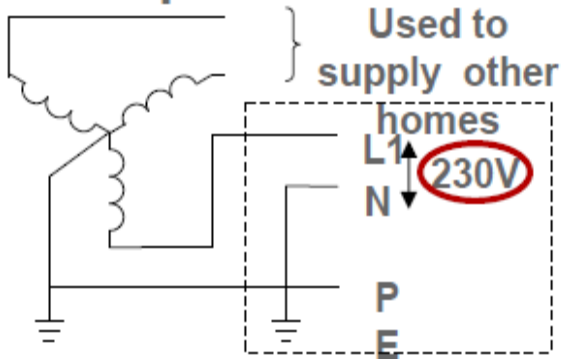
- 1 1-phase AC charging with Type 2
- 2 Integration into smart grid
- 3 DC charging with Type 2
- 4 3-phase AC charging with Type 2
- 5 High power DC charging via dedicated pins

插座

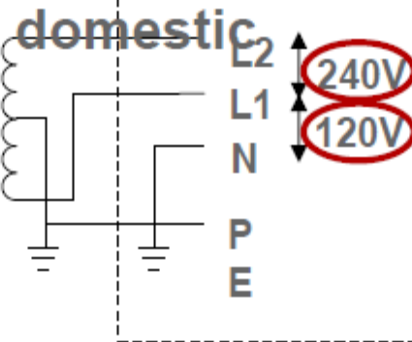
插頭



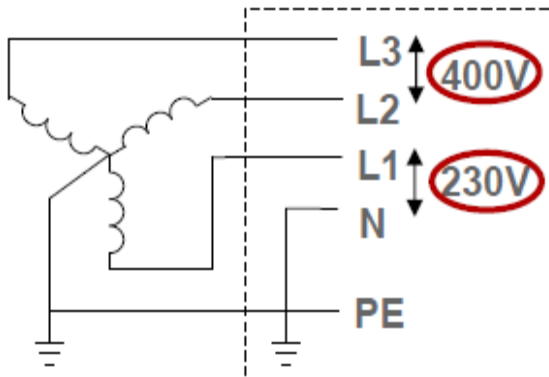
Europe domestic



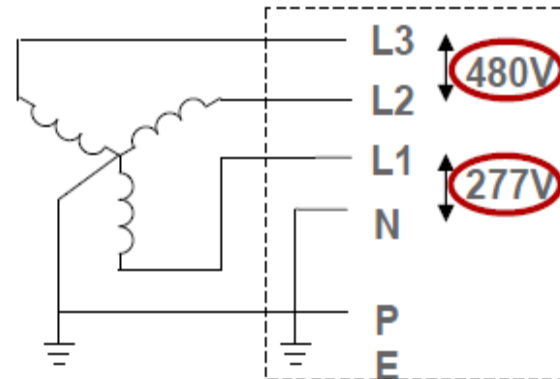
USA



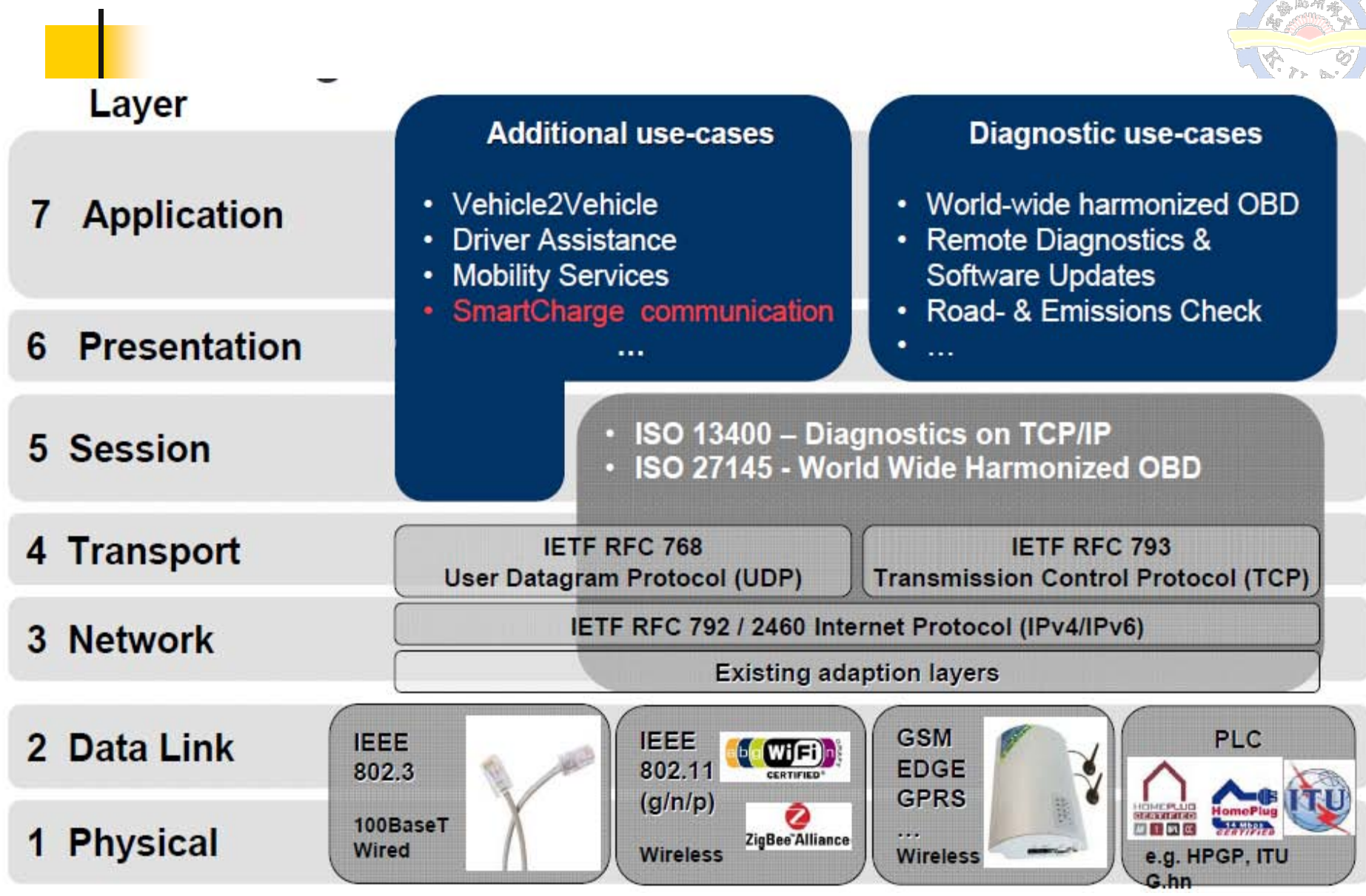
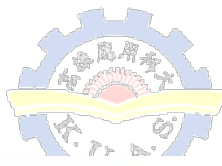
Europe commercial*

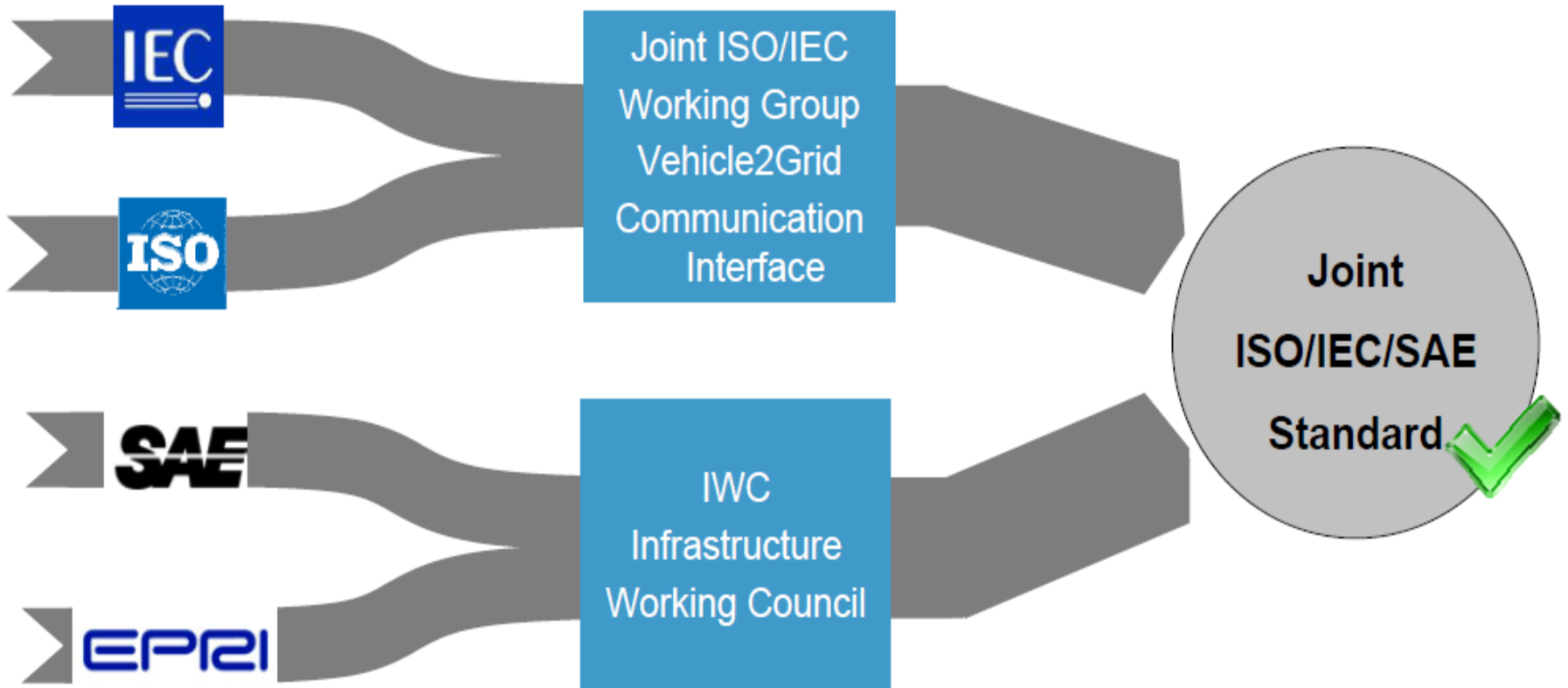


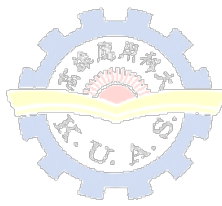
USA commercial



*in northern Europe also domestic

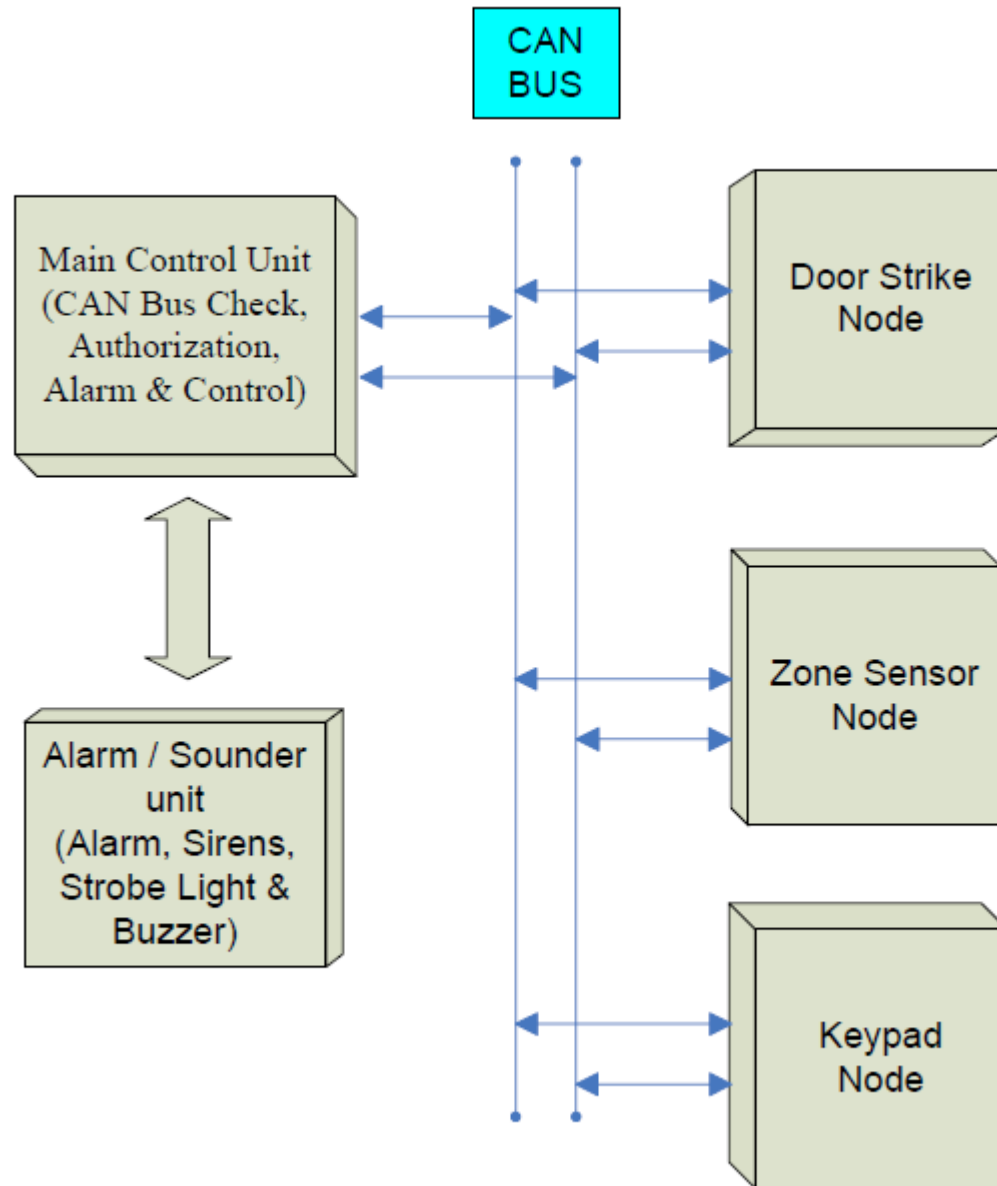






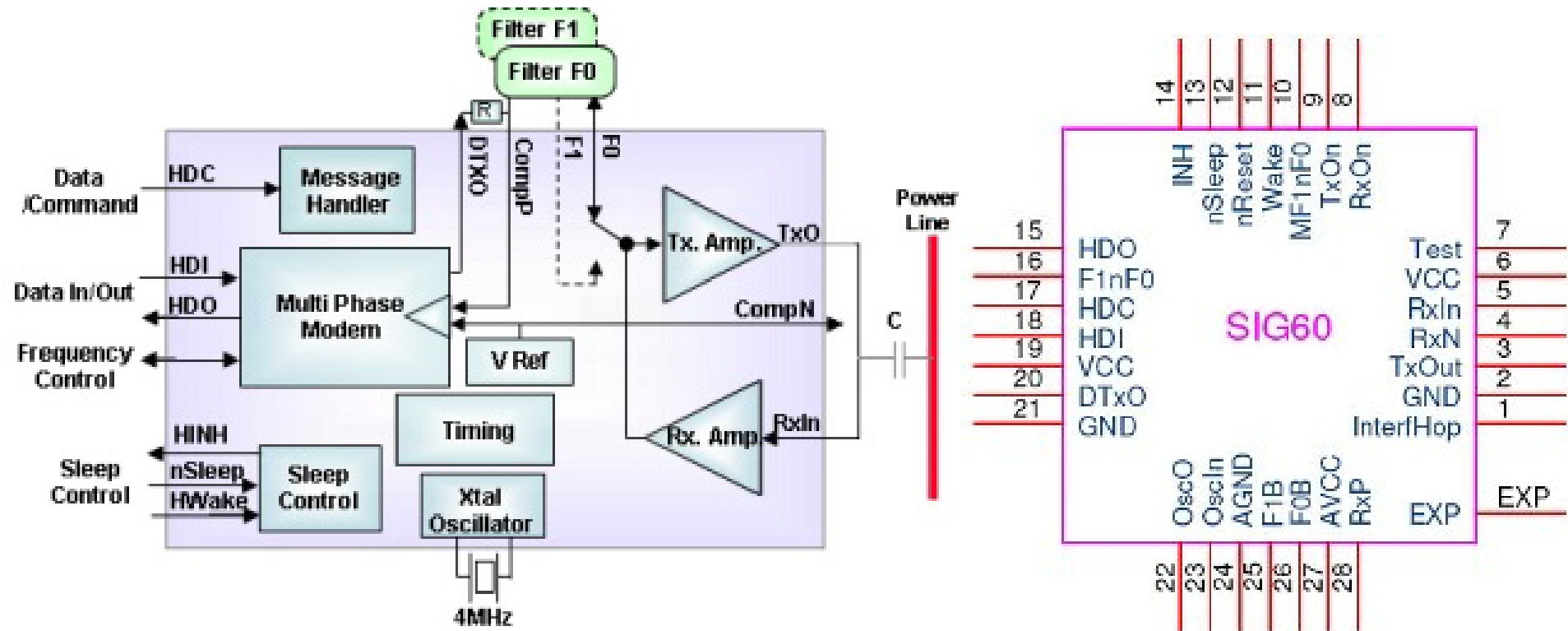
| | Toyota 普瑞斯第一 代 | Toyota 普瑞斯第三 代 | 本田 INSIGHT | 三菱 i-Mi EV | 日產 LEAF EV |
|-----------------------|----------------------|----------------------|------------------|---------------|---------------|
| 驅動方式 | HEV 1997 | HEV 2009 | EV 2009 | EV 2009 | EV 2010 |
| 車重 | 1240Kg | 1490Kg | 1200Kg | 1100Kg | 1520Kg |
| Motor磁極 | IPM | PFM | IPM | IPM | IPM |
| MOTOR MAX. POWER | 33KW | 60KW | 10KW/ 1500RPM | 47KW | 80KW |
| Motor max. torque | 350Nm | 207Nm | 78Nm /1000RPM | 180Nm | 280Nm |
| Motor max. speed | 6000rpm | 13900rpm | 6000rpm | 8500rpm | 10390rpm |
| Motor max. voltage | 274V | 650V | 100V | 330V | 345V |

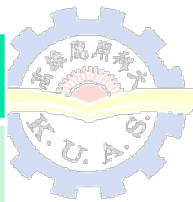
Security System Block Diagram



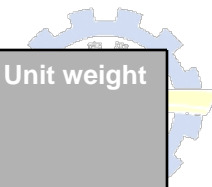
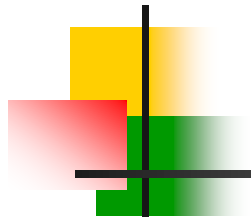
Functional Block Diagram

