

# Autonomous And Electric Vehicle 自動駕駛與電動車

產品及產業化 Product And Industrialization



# 電動車傳動設計技術

## EV Transmission Design Technology

### 簡介 Introductions

電動車傳動完整設計與開發方案，依據不同車型規格及性能需求進行客製化設計，如齒比、殼體鎖附位置修改與優化等。提供二速傳動模組的產品，其中包含馬達與齒輪組高度集成的方案。具有同步器與離合器兩種可行的變速機構，將依據系統規格安排最適設計。

A total solution for design and development of EV transmission. Based on the different kinds of vehicle's specifications and performance requirements, our team can offer customization design, such as gear ratio, case mounting positions, etc. provide 2-speed transmission products, including the highly integrated 2-in-1 system which composes of a motor and gear sets in one case. Two kinds of Shifting mechanisms: synchronizer and clutch. The suitable design would be recommended through analyzing the system specifications by our team.

### 特色與創新 Features and Innovations

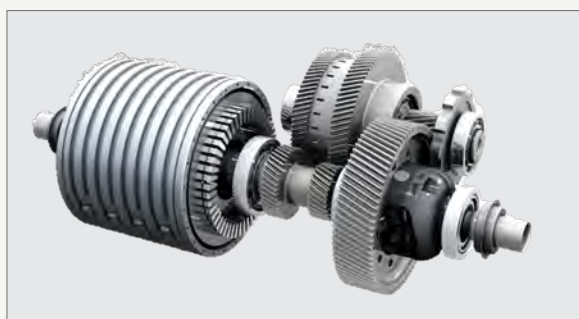
- 95~220 kW 電動車齒輪箱。
- 客製化駐車系統差速器。
- 高效率及優秀 NVH 特性。
- 輕量化設計。
- 適用於轎車、SUV、輕型卡車。
- 95 ~ 220 kW eDrive gearbox.
- Customized design of parking system differential.
- High efficiency and Excellent NVH.
- Compact and light weight.
- Apply to Sedan, SUV, Light truck.

### 應用與效益 Applications and Benefits

- 電動車傳動系統開發商。
- EV transmission system developer.



EVS-150 : 150 kW 單速齒輪箱  
150 kW single speed gearbox



EBT-100 : 100 kW 雙檔位變速箱  
100kW two speed transmission



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# 車用電源轉換器模組

## Automotive Power Converter Module

### 簡介 Introductions

為了解決現階段電動汽車存有電池高成本和低續航問題，提高充電效率的快速充電技術為目前的發展趨勢。高效率、高功率密度、快速充電為各廠商高度重視的目標。此外，電動車與電網聯結 (Vehicle-to-Grid; V2G) 的電路架構，透過雙方向車載充電器將車載電池配合智慧管理進行對電網供電為另一發展趨勢。因此，快速充電與雙方向車載充電電源轉換器模組為本開發產品的重點技術。

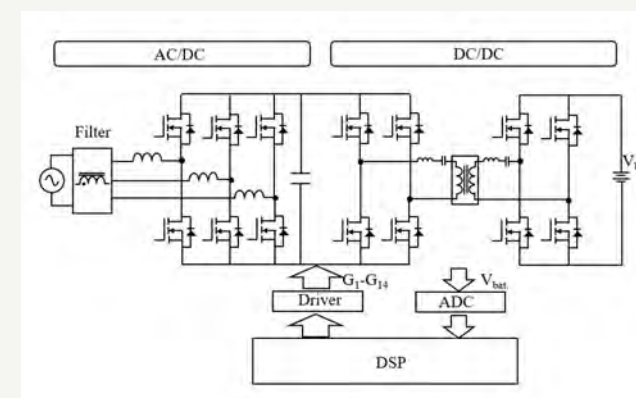
To overcome the current challenges of high battery cost and low battery life in electric vehicles, fast charging technology to improve charging efficiency is the current development trend. High efficiency, high power density, and fast charging are the development goals of every manufacturer. Additionally, the circuit structure of the electric vehicle and the grid connection (Vehicle-to-Grid; V2G) is another development trend. Therefore, fast charging and bidirectional vehicle charging power converter modules are key technologies of our developing products.

### 特色與創新 Features and Innovations

- 兼容單向、三相交流電壓。
- 雙方向車載充、放電架構。
- 寬域電壓範圍操作。
- 寬域負載軟切換，效率 > 96%。
- Compatible with single-phase, and three-phase AC voltage.
- Bidirectional on-board or off-board charging and discharging architecture.
- Wide voltage range operation.
- Wide-area load soft switching, efficiency > 96%.