Device Pinout





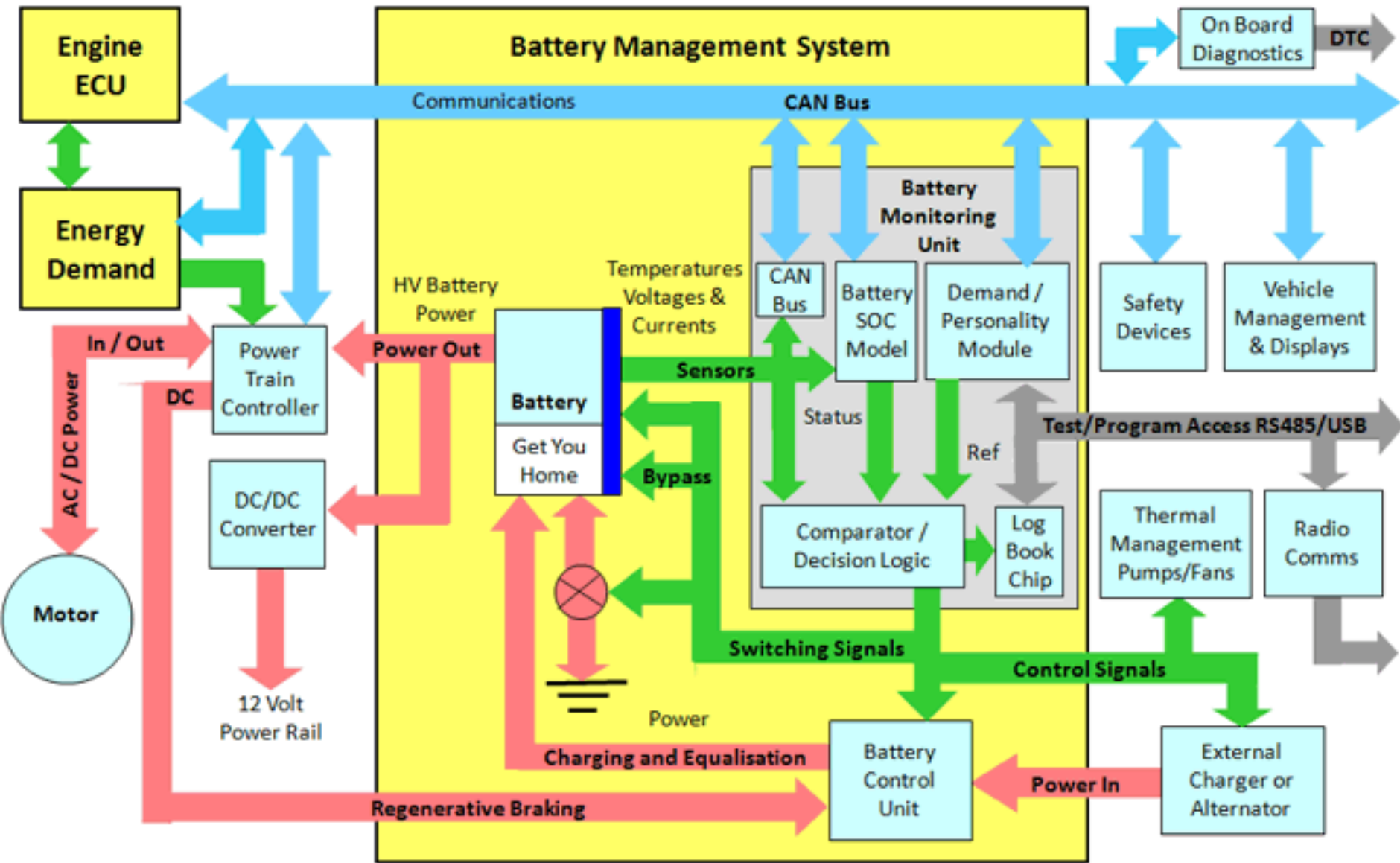
| | 大型車 | 中型車 | 小型車 |
|-------------------|---|---|---|
| 最大行駛里程 (Km) | 50 | 90 | 50 |
| 最高行駛時速 (Km/hr) | 100 | 70 | 60—120 |
| 電池容量 | $50 * 0.8 = 40\text{KWH}$ $40 / 0.7 = 60\text{KWH}$ $S = 60 / 388 * 1000$ $= 154\text{AH}$ | $90 * 0.6 = 54\text{KWH}$ $54 / 0.7 = 77\text{KWH}$ $S = 77 / 312 * 1000$ $= 247\text{AH}$ | $50 * 0.3 = 15\text{KWH}$ $15 / 0.7 = 21.4\text{KW}$ H $S = 21.4 / 288 * 1000$ $= 74.4\text{AH}$ |
| 充電輸出電壓 | | | |
| | $(388 / 3.6) * 4.2 * 1$ $.05 = 475\text{V}$ $I = 180 * 0.3 = 54\text{A}$ $P = VI = 25.66\text{KW}$ | $(312 / 3.6) * 4.2 * 1$ $.05 = 393\text{V}$ $I = 270 * 0.3 = 81\text{A}$ $P = VI = 31.85\text{KW}$ | $(288 / 3.6) * 4.2 * 1$ $.05 = 353\text{V}$ $I = 90 * 0.3 = 27\text{A}$ $P = VI = 9.53\text{KW}$ |
| | | | |
| | | | |
| | | | |

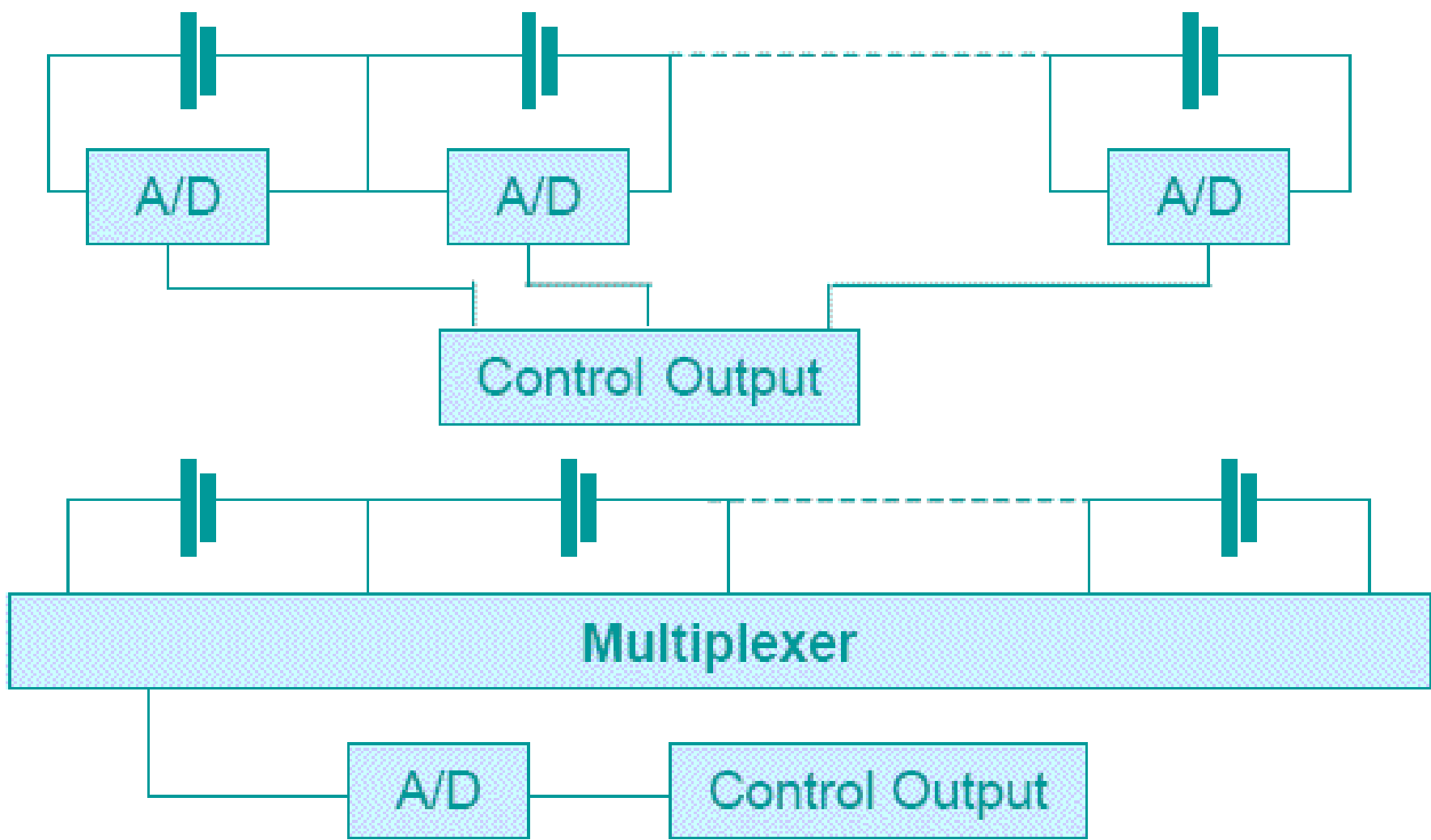
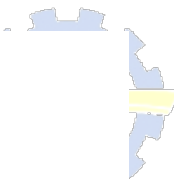


| Model C*/CF** | V o l t | Ampere | Effect 15min. | Pe a k | Cell balance | Dimensions (mm) | Unit weight |
|----------------|------------------|-------------|---------------|--------------|--------------|-----------------|-------------|
| BMS 4C / 4CF | 1 2 | 250A / 300A | 350A / 350A | 50 0A | 1,5A | 320 x 185 x 67 | 4 Kg |
| BMS 8C / 8CF | 2 4 | 250A / 300A | 350A / 350A | 50 0A | 1,5A | 320 x 185 x 67 | 4 Kg |
| BMS 12C / 12CF | 3 6 | 250A / 300A | 350A / 350A | 50 0A | 1,5A | 320 x 185 x 67 | 4 Kg |
| BMS 15C / 15CF | 4 8 | 250A / 300A | 350A / 350A | 50 0A | 1,5A | 320 x 185 x 67 | 4 Kg |
| BMS 19C / 19CF | 6 0 | 125A / 250A | 150A / 300A | 40 0A | 1,5A | 320 x 185 x 67 | 4 Kg |
| 23C / 23CF | 7 2 | 125A / 250A | 150A / 300A | 40 0A | 1,5A | 320 x 185 x 67 | 4 Kg |



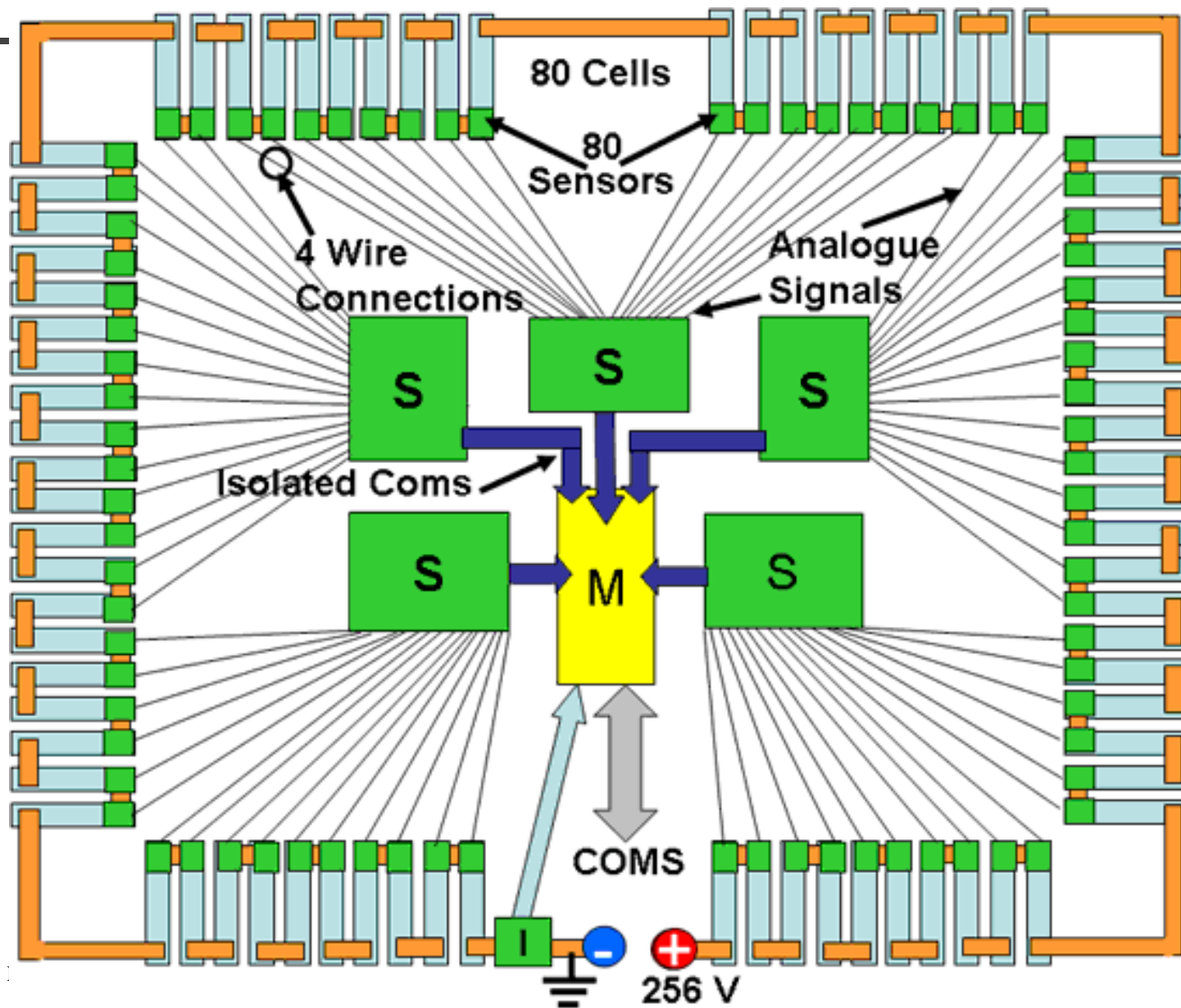
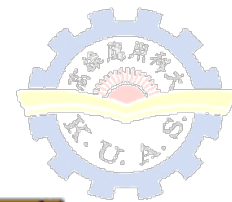
Vehicle Energy Management Functions

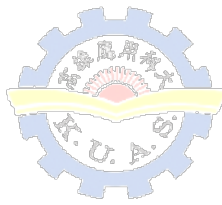




Multiplexing to reduce component count

Bms master and slave (star topology)

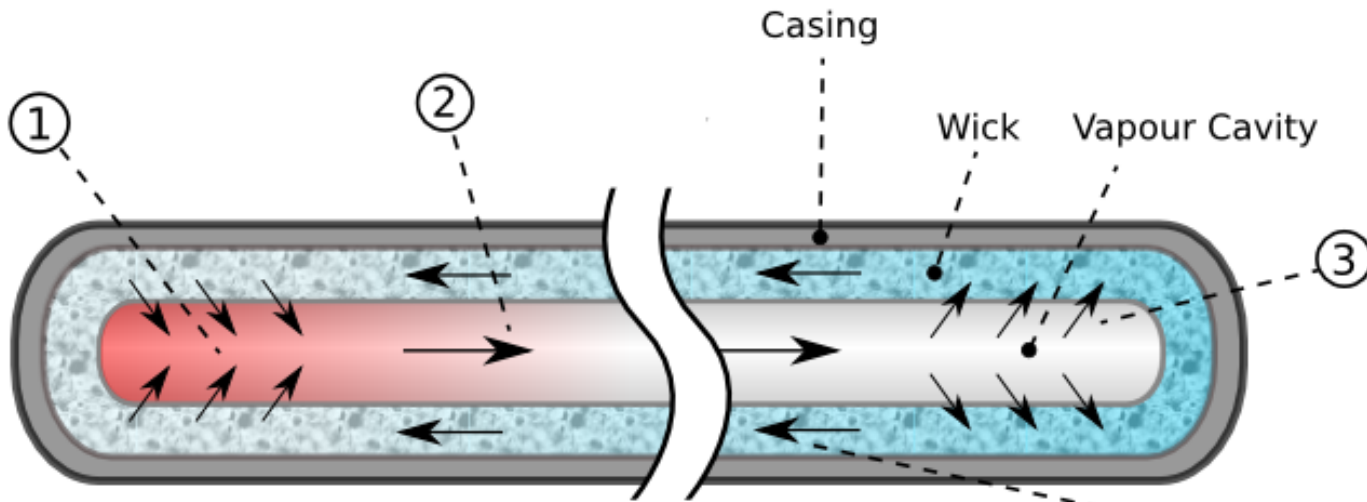




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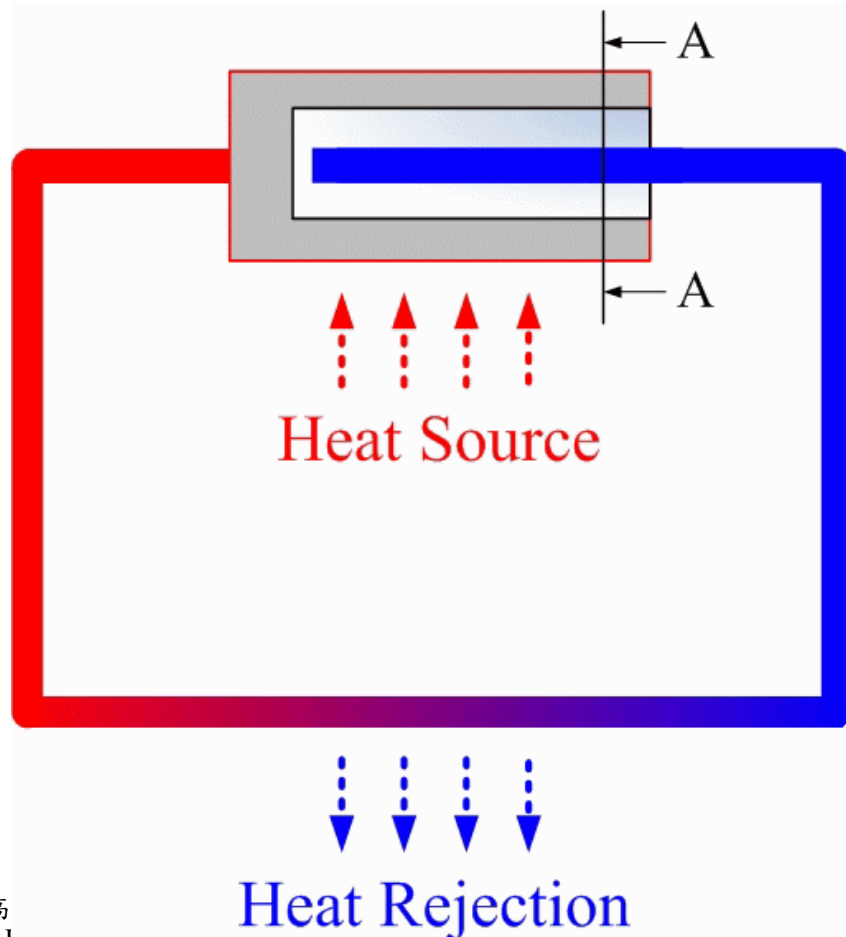
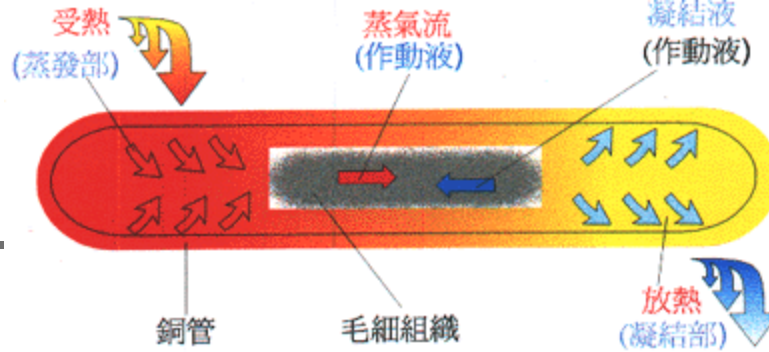
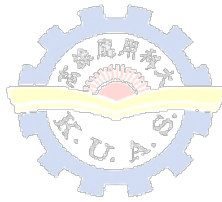
- 1. 氣冷
- 2. 水冷
- 3. 熱導管

熱導管



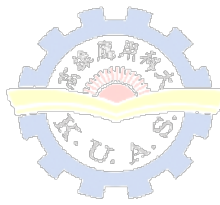
係一種具有快速均溫特性的特殊材料，其中空的金屬管體，使其具有質輕的特點，而其快速均溫的特性，則使其具有優異的**熱超導**性能；熱管的運用範圍相當廣泛，其最早期運用於**航太領域**，現早已普及運用於各式熱交換器、冷卻器、天然地熱引用等，擔任起快速熱傳導的角色，更是現今電子產品散熱裝置中最普遍高效的導熱（非散熱）元件。

4) Working fluid flows back to higher temperature end.



熱導管（或稱熱管）

- 熱導管基本上是一內含作動流體之封閉腔體，藉由腔體內作動流體持續循環的液汽二相變化，及汽&液流體於吸熱端及放熱端間汽往液返的對流，使腔體表面呈現快速均溫的特性而達到傳熱的目的；
- 其作動機制為，液相作動流體於吸熱端蒸發成汽相，此一瞬間在腔體內產生局部高壓，驅使汽相作動流體高速流向放熱端，汽相作動流體於放熱端凝結成液相後，藉由重力/毛細力/離心力…迴流至吸熱端，循環作動。由此可知，熱導管作動時，氣流係由氣壓壓力差驅動，液流則須依使用時之作動狀態，採用或設計適合的迴流驅動力。
- 熱導管理想作動時，作動流體處於液&汽兩相共存的狀態，兩相無溫差，亦即整個腔體內均處於均溫狀態，此時雖然有熱能進出此一腔體系統，但吸熱端與放熱端卻是等溫，形成等溫熱傳的熱超導現象。

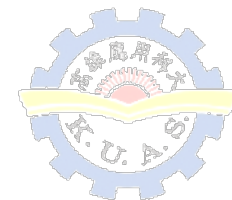


管體結構

- 熱導管須藉由管體結構形成封閉腔體，管體既須具有承受內外壓差的結構功能，亦是熱傳入與傳出腔體的介質材料，因此除演示用熱導管，會以玻璃材質以展示其內部作動現象外，其它實用熱導管之管體材料均為金屬。
- 運用於電子散熱業界的小形熱導管，其管體材質大多為銅，亦有因重量考量而採用鋁管或鈦管。

熱導管有不同分類方式，通常有：

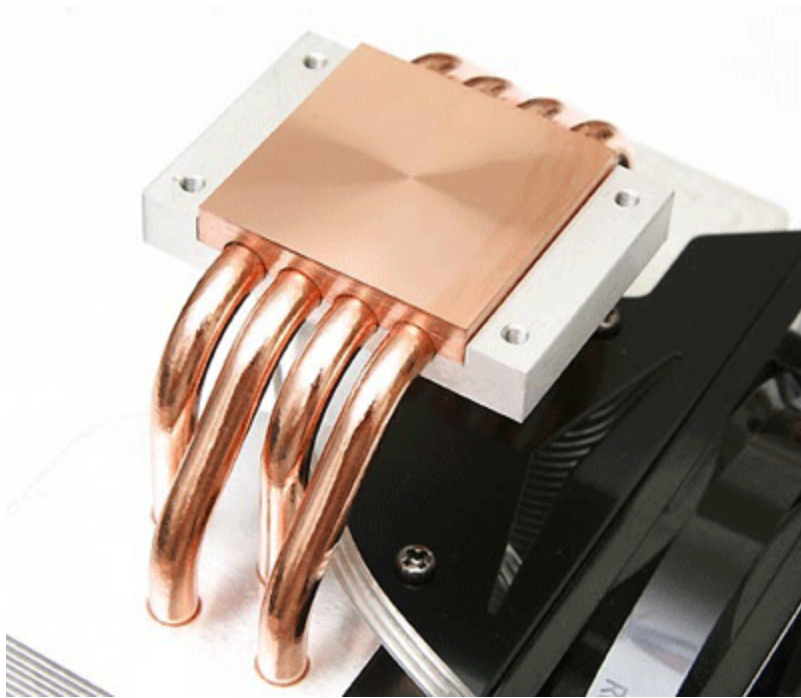
- 依液相迴流方式：熱虹吸式、毛細式…
- 依工作溫度：



| 工作溫度 | 主要的作動流體 |
|------------------|--|
| 極低溫 (-273~-70°C) | <u>氫</u> 、 <u>氫</u> 、 <u>氫</u> 、 <u>氮</u> 、 <u>甲烷</u> |
| 低溫 (-70~200°C) | <u>氟利昂</u> 、 <u>氫</u> 、 <u>丙酮</u> 、 <u>甲醇</u> 、 <u>乙醇</u> 、 <u>庚烷</u> 、 <u>水</u> |
| 中溫 (200~500°C) | <u>萘</u> 、Dowtherm、thermex、 <u>硫</u> 、 <u>水銀</u> |
| 高溫 (500~1000°C) | <u>鉍</u> 、 <u>銻</u> 、 <u>鉀</u> 、 <u>鈉</u> |
| 極高溫 (>1000°C) | <u>鋰</u> 、 <u>鈣</u> 、 <u>鉛</u> 、 <u>銻</u> 、 <u>銀</u> |

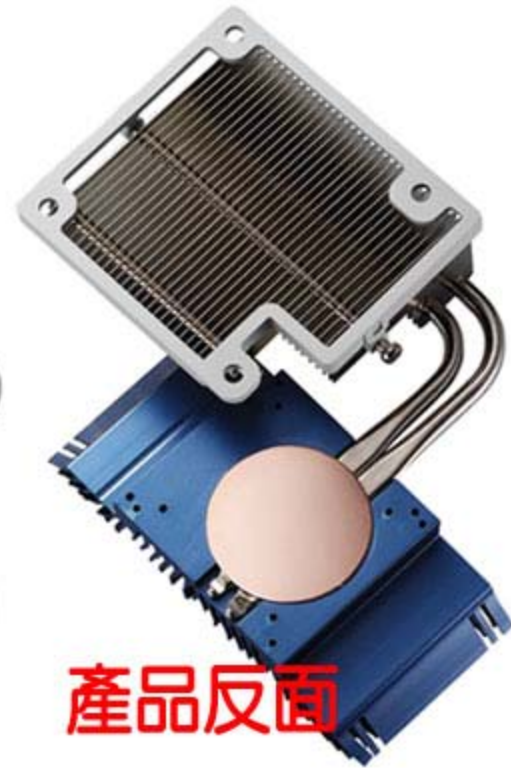
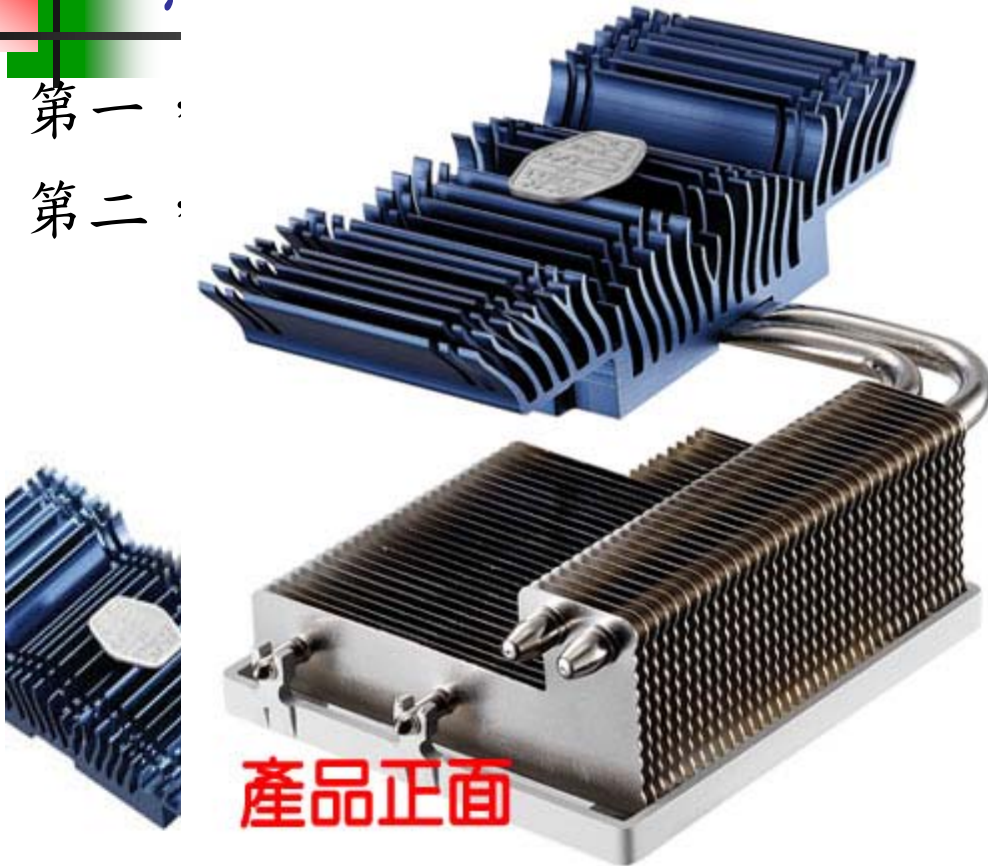
熱導管測試

- 利用毛細作用與相變化..等原理，進行快速熱量傳輸的裝置，熱導管的傳熱速度可到銅和銀的數百倍，常用在電腦散熱上或是不適合風扇散熱電子產品。



熱導管產品

- 第一：
- 第二：

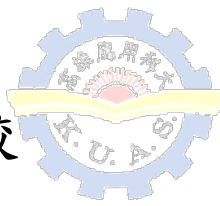


熱導管

可選元OCIII風扇

液冷式驅動器





無刷永磁馬達與傳統感應馬達以及銅轉子馬達特性比較

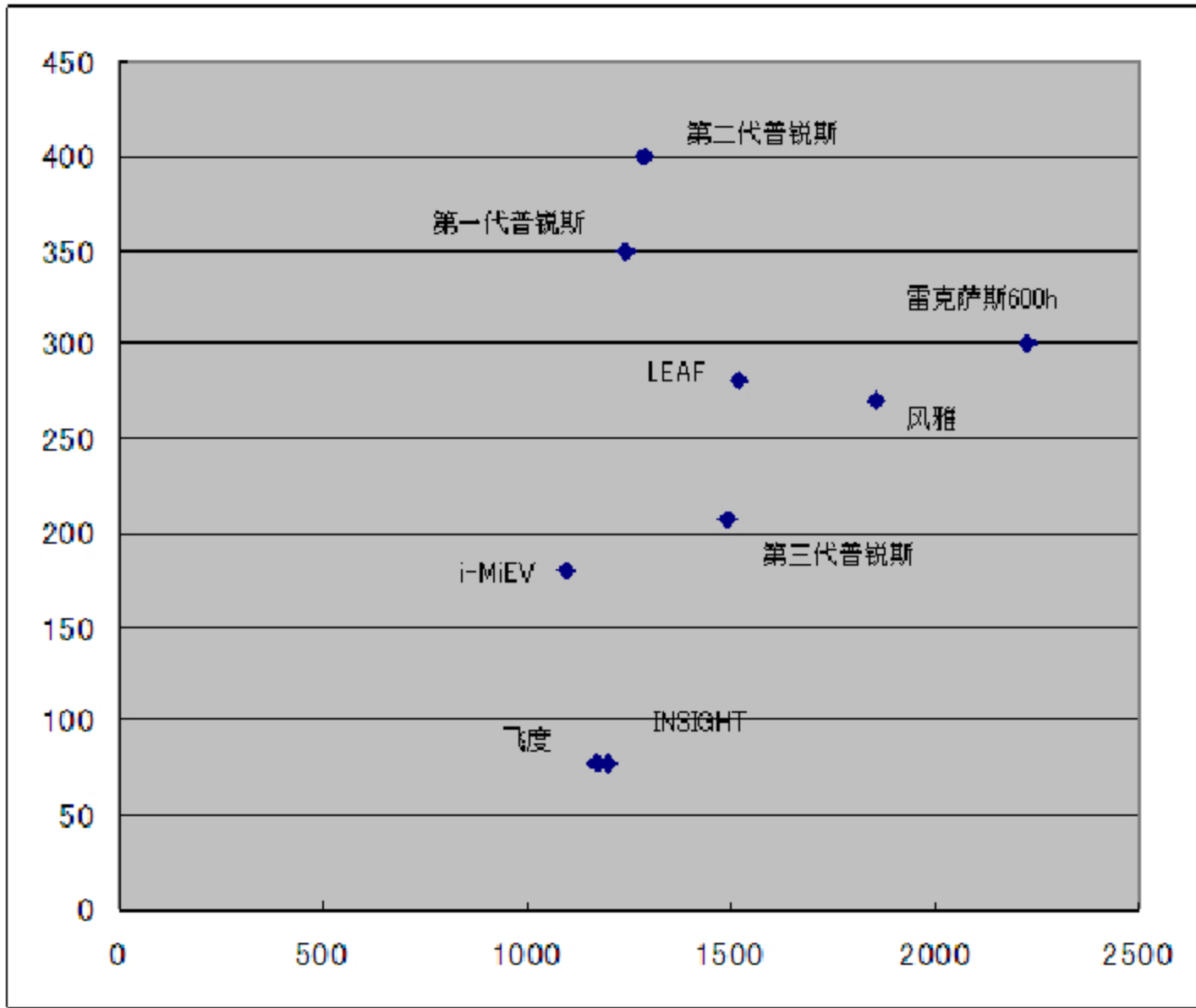
| | 交流三相 無刷永磁馬達 | 傳統交流三相感 應馬達 | 交流三相 銅轉子馬達 |
|---------------------|----------------|----------------|---------------|
| 響應速度(time response) | 快 | 慢 | 快 |
| 準確度 | 精準 | 較差 | 精準 |
| 低速高轉矩 或起動高轉矩 | 佳 | 較差 | 佳 |
| 效率 | 高 | 稍差 | 高 |
| 能量密度 | 高 | 稍差 | 高 |
| 高溫對磁場之影響 | 磁鐵受影響較大 | 較好 | 較好 |



Table 1: Comparison of the qualities of a DC motor with a IM motor for a low power traction drive

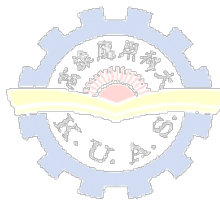
| | traction drive with permanent excited DC Motor (24 V_{DC} supply) | traction drive with inverter fed induction motor (36 V_{DC} supply) |
|------------------------------------|--|--|
| <i>Torque-Speed Characteristic</i> | field weakening not possible → problem of dimensioning | IM with high field weakening range produces the typical torque-speed characteristic of a traction drive → adapted dimensioning possible |
| <i>Efficiency</i> | 50-60% for optimal operating points | 65-75% for the main operating range |
| <i>Purchase cost</i> | more expensive for output power over about 1 kW (more expensive motor, additional expense for hardware protecting the drive) | because of the new low-cost DSP's (including tasks for open loop control and protection in the software), power electronics and the simple IM are cheaper than a solution with DC motor for output power > than about 1 kW |
| <i>Maintenance cost</i> | maintenance because of the brushes required | no maintenance required |
| <i>Robustness</i> | problem of overloading the drive thermally (especially for a mechanically blocked vehicle) | all operation points can be run permanent including speed zero (blocked motor) |
| <i>Adaptability</i> | only standard solutions available except for high number of pieces | high → specifications of the drive and dynamic performance of the vehicle easily managed by an adaptation of the software (DSP) |

馬達驅動最大扭矩 [Nm]



車輛重量 [Kg]

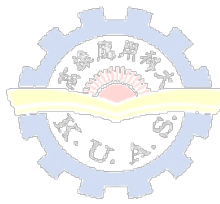
車輛重量與驅動扭矩約有 3.3Nm/Kg



Motor problem

- 1. 低速高扭矩力輸出
- 2. 高速高效率
- 3. 輪胎轉動扭矩
- $= [\text{馬達扭矩}] * [\text{變速比}] * [\text{減速比}(\text{減速齒輪比})]$