### 應用與效益 Applications and Benefits

- 車載充電器、充電樁電源轉換模組、汽車對電網儲能系統。
- On-Board Charger, Off-Board Charger, Vehicle-to-Grid, Energy Storage Systems.



車用電源轉換模組架構  
Architecture of automotive power converter



車用電源轉換模組  
Automotive power converter



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## 車輛動力與底盤線控化技術

### Automotive Powertrain and Chassis By-wire Technologies

#### 簡介 Introductions

因應國際車輛智能自駕趨勢，車輛自駕化及線控化需求遽增。工研院機械所已建立完整的車輛動力與底盤線控化技術，包含線控動力 (throttle-by-wire)、線控排檔 (shift-by-wire)、線控轉向 (steer-by-wire) 及線控煞車 (brake-by-wire) 技術，並具備多家車廠貨卡車以及巴士等車型線控化技術服務實績，搭配工研院之車輛自駕技術，協助業者獲得政府之智能自駕運行計畫。

With the growing trend of intelligent automated driving in the global automotive industry, the demands for automated and X-by-wire technologies are also increasing dramatically. ITRI has established comprehensive powertrain and chassis by-wire technologies that include throttle-by-wire, shift-by-wire, steer-by-wire and brake-by-wire. With ITRI's satisfactory technical services to several automotive OEMs, the automated and X-by-wire technologies have been implemented in several vehicles and have helped those OEMs to obtain government's intelligent automated driving pilot projects.

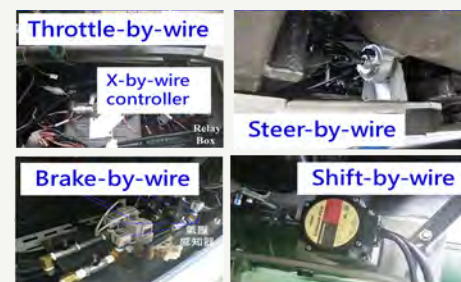
#### 特色與創新 Features and Innovations

- 應用工研院創新之整合式動力與底盤線傳控制器，執行動力、排檔、轉向及煞車之整合線控。
- 符合 SAE 自駕 Level 3 之線控需求。
- 線控轉向響應：overshoot  $\leq 3\%$ ；rise time  $\leq 0.3$  s；頻寬  $> 1.2$  Hz。
- 線控煞車反應時間  $\leq 0.3$  s。
- Throttle-by-wire, shift-by-wire, steer-by-wire and brake-by-wire achieved through the innovative integrated powertrain and chassis by-wire controller.
- Powertrain and chassis by-wire requirements compliant with SAE level 3 automation.

- Steer-by-wire response: overshoot  $\leq 3\%$ ; rise time  $\leq 0.3$  s; bandwidth  $> 1.2$  Hz.
- Brake-by-wire response time  $\leq 0.3$  s.

#### 應用與效益 Applications and Benefits

- 轎車、貨卡車以及巴士等車型之動力與底盤線控化。
- Powertrain and chassis by-wire for cars, trucks and buses.



車輛線控化實施  
X-by-wire Implementation



車輛線控化應用實績案例  
Successful Applications



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## 下世代碳化矽電動驅控器

### Next Generation Silicon Carbide Electric Power Inverter

#### 簡介 Introductions

台灣首套自主研發碳化矽馬達驅控器，透過採用離散式薄膜電容最佳化設計，大幅縮小體積占比最大的薄膜電容被動元件，並透過可達 40 kHz 高切頻之一體化驅控板的設計，可再降低薄膜電容使用的容值，縮小體積，已於動力計測試達 50 kW/L 之體積功率密度，符合 US DOE 能源部訂定之階段性技術目標。

Taiwan's first self-developed silicon carbide motor drive controller. Through the optimal design of discrete film capacitors and the integrated drive control board that can reach 40 kHz switching frequency, the size of the largest film capacitor are greatly reduced. The design can further reduce the capacitance value of the film capacitor and the volume. The volumetric power density has reached 50 kW/L in the dynamometer test, which is in line with the phased technical goals set by the US DOE Department of Energy.