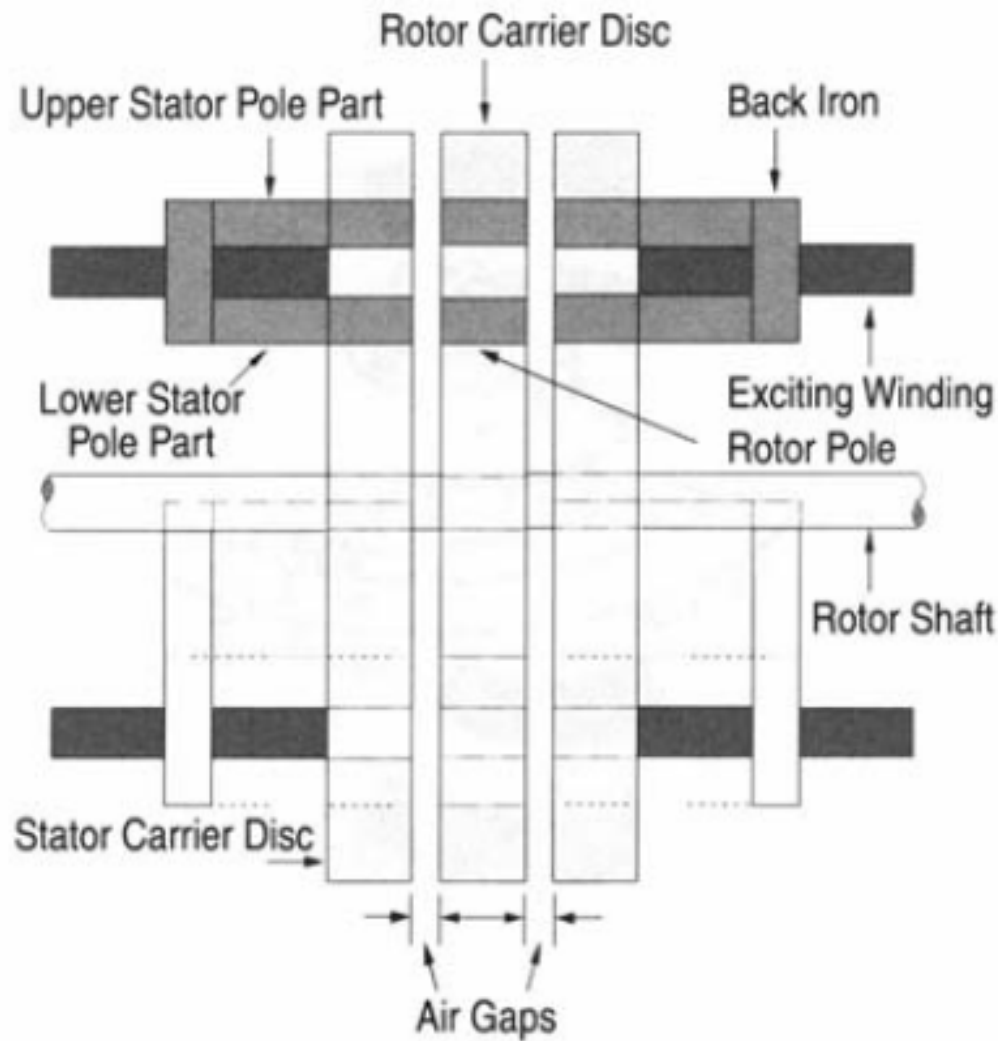
1. 馬達低速高扭矩—可在轉子嵌入磁鐵；但一旦轉速增加—高速時，磁鐵會形成阻礙，降低效率。
2. 高速提升其效率：
 - a. 定子繞阻繞線方式變更；
 - 或b. 使用補助線圈；(如安川馬達)
 - 或c. 轉子使用可變磁力之設計



sr

- 1) 構造簡單、製造成本低
- 2) 結構堅固、可應用於惡劣環境
- 3) 效率高
- 4) 起動轉矩大
- 5) 調速範圍寬
- 6) 轉矩漣波與噪音大

SR電機系凸極可變磁阻電動機，其定、轉子凸極均由具有高磁導率的矽鋼片疊成，轉子既無繞組亦無永磁體或磁性材料，定子極上繞有集中繞組，徑向相對的兩個繞組串聯（或並聯）構成一“相”。



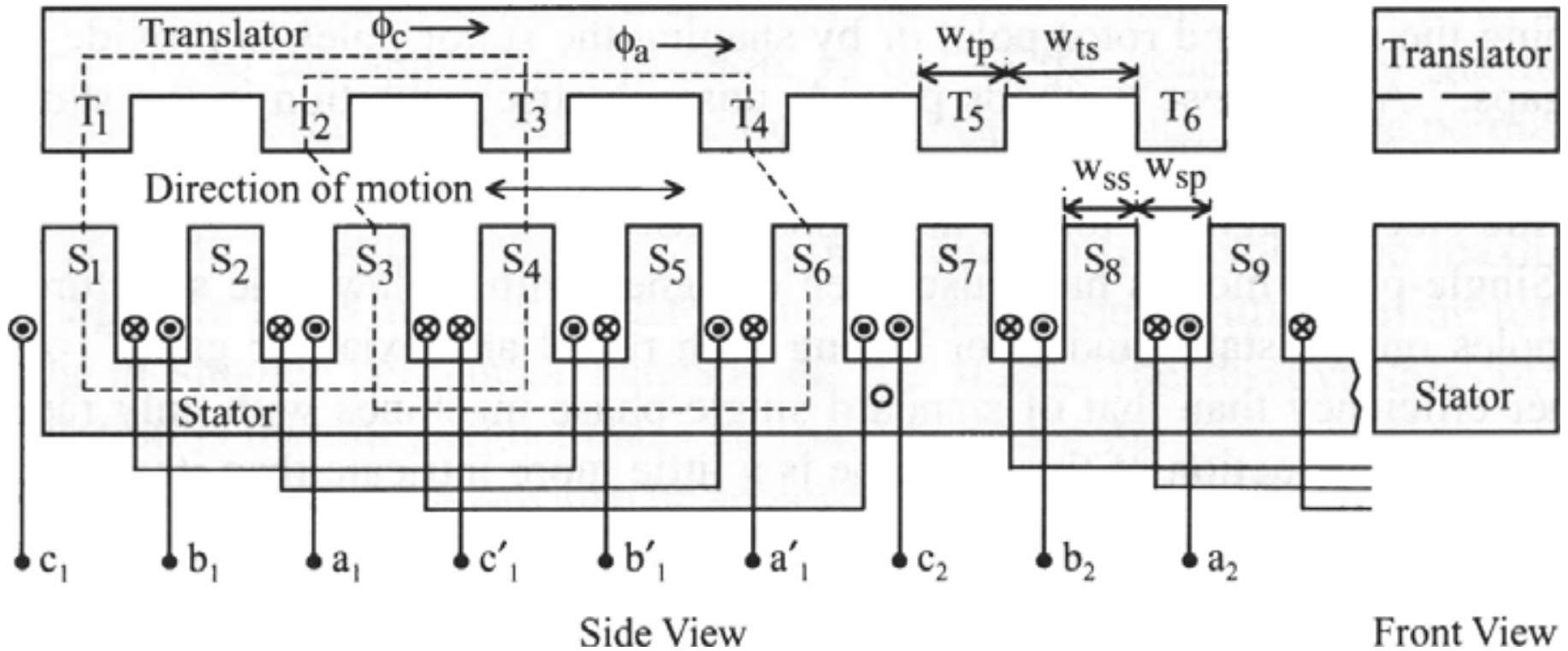
Basic structure
 Doubly salient with concentrated winding only this will be highly emphasized (diametrically opposite windings are in series to form a phase)

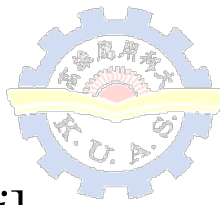
Short flux path machines
 Adjacent pole windings are in series to form a phase winding

Linear srms

multistack

Nominal treatment only



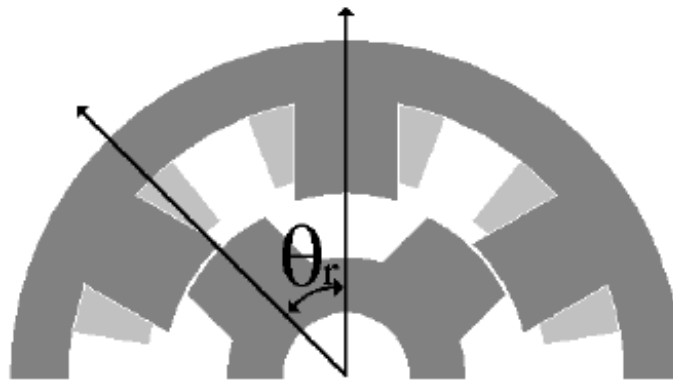


Torque

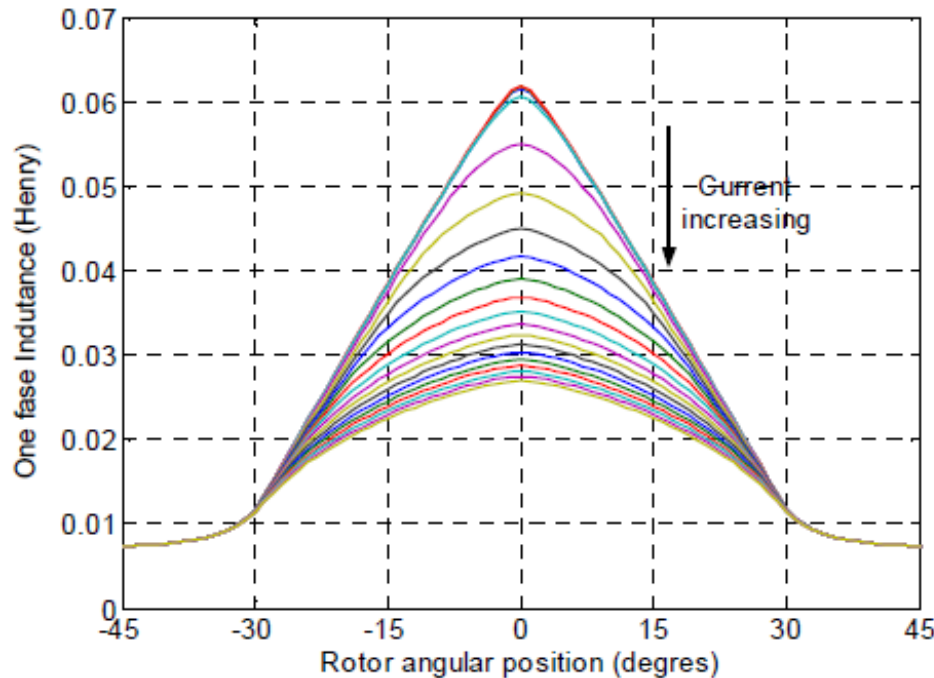
$$T_e(\theta_r, i) = \frac{\partial}{\partial \theta_r} \left[\int_0^i \lambda(\theta_r, i) di \right]$$

$$V = r_s \cdot i + \frac{d\lambda(\theta_r, i)}{dt}$$

$$J \frac{d^2 \theta_r}{dt^2} = T_e - T_m$$

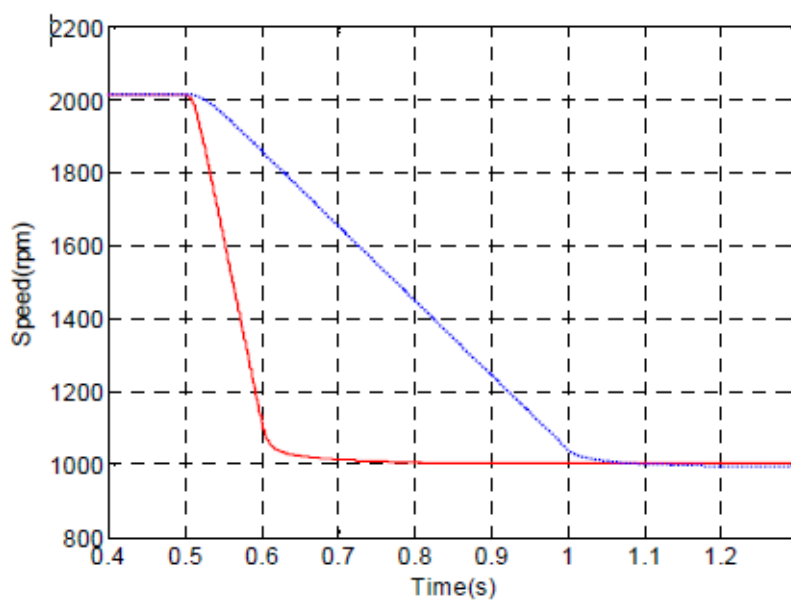


6/4 srm reference frame

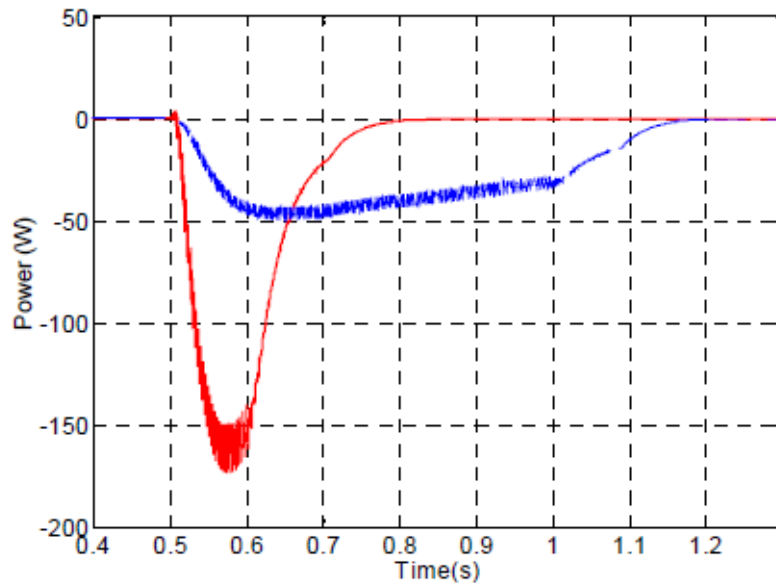


shows a family of inductance profile curves for one phase, which have been calculated as a function of rotor position for different values of phase current.

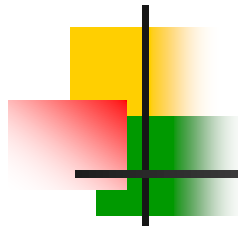
Phase inductance for current varying from 1A to 10A in steps of 1A.

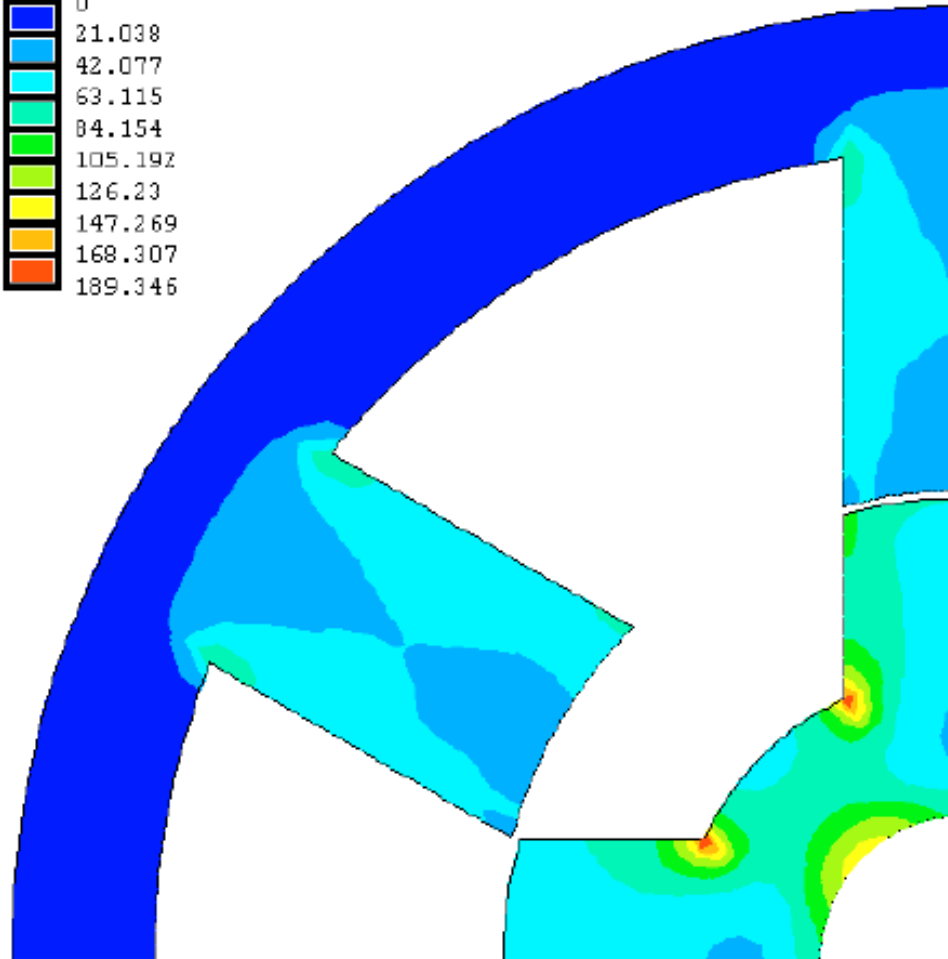
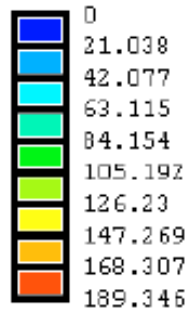
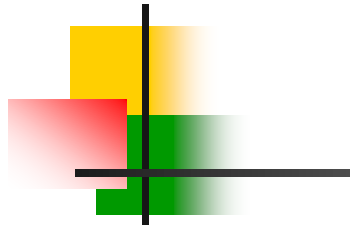


Imposed speed variation.

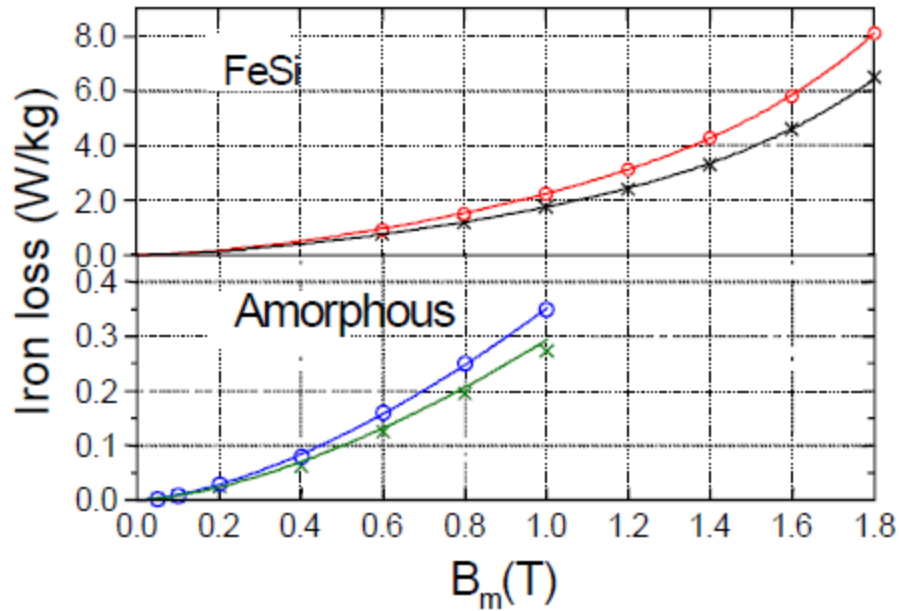


Electric power



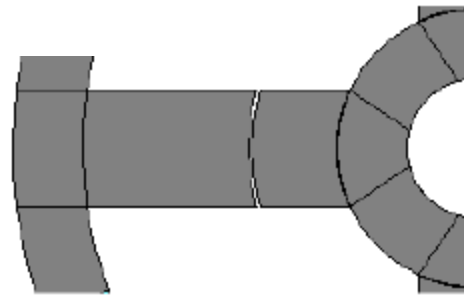


Loss density distribution

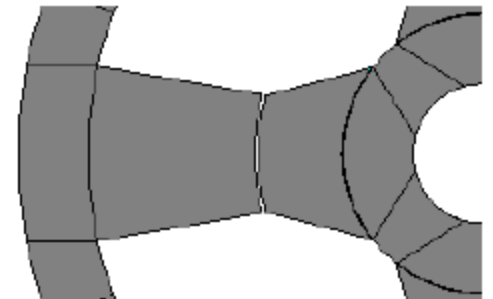


| | Geometry A | Geometry B |
|-----------|------------|------------|
| FeSi | 67.6W | 48.9W |
| Amorphous | 1.26W | 0.95W |

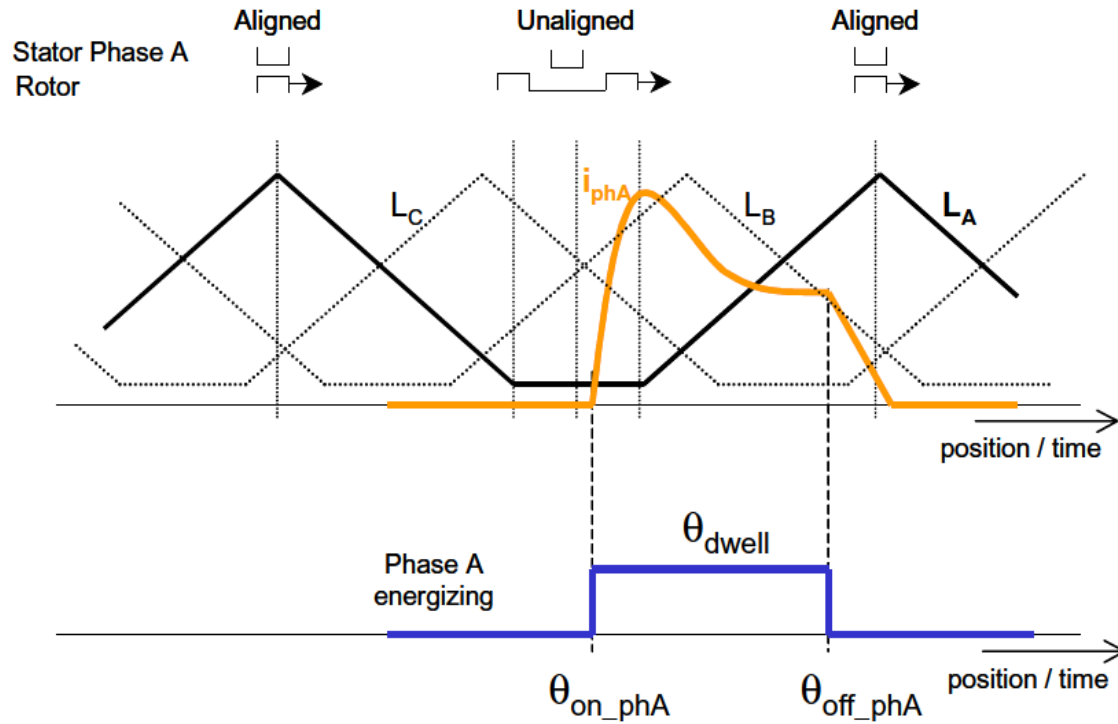
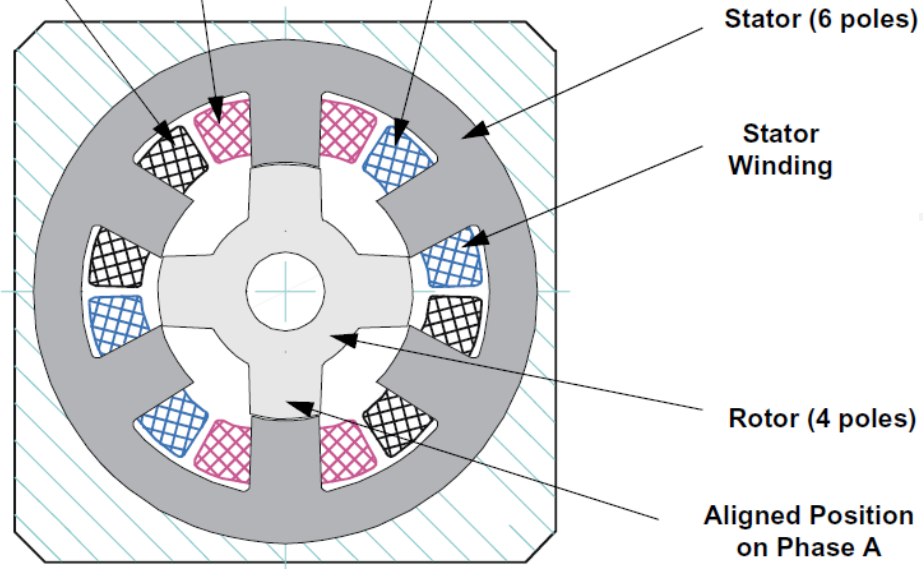
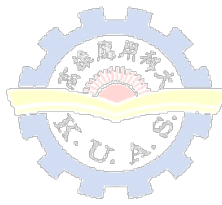
Iron loss data for FeSi and Amorphous material



pole of type geometry A



pole of type geometry B



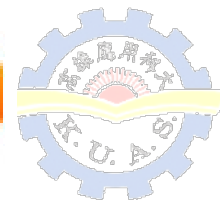
SHARP 夏普15kg變頻式洗衣機(ES-SD159T)

- SHARP洗衣機採用超效能直接驅動變頻磁阻馬達，磁扭力與磁阻力並用，以直接驅動變頻式控制，提昇圓筒洗衣槽的運轉效率。即使低速運動也能產生高扭力，再配合衣物的種類及重量，精密制轉速及水流衝擊力，徹底洗淨衣物。直接驅動洗衣槽及脫水盤，徹底解決傳統馬達靠皮帶傳動產生的噪音問題，更在低速脫水時，避開震動時共振過大的缺點，脫水更順暢，更安靜。

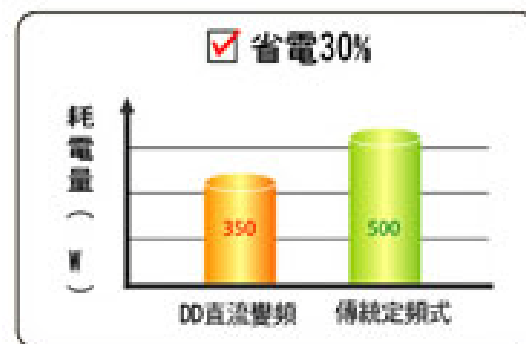
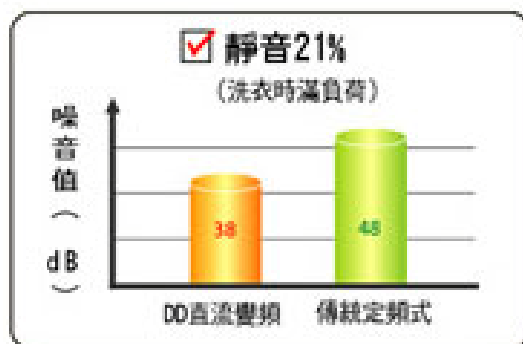
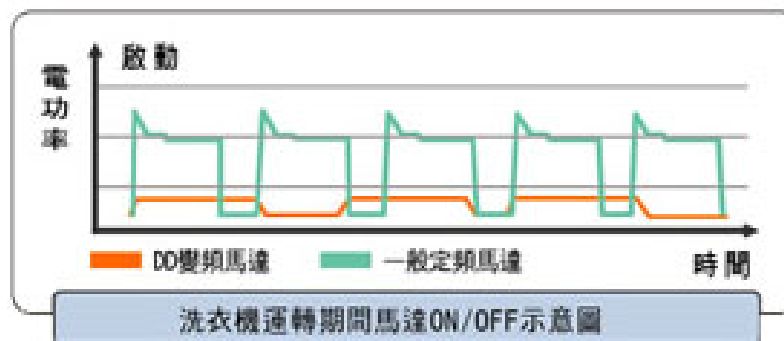




DD直流變頻馬達 省電+靜音 雙效能出擊



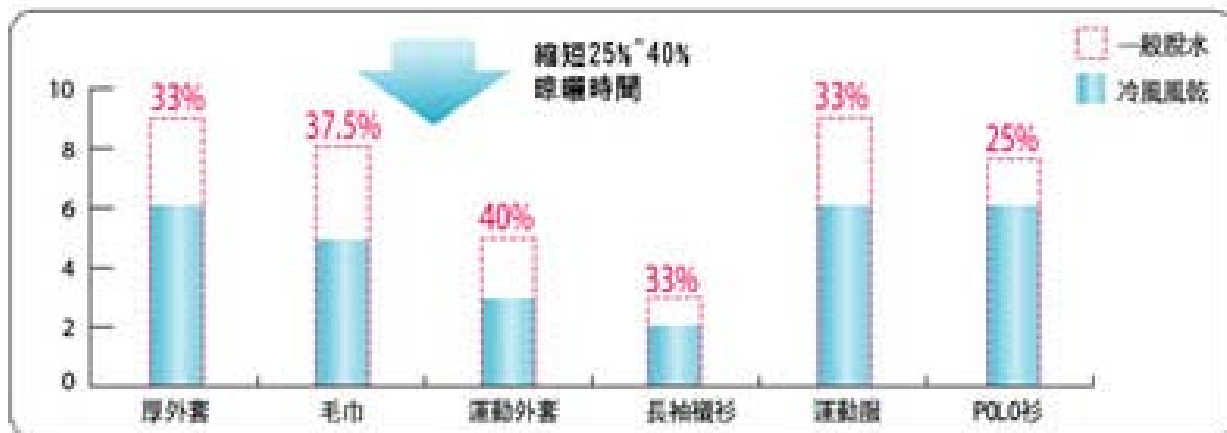
- 超強淨** 運用不同洗程自動調整搭配轉速與時間，以達到最完美高效的洗淨效果，省時省力一級棒。
- 最穩定** 無論脫水或洗衣，都能避免過大共振，維護躋身穩定運作。
- 好安靜** 馬達運轉時聲音小，享受舒適靜音時刻。
- 真正省** 自動偵測衣物重量並調整效能，待機時立即幫您自動斷電，節能省電省荷包！
- 更耐用** 進化科技DD直流變頻馬達能直接驅動洗衣槽與迴轉盤，避免因皮帶驅動產生之耗損。



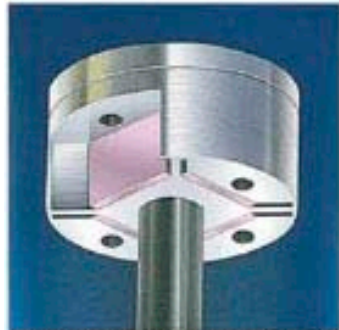


冷風風乾 衣物乾得快

冷風風乾功能，預先以冷風減少衣物殘水量，縮短衣物量曬時間25%-40%，衣物更快乾，連洗完衣物時常見的霉味也不見了。



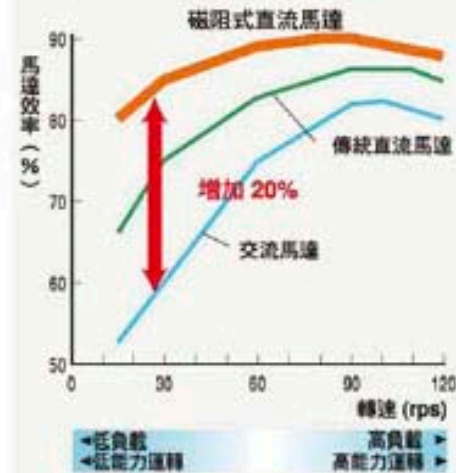
壓縮機的磁阻式直流馬達



釹磁鐵使用於圖中粉紅色的區域

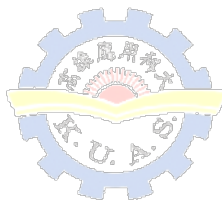
DAIKIN 直流變頻系列在壓縮機內搭載磁阻式直流馬達。磁阻式直流馬達使用兩種不同的轉矩、釹磁鐵*1 及磁阻式轉矩*2，與交流電或傳統的直流電馬達相比，此馬達功率較小，因此可產生更多電力而達到省電效益；在空調機最常使用的低負載運轉時*3，效率可提高約20%。

磁阻式直流馬達的效率*4

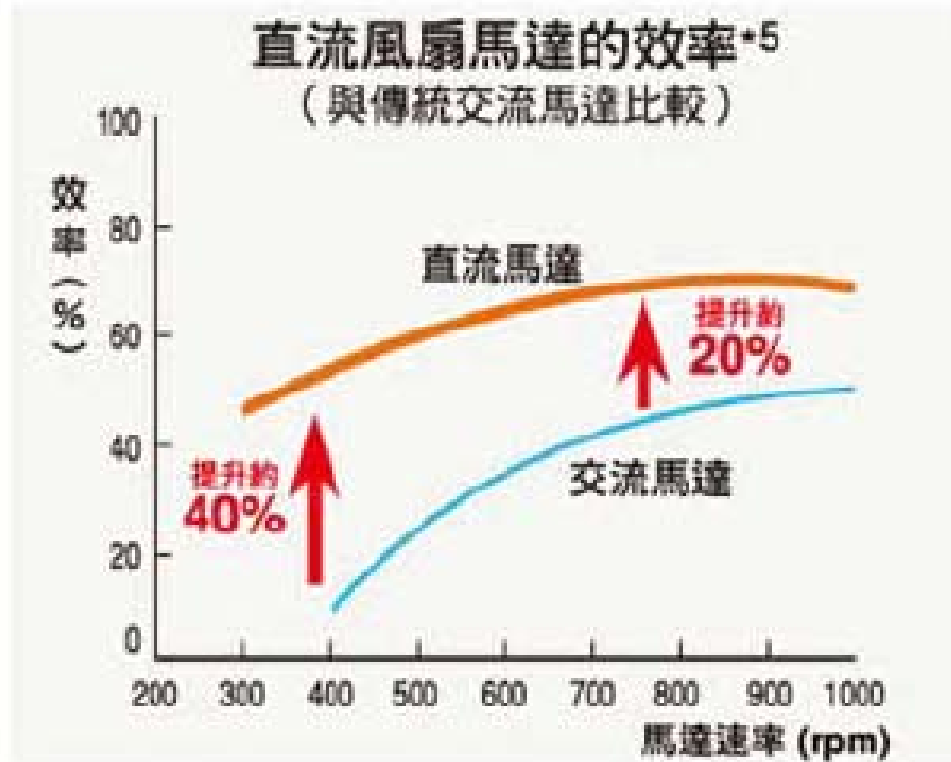


DAIKIN 首創於一般市售空調機內使用配備磁阻式直流馬達的渦捲式壓縮機，於1998年榮獲日本電氣學會大獎。

- *1 釹磁鐵的磁力比一般鐵磁鐵約強十倍。
- *2 改變鐵與磁鐵零件之間的功率就能產生轉矩。
- *3 此為空調在穩定運轉時的頻率區間，其運轉時間最長。
- *4 本資料取自 DAIKIN 實驗室，使用 DAIKIN 產品在模擬環境中的研究結果。