#### 特色與創新 Features and Innovations

- 採用離散式薄膜電容最佳化設計及高頻切換技術，大幅縮小體積占比最大的薄膜電容被動元件，達 4L 小體積設計。
- 導入第三代半導體碳化矽功率模組，以高壓高效率驅動優勢，達 800V 高壓、98% 高效率驅動，體積功率密度  $> 50$  kW/L。
- The optimized design of discrete film capacitors and high switching technology are adopted, which greatly reduce the passive components of film capacitors with the largest volume ratio, and reach a small volume design of 4L.
- The third-generation semiconductor silicon carbide power (SiC) module is applied, with the advantages of high-

voltage and high-efficiency driving, up to 800V high-voltage, 98% high-efficiency driving, and volume power density  $> 50$  kW/L.

#### 應用與效益 Applications and Benefits

- 可應用於電動巴士 / 貨卡，透過高電壓、高效率特性，達更節能之效益。
- It can be applied to electric buses or trucks, and achieves more energy-saving benefits through high-voltage and high-efficiency characteristics.



下世代碳化矽電動驅控器  
Next Generation Silicon Carbide  
Electric Power Inverter

800V 高壓動力測試  
800V High Voltage Power Test



整車動力驗證  
Vehicle Power Verification



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# 車輛電動化技術

## Automotive Electrification Technology

### 簡介 Introductions

因應國際車輛產業節能減碳法規日益趨嚴，加速全球電動車發展趨勢，車輛電動化需求遽增。工研院機械所已建立完整的車輛電動化技術，從電動化次系統配置規劃、次系統設計開發、次系統功能驗證以迄整車性能驗證，並具備轎車、貨卡車以及巴士等車型電動化技術服務實績，協助業者之自主電動車輛開發並獲得相關之政府電動車計畫補助。

With increasingly strict regulations on energy saving and carbon reduction in the global automotive industry, the demands for automotive electrification technology are also increasing dramatically. ITRI has established a comprehensive automotive electrification technology that includes system layout planning, system design and development, function validations at the system level and performance validations at the vehicle level. With ITRI's satisfactory technical services to several automotive companies, the automotive electrification technology has helped those companies to develop their own electric vehicles and to obtain incentives from related government projects.

### 特色與創新 Features and Innovations

- 完整的車輛電動化技術，從電動化次系統配置規劃、次系統設計開發、次系統功能驗證以迄整車性能驗證。
- 完整的車輛電動化次系統技術，包含整車控制器、電動動力系統（電機、電控及電池）、電力轉換模組、車載充電模組、充電系統等等。
- 整車性能符合電動車法規，次系統及零組件符合車規等級。
- Comprehensive automotive electrification technology includes system layout planning, system design and

development, function validations at the system level and performance validations at the vehicle level.

- Comprehensive sub-system technologies include VCU, motor, inverter, battery, AC-DC/DC-AC/DC-DC converters, OBC, charging systems, and so on.
- Vehicle performance compliant to automotive regulations; automotive-grade sub-systems and components.

### 應用與效益 Applications and Benefits

- 轎車、貨卡車以及巴士等車輛電動化。
- Automotive electrification for cars, trucks and buses.



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# 高擬真電動巴士與商用車動態模型

## High Fidelity Dynamic Model of Electric Bus and Commercial Vehicles

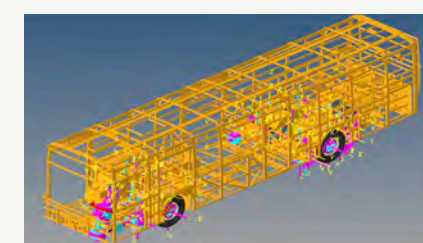
### 簡介 Introductions

以多體動力學方法搭配目標車數據量測建立車輛動態模型。應用電腦輔助工程 (CAE) 軟體建立目標車前後軸模板，藉由量測取得懸吊與轉向機構硬點、懸吊零部件特性以及整車重量 / 慣量 / 重心等參數並匯入軟體，確保車輛模型具備高擬真與高可靠度。

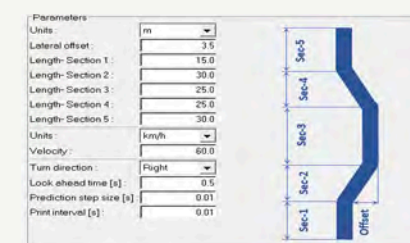
The vehicle dynamic model was created by the multi-body dynamics (MBD) method and target vehicle data measurement. Templates of front and rear axle were built with computer aided engineering (CAE) software. Parameters such as hard points of suspension and steering mechanism, characteristics of suspension components and weight/inertia/center of gravity were obtained through measurement then imported into software; thereby, ensuring that the vehicle model meets high levels of fidelity and reliability.