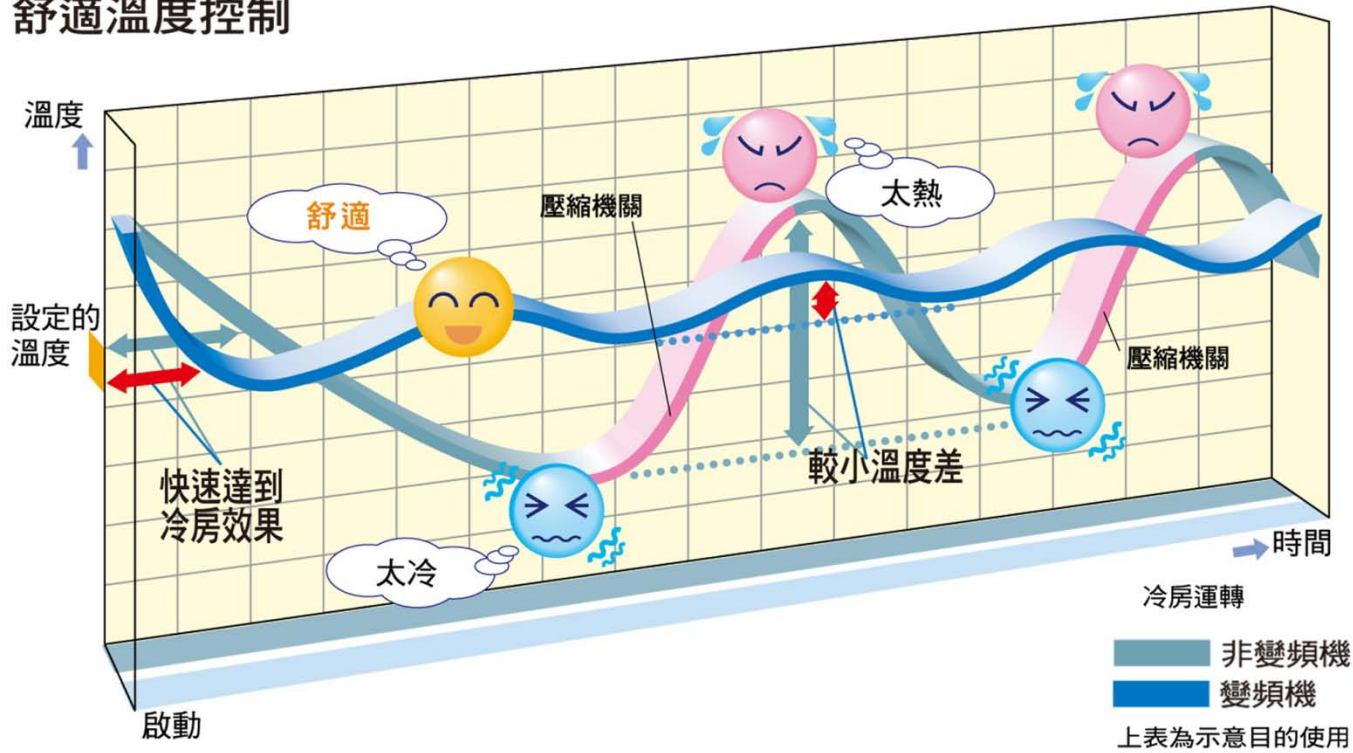


直流馬達可進行更精確的轉動控制，大幅減少能源耗損，與交流馬達相比，增加運轉效率達40%，其在低速運轉時益發顯著。

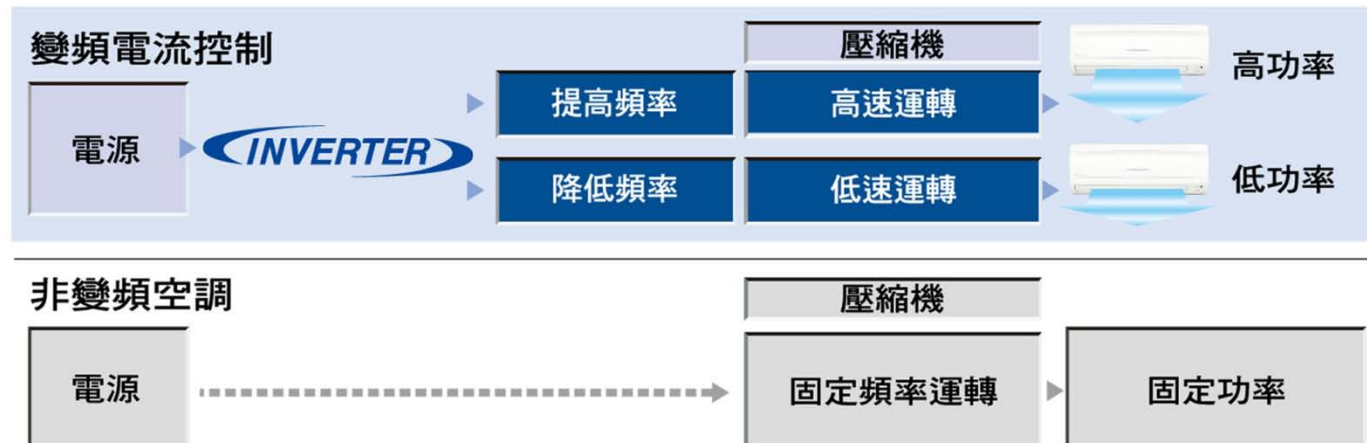


*5. 本資料取自於DAIKIN實驗室，使用DAIKIN產品在模擬環境中的研究結果。

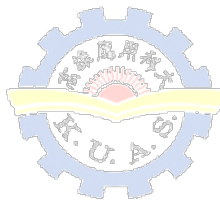
舒適溫度控制



隨時變換運轉功率



變頻空調可隨時變換運轉功率。非變頻空調只會在一固定的功率下運轉。

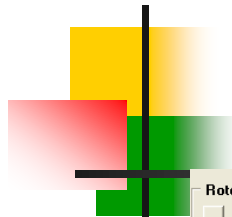


定、轉子設計(1/6)

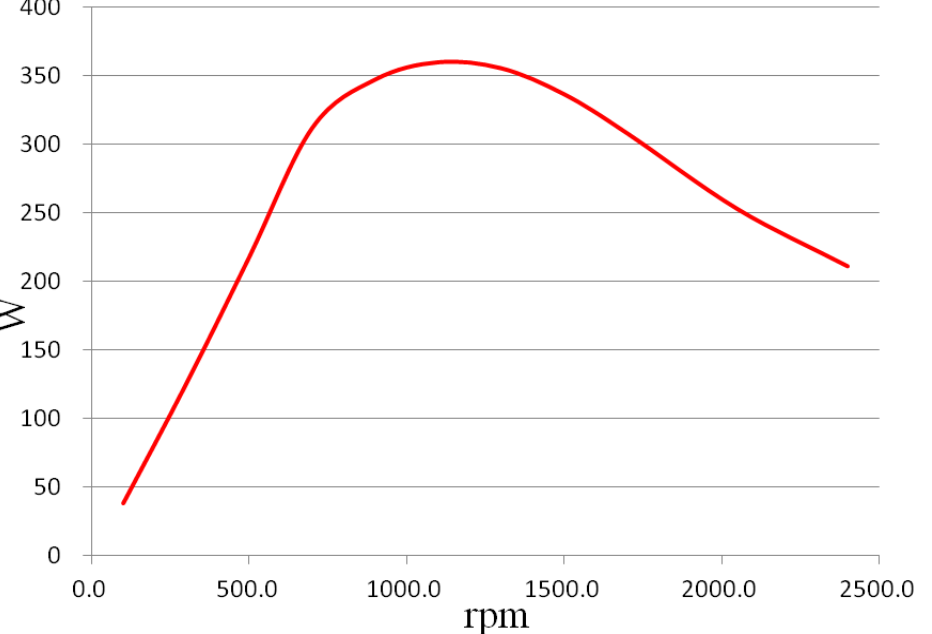
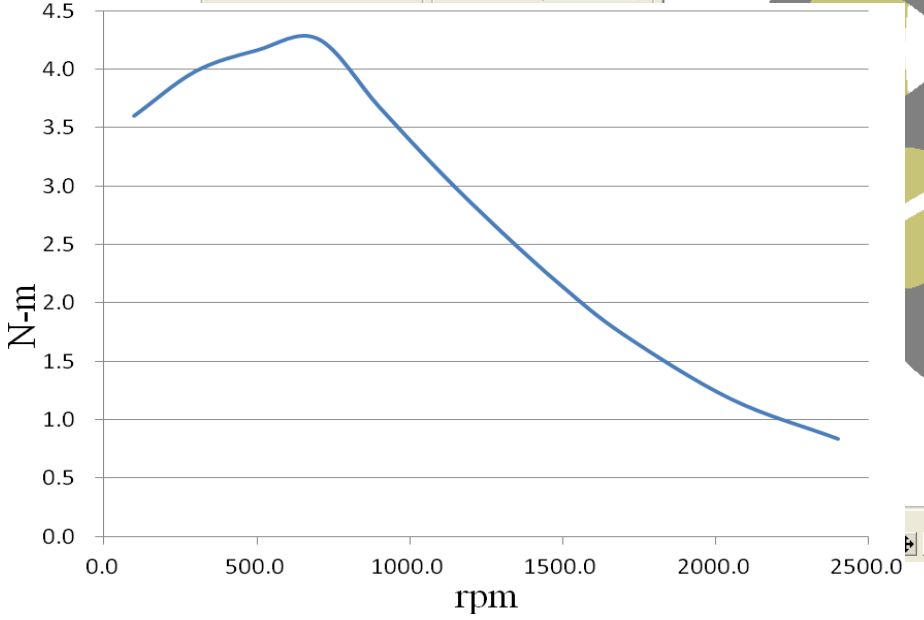
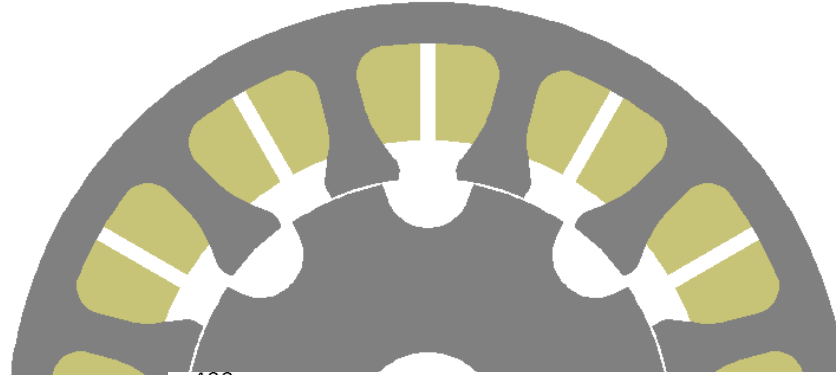
表一 16極24槽300W SRM規格

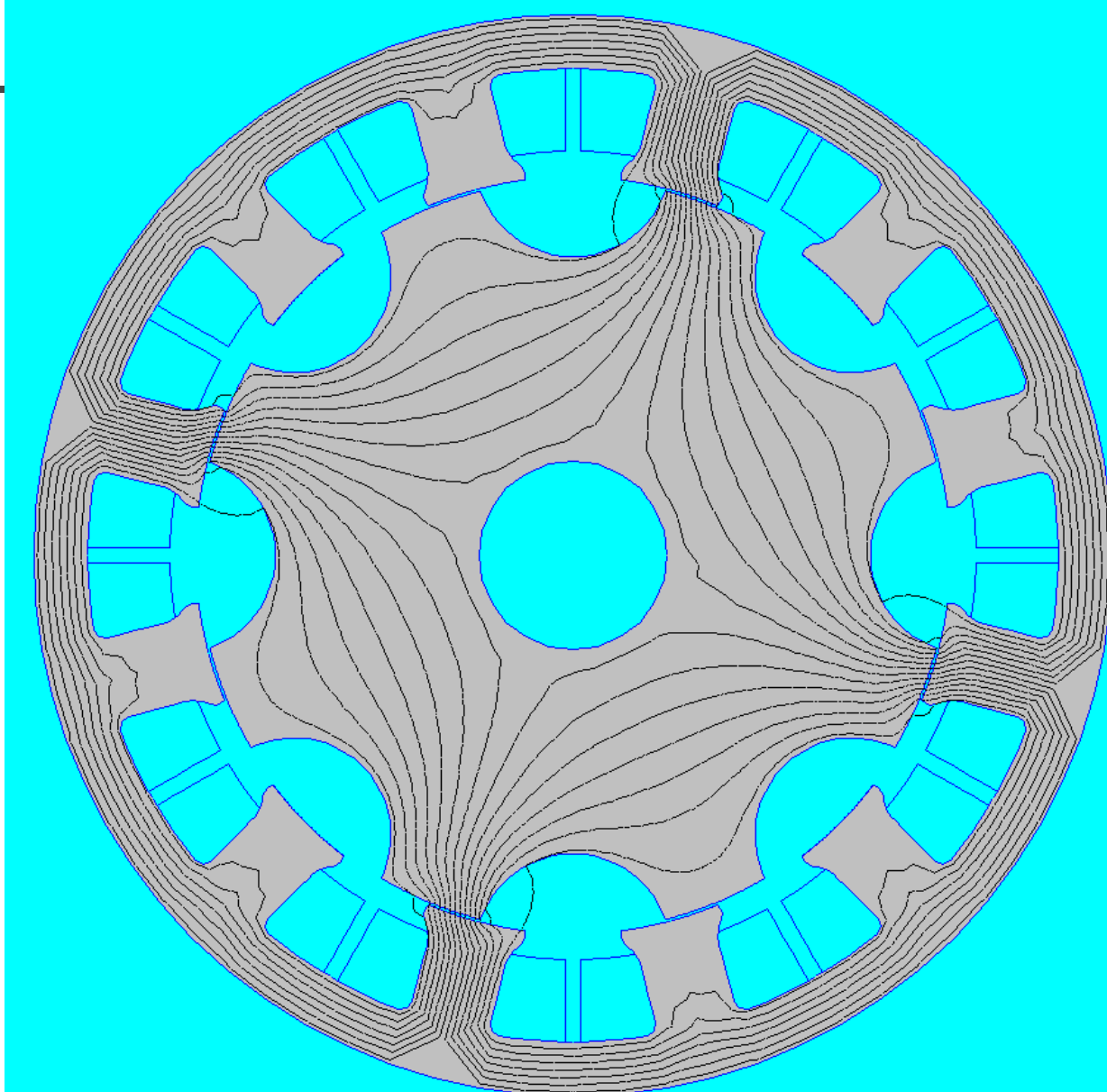
| | | | | |
|--------|--------|------|-------|---------|
| 相數 | 3 | | 轉矩 | 9.97N-m |
| 電壓(DC) | 52V | | 功率 | 300W |
| 轉速 | 290rpm | | 效率 | 83% |
| 頻率 | 77Hz | | | |
| | 定子規格 | 轉子規格 | | |
| 外徑 | 110mm | 54mm | | |
| 內徑 | 55mm | 20mm | 矽鋼片材質 | 50A1300 |
| 鐵心積厚 | 100 | | 線徑 | 0.5mm |
| 極數 | | 16 | 匝數 | 25 |
| 槽數 | 24 | | 並聯路徑數 | 2 |
| 氣隙 | 0.5mm | | 佔槽率 | 94.27% |

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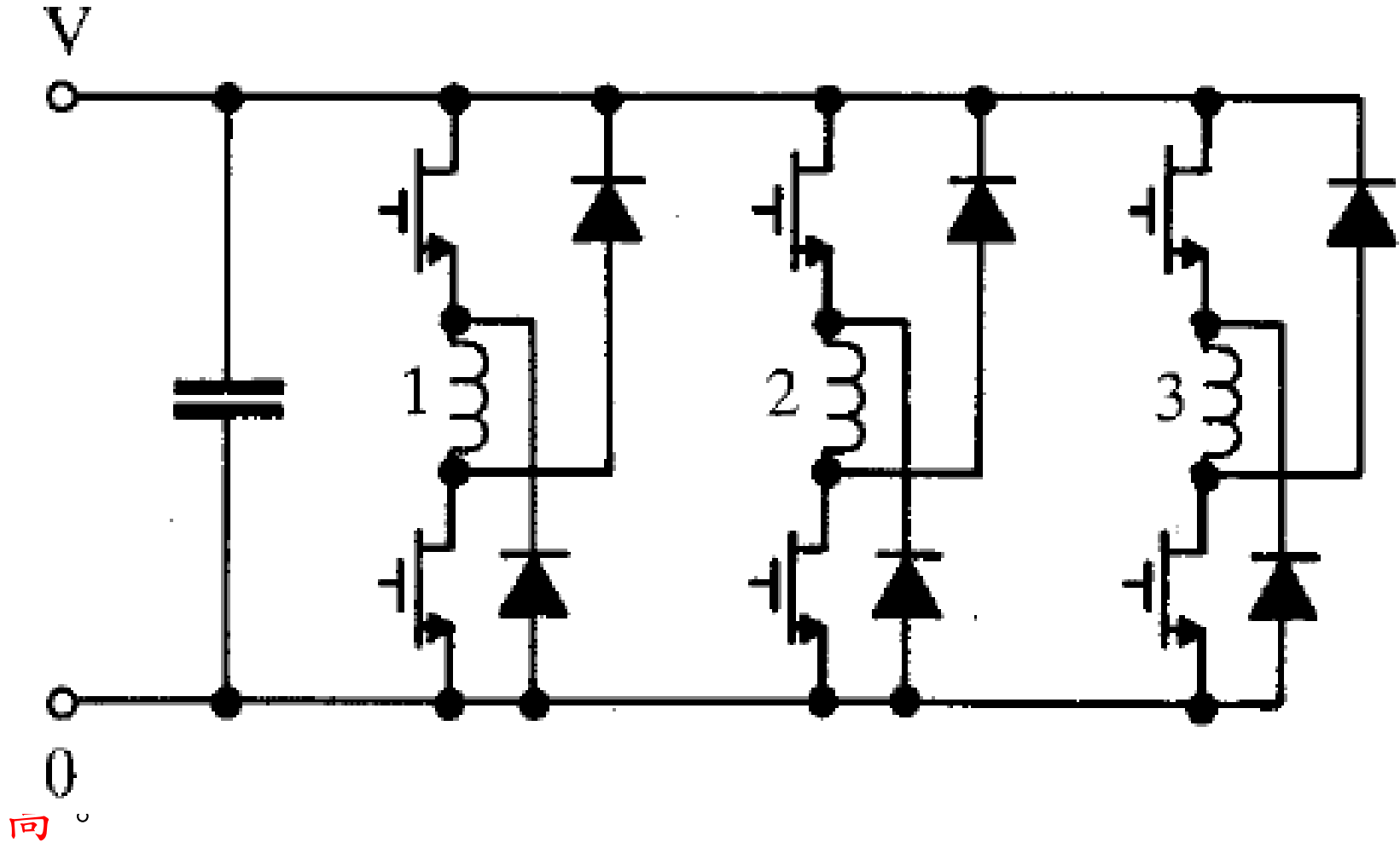


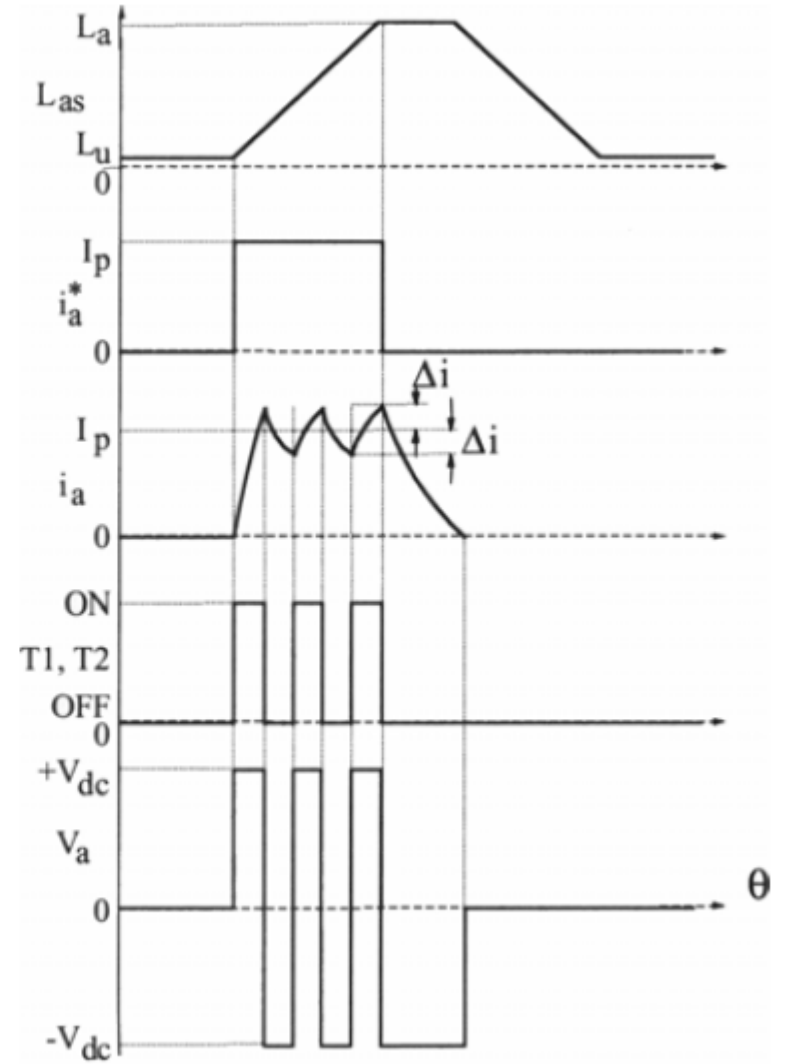
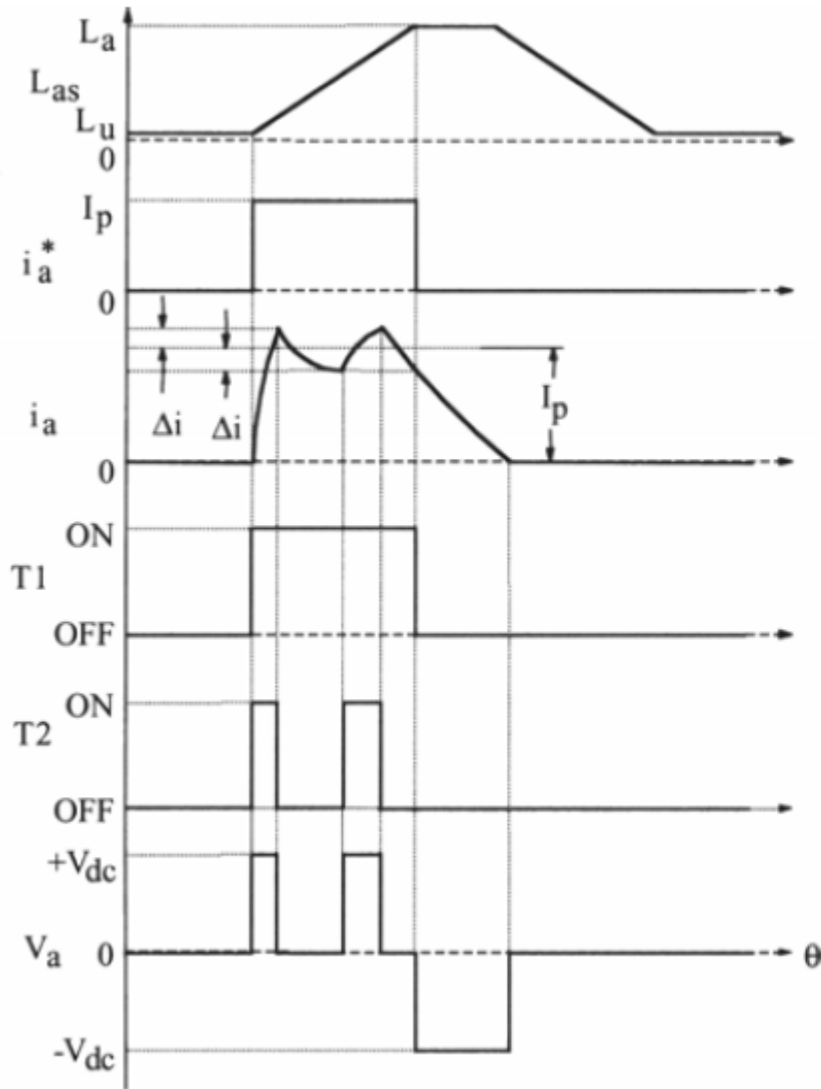
| Rotor | | Stator | |
|------------|-------------|----------------|---------|
| Type | type101.usr | Type | type706 |
| Num Teeth | 8 | Outer Dia | 60 |
| Outer Dia | 34.5 | Inner Dia | 35 |
| Innter Dia | 10 | Num Slots | 12 |
| | | Tooth Width | 3 |
| | | Yoke Width | 3 |
| | | Slot Open | 4 |
| | | Tip Def | 1 |
| | | Tip Thickness | 1 |
| | | Foot Thk | 4 |
| | | Coil Clearance | 1 |
| | | Tip Rad | 2 |
| | | Slot Top R | 5 |
| | | Slot Bottom R | 2 |
| | | Slot Wedge Thk | 1 |
| | | Tooth Arc R | 1 |

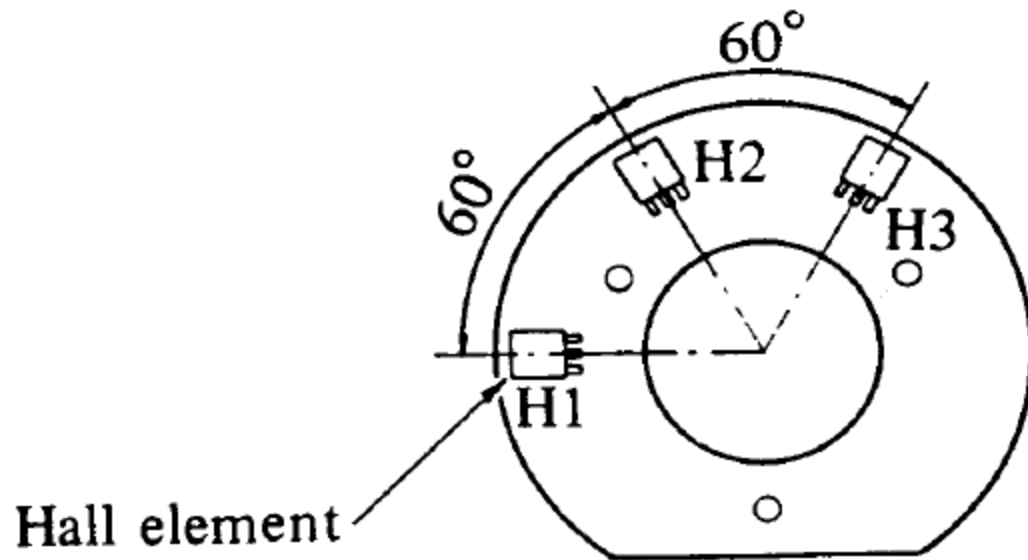




驅動電路比較(3/3)

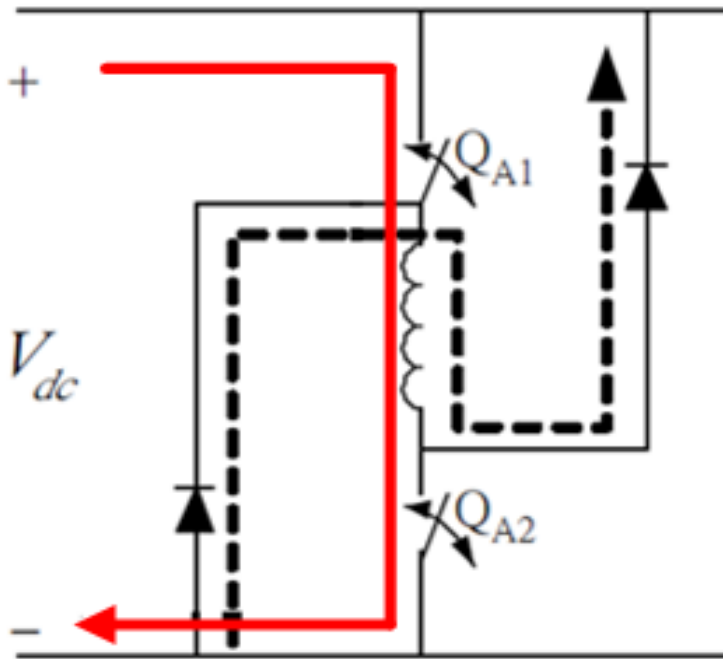




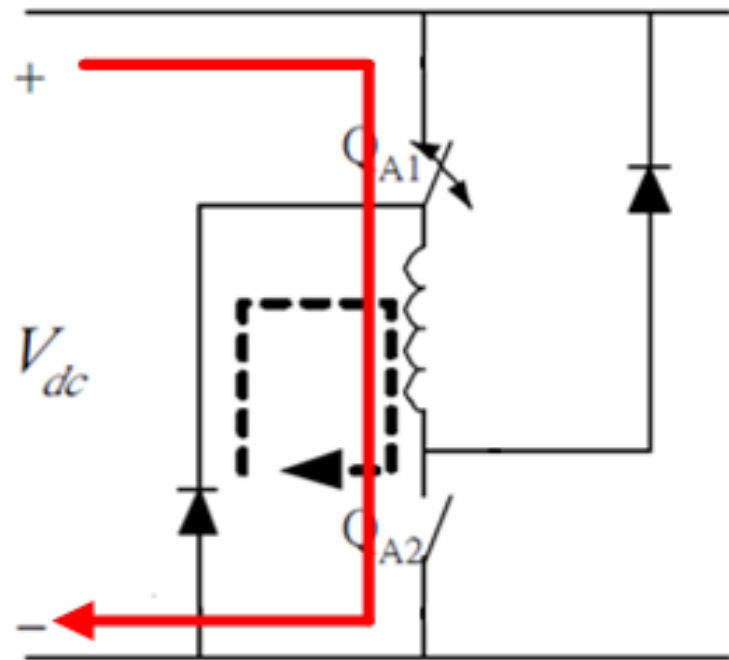


驅動電路設計(1/5)

- 這裡採用非對稱半橋型轉換器來進行設計，此驅動電路分別為硬式截波導通與軟式截波導通。



(a)

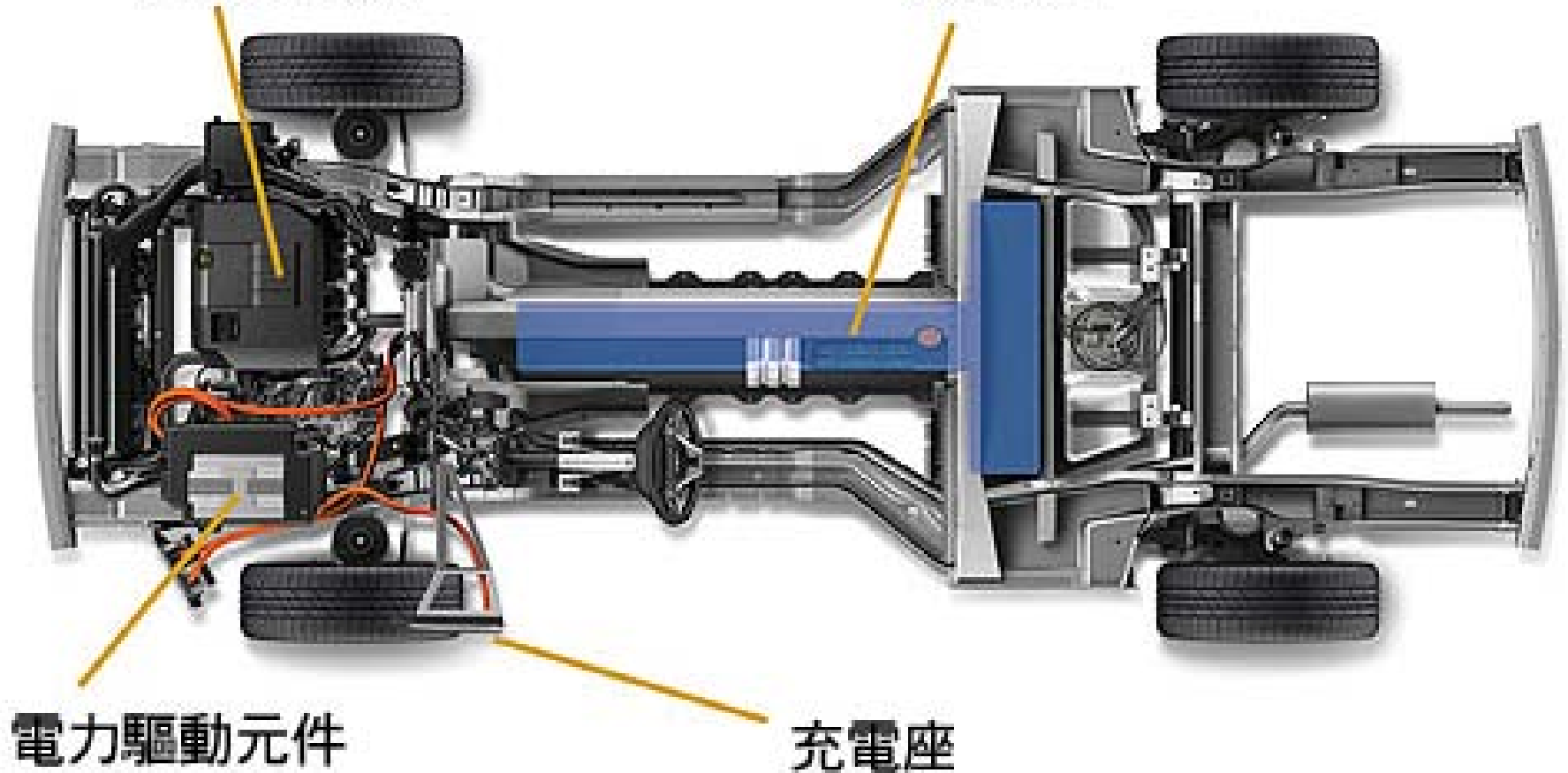


(b)

Volt/Ampera擁有Electric純電動以及Extended-Range兩種運轉模式，若是純電行駛倚靠的電池模組消耗殆盡時，所搭載的1.4升汽油引擎將會轉換成發電機的角色，為Volt/Ampera在競爭中脫穎而出的關鍵。