### 特色與創新 Features and Innovations

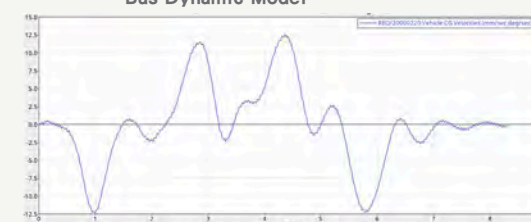
- 完整且詳細的巴士與商用車零件數據資料庫：葉片彈簧、空氣彈簧、緩衝塊與避震器。
- 準確可靠的整車動態模擬：穩態 95%；暫態 80%。



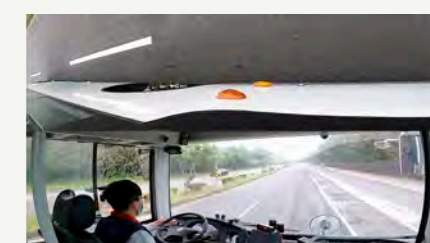
巴士動態精準模型  
Bus Dynamic Model



雙車道變換  
Double Lane Change



雙車道變換的橫擺率  
Yaw Rate (DLC)



車道維持系統  
Lane Keeping System

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# 電動巴士與商用車能耗估算

## Energy Consumption Estimation of Electric Bus and Commercial Vehicles

### 簡介 Introductions

導入國際車廠正向開發方法與 V 型開發流程，應用電腦輔助工程 (CAE) 軟體工具建立車輛、馬達和電池等系統模型，並使用功能性模擬接口 (FMI) 確保各模型間互通，執行整車系統模擬並且在車輛開發初期評估整車性能與可行性，減少問題診斷所需的實車驗證成本與時間，更可加速國產電動巴士與商用車自主開發。

Importing forward development method and V-shaped developing process from international vehicle manufacturers . Vehicle, motor and battery system model were built by computer aided engineering (CAE) software tools. Then, functional mock-up interface (FMI) was adopted to ensure interoperability of each subsystem model. Conducting full-vehicle system simulation as well as evaluating vehicle performance and feasibility at early stage of vehicle development makes it possible to reduce cost and time of vehicle verification and trouble shooting. Further, accelerating independent development of domestic electric buses and commercial vehicles.

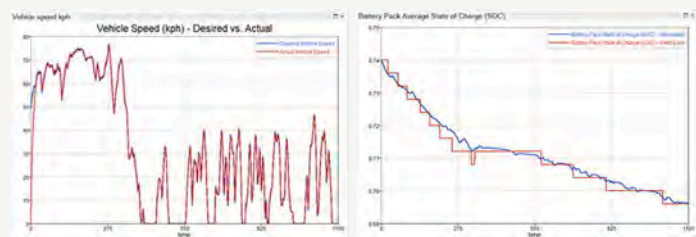
### 特色與創新 Features and Innovations

- 巴士與商用車實際的數據資料來源。
- 基於模型開發與採用功能性模擬接口 (FMI) 串聯各次系統，確保模型互通與交換性。
- 極高可信度的車輛模型與精確能耗估算 (>90%)。
- Actual database from bus and commercial vehicle.
- Model-based development and application of functional mock-up interface (FMI) which guarantee capability of model interoperability and exchange.

- Extremely high credibility vehicle model accompanied with accurate energy consumption estimation (>90%).

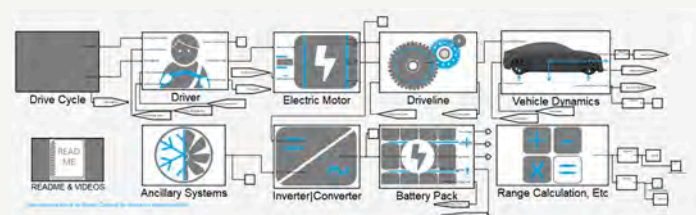
### 應用與效益 Applications and Benefits

- 電動車能耗與續航力計算。
- 電動車熱管理策略開發。
- 電動車動力系統硬體在環 (HIL) 驗證。
- Energy consumption estimation nd range calculation.
- Thermal management strategy development.
- Hardware-in-the-loop (HIL) verification of electrified vehicle’ s powertrain.



行駛車速 Driving Speed

電池電量狀態變化 SOC Variation



純電動車系統模型 BEV System Model

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