引擎發電機

鋰電池



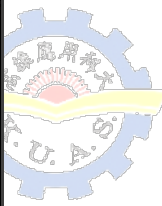
電力驅動元件

充電座

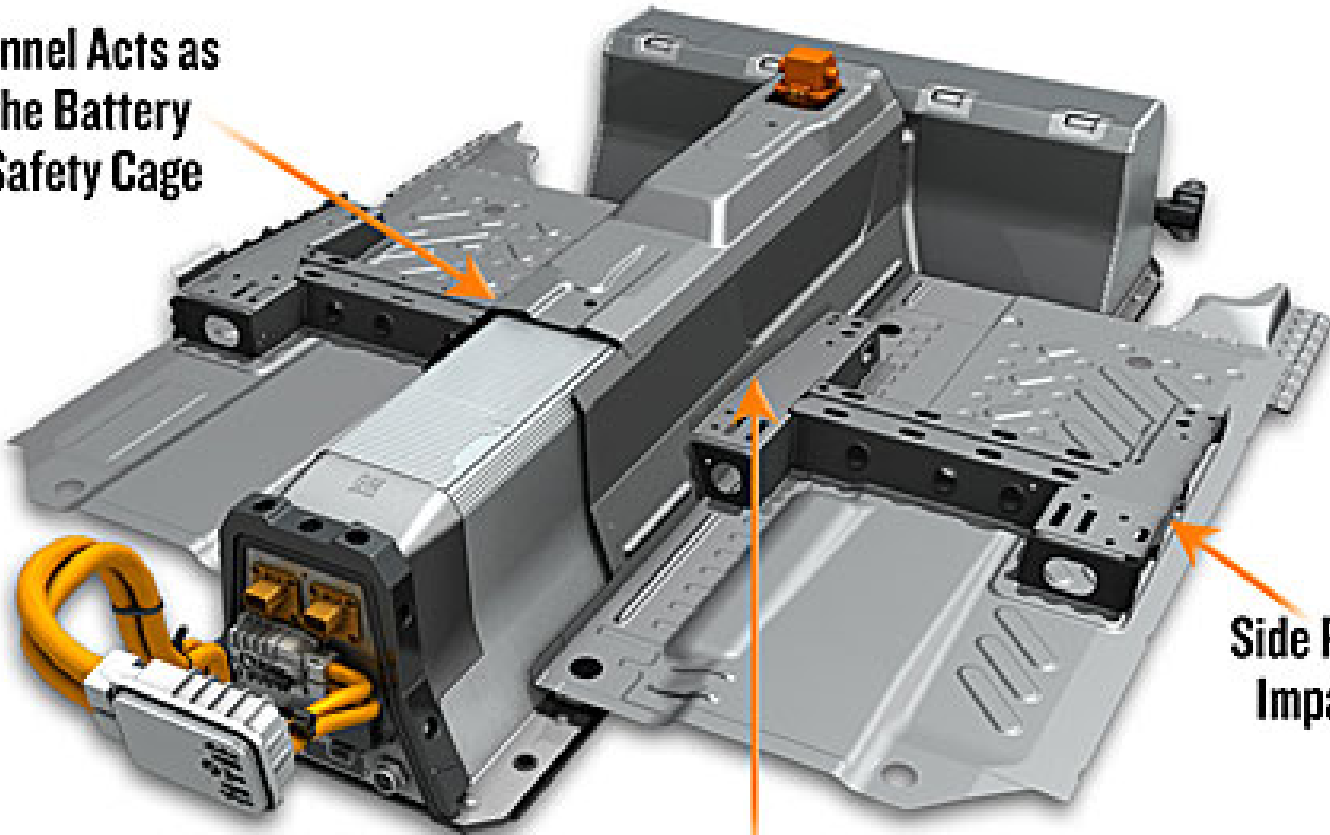


VOLT

STRUCTURE ENHANCEMENTS



Tunnel Acts as the Battery Safety Cage



Side Pole Impact

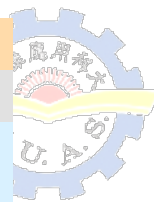
Point of Intrusion

View Shown: Current Volt Underbody



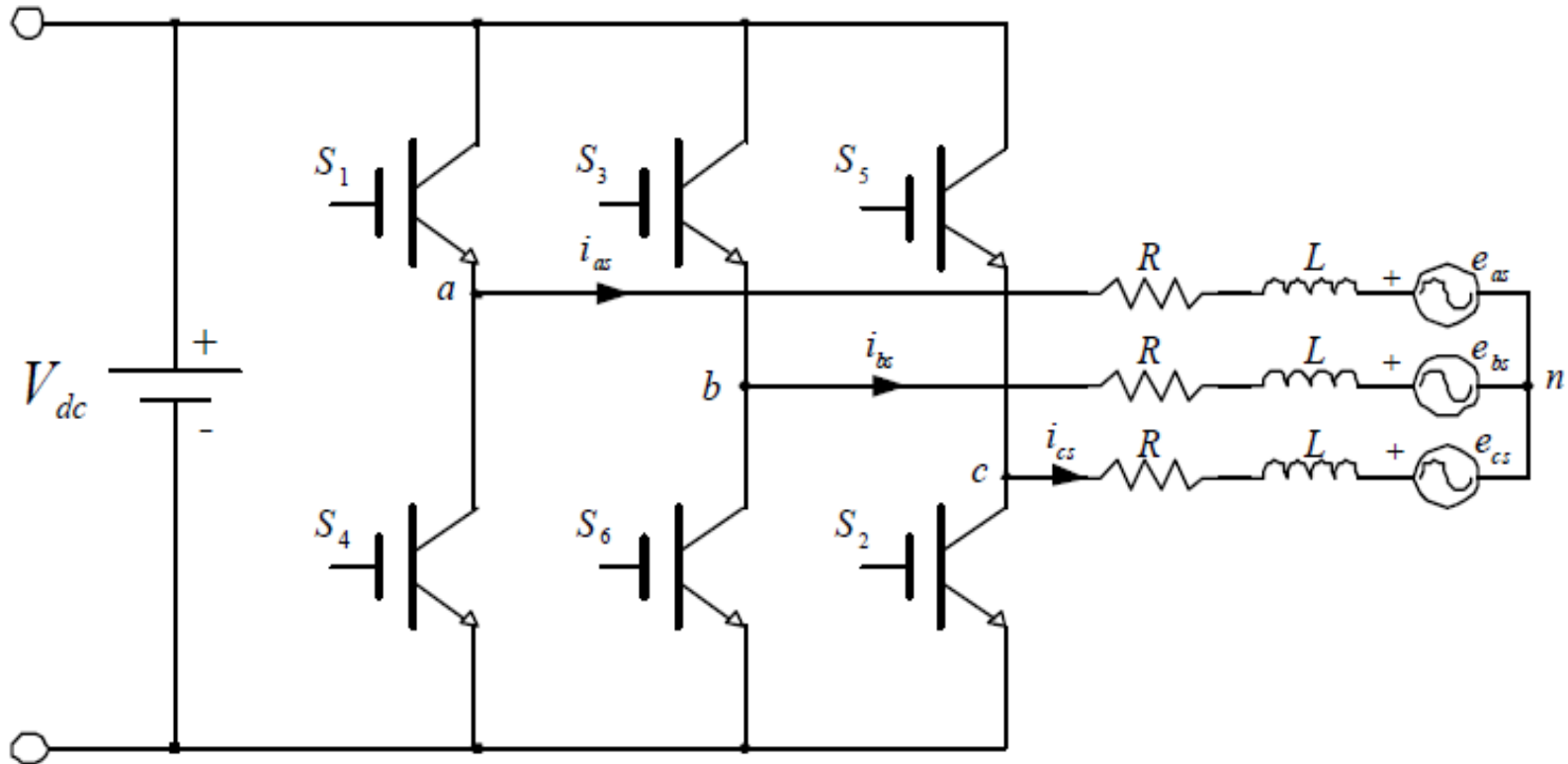
GM集團於2012初宣布Chevrolet Volt將擁有一系列的強化措施。針對了底盤電池組的側面撞擊以及電池組穿刺點進行安全性的強化。而評審團也表示相信強化結構辦法將解決此問題。

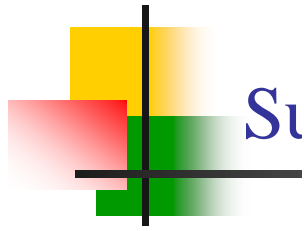
2012歐洲年度風雲車入圍名單



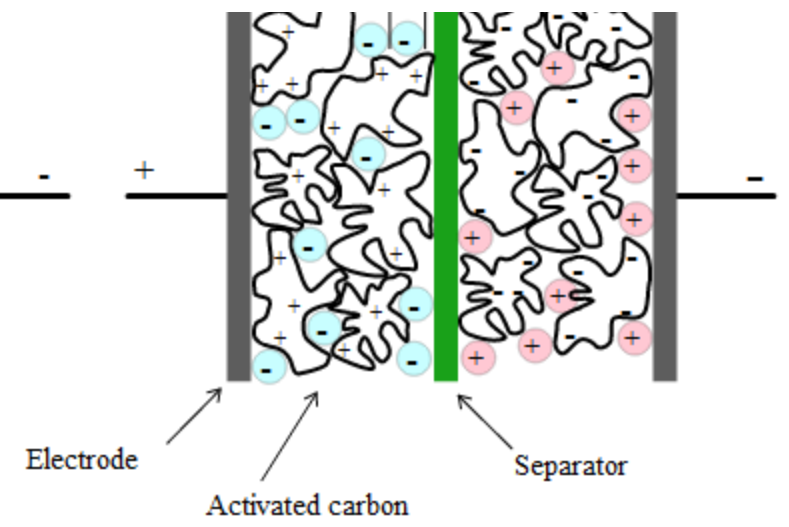
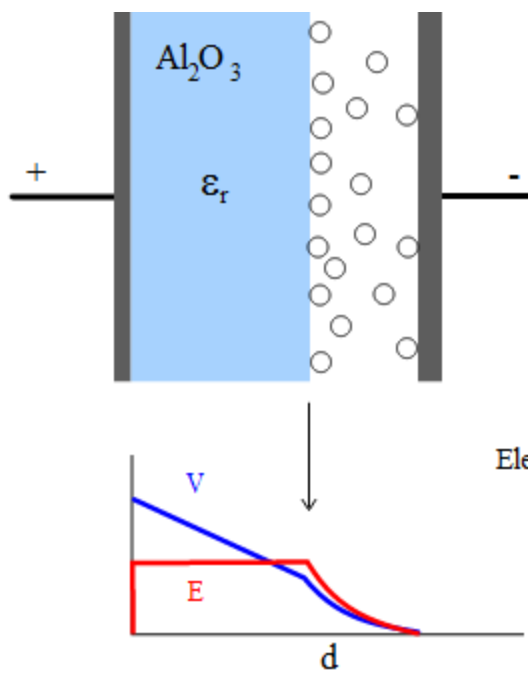
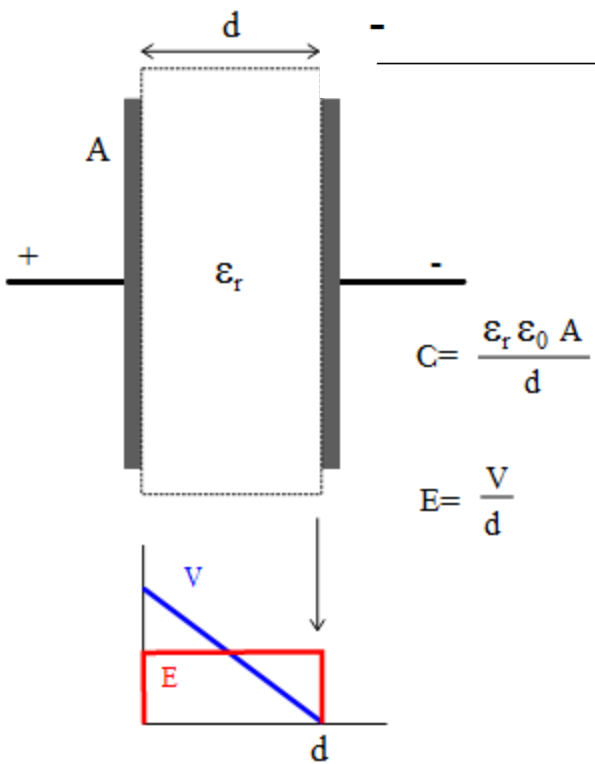
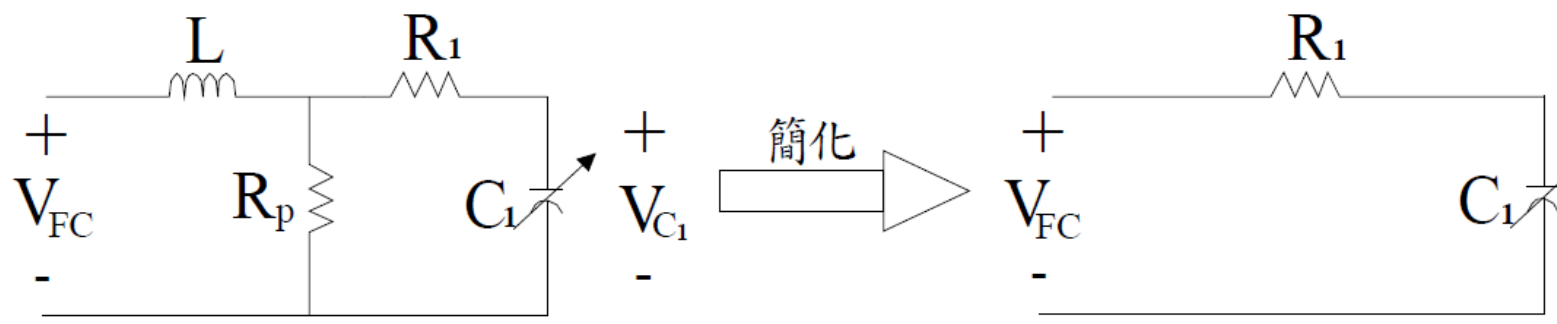
| | | |
|-------------------|----------------------------|------------------------------|
| Audi A6 | Hyundai i40 | Peugeot 508 |
| Audi Q3 | Hyundai Veloster | Peugeot 3008 HYbrid4 |
| BMW 1 Series | Kia Picanto | Porsche 911 |
| BMW 6 Series | Kia Rio | Ranger Rover Evoque |
| Chevrolet Aveo | Lancia Ypsilon | Renault Kangoo Z.E. |
| Chevrolet Orlando | Lexus GS | Renault Fluence Z.E. |
| Citroën DS4 | Mazda CX-5 | Ssangyong Korando |
| Citroën DS5 | M-Benz B-Class | Toyota Verso S/Subaru Trezia |
| Fiat Panda | M-Benz ML-Class | Toyota Yaris |
| Ford Focus | M-Benz SLK-Class | VW Beetle |
| Honda Civic | Opel Ampera/Chevrolet Volt | VW Jetta |
| | Opel Zafira Tourer | VW up! |

INVERTER

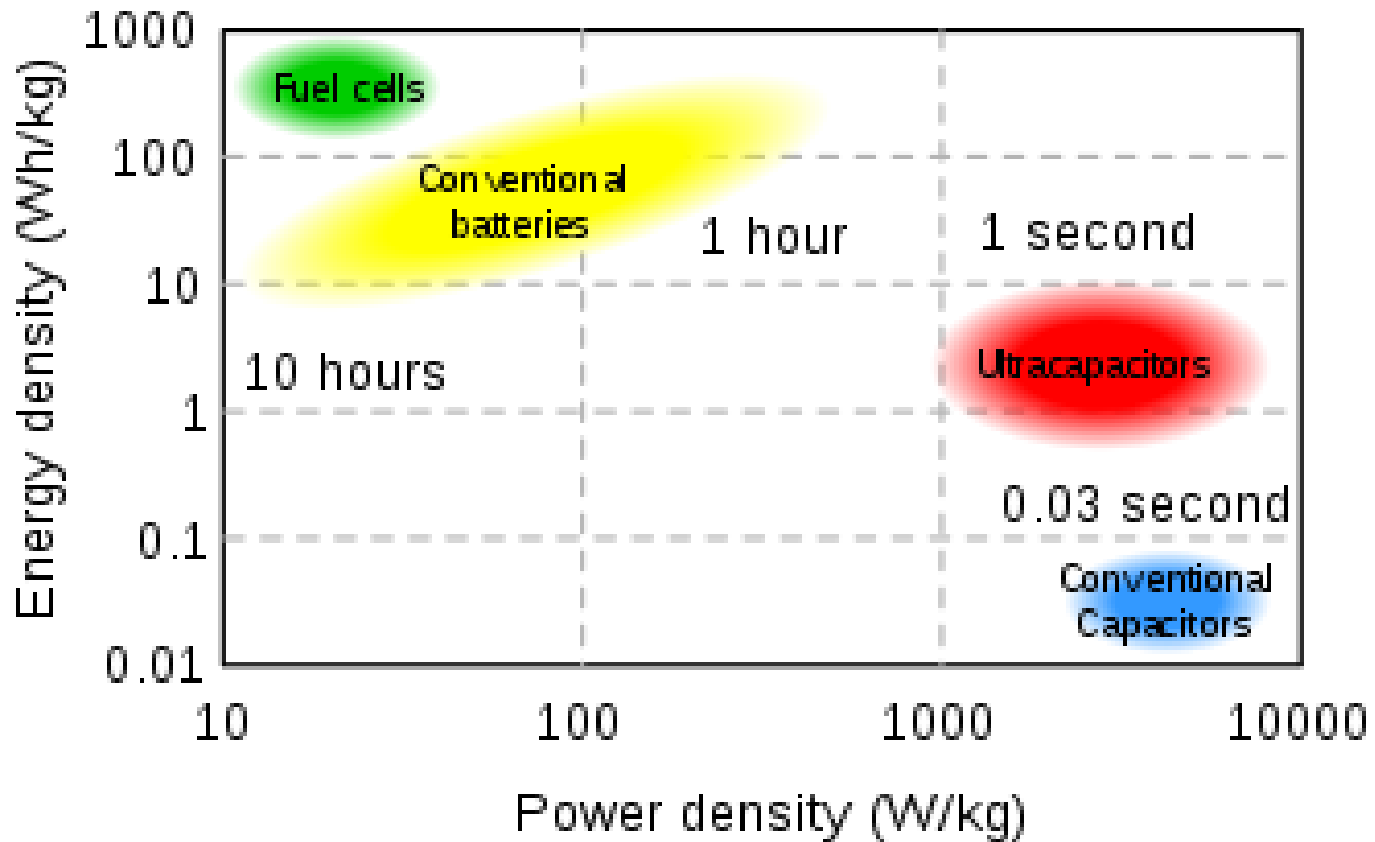




Electrostatic



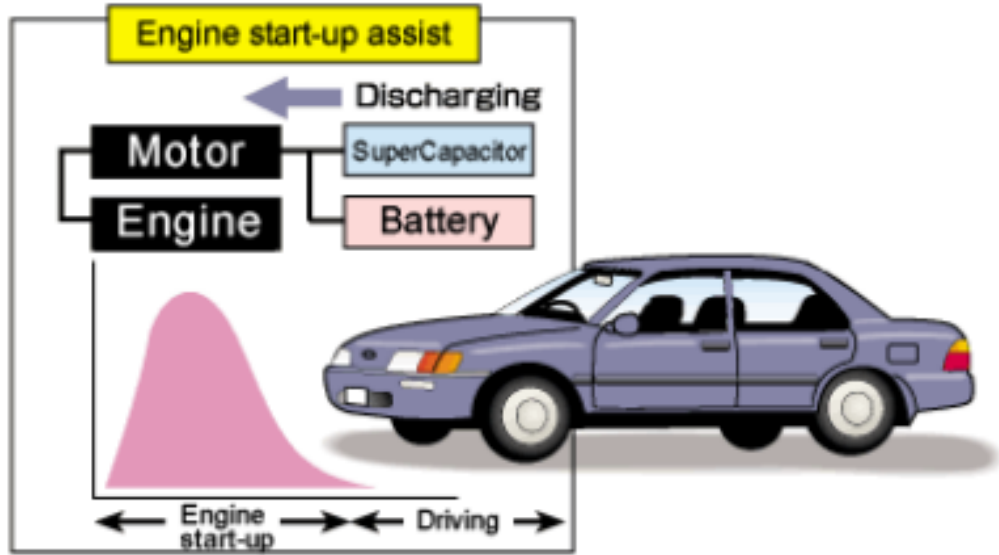
An electric double-layer capacitor (EDLC), also known as supercapacitor, supercondenser, electrochemical double layer capacitor, or ultracapacitor,



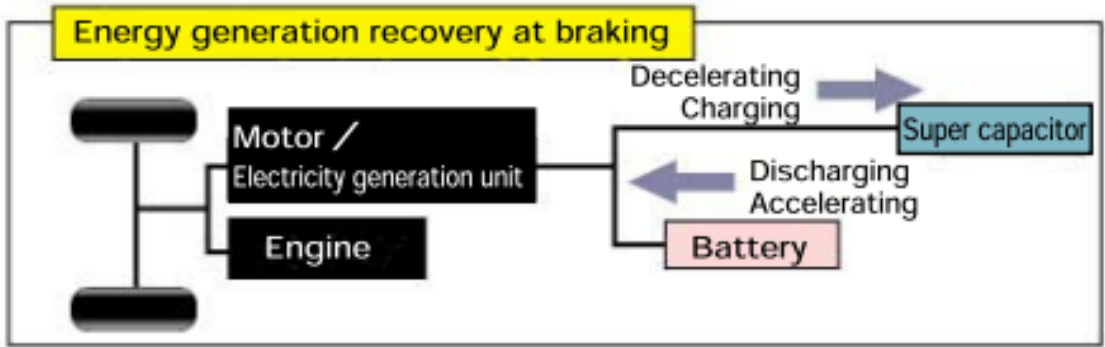
Automobile Engine Start-up Assist

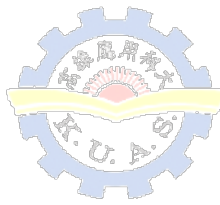


- 功率密度大
- 充電時間短
- 充放電效率高
- 壽命長



Automobile Energy Recovery at Deceleration





未來發展

- 1. 充電與電池：安全可靠之鋰鈹電池、主動式能量管理系統BMS、充電法規統一趨勢為歐美規範、安全可靠之快充電路、具識別計算功能之扣取預付儲值收銀機
- 2. 馬達與驅動：銅轉子、高效率馬達加速商品化、散熱技術—熱導管技術商化、汽油發電機+高效率液冷馬達+液冷驅動器之組合
- 3. 電子衍性產品：CANBUS、EPS電子動力轉向盤、LDWS電子越線警告裝置、CANBus與行車紀錄器結合、canbus三合一之NPC、具識別功能之預付儲值卡等



感謝各位的參與
歡迎指正與指教

