

# iA, Inc.

# 目录

---

iA集团公司简介

工作简介

iA集团子公司简介

功率模块事业部简介

# 公司简介

---

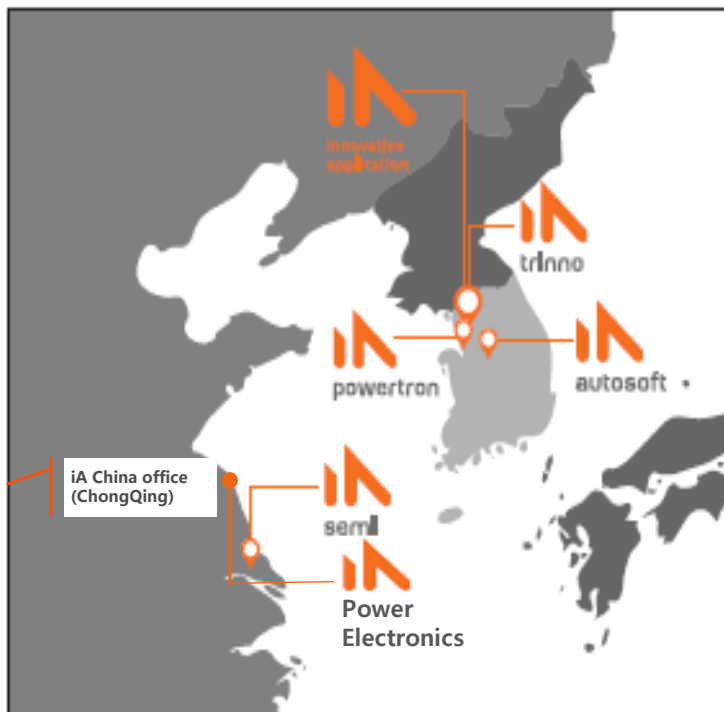
# 公司概要



## ■ iA, Inc.

|      |  |
|------|--|
| 成立   | 1993年8月  |
| 代表理事 | 金东晋  |
| 资本金  | 20,644百万韩元 (约合12,500万元人民币)   |
| 雇员人数 | 581人 (包括iA Powertron、iA TRinno、iA Autosoft、iA Semi、iA Power Electronics) |
| 业务范围 | 汽车半导体、模块解决方案   |
| 总部地址 | 韩国首尔特别市松坡区松坡大路2路5-23 iA大厦  |
| 主页   | <a href="http://www.ia-inc.kr">www.ia-inc.kr</a>                         |

## ■ Affiliates



- China Joint Venture Company
- Power Semiconductor (IGBT, MOSFET, Diode) production and sales



- Power Semiconductor Development and Manufacturing
- High-speed switching elements (IGBT, MOSFET, Diode)
- Home appliances, and power semiconductor for industrial use



- Power Module Development and Manufacturing
- Power module for automotive application
- Power module for industrial application

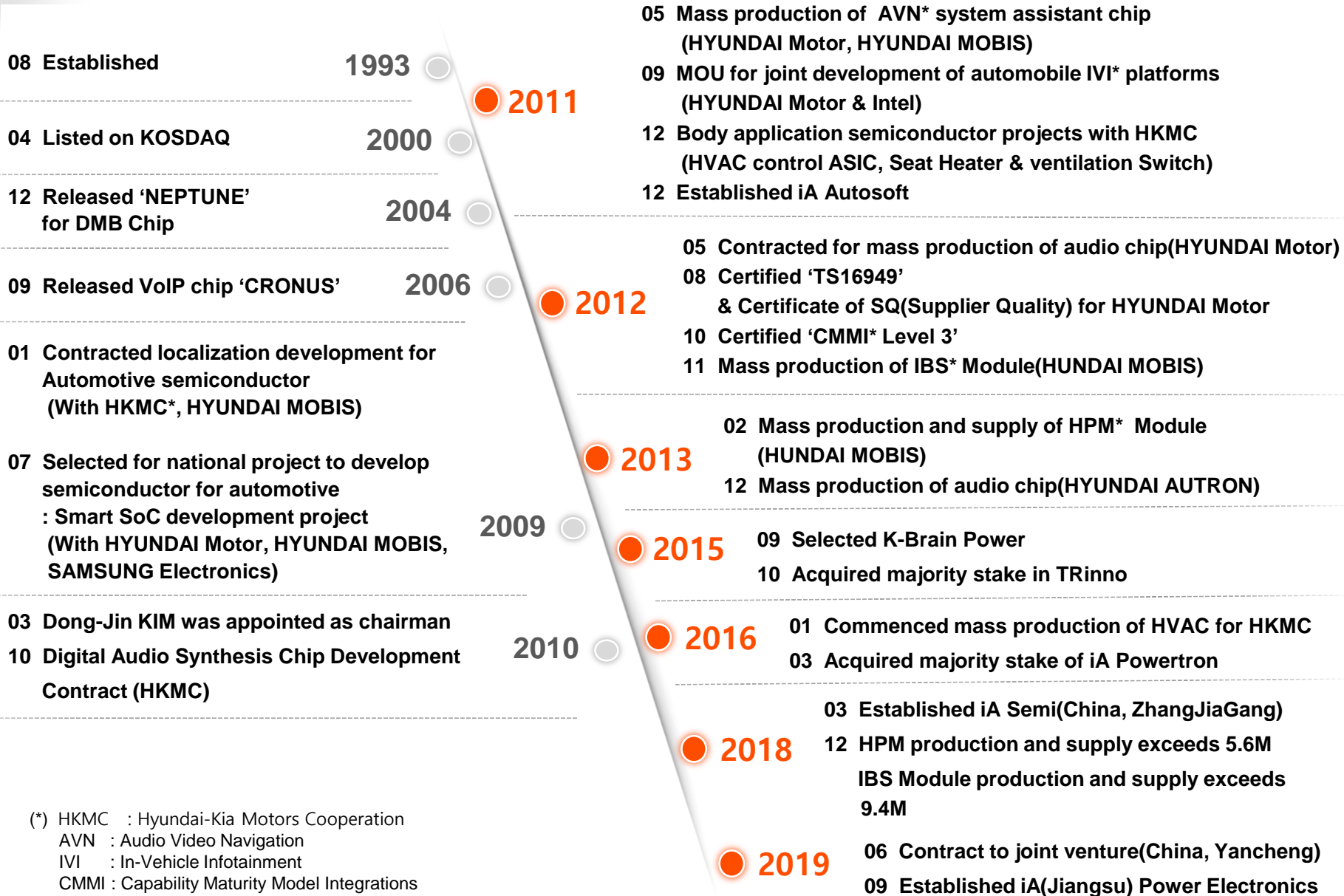


- China Joint Venture Company
- China's specialized power controller & power module R&D and Production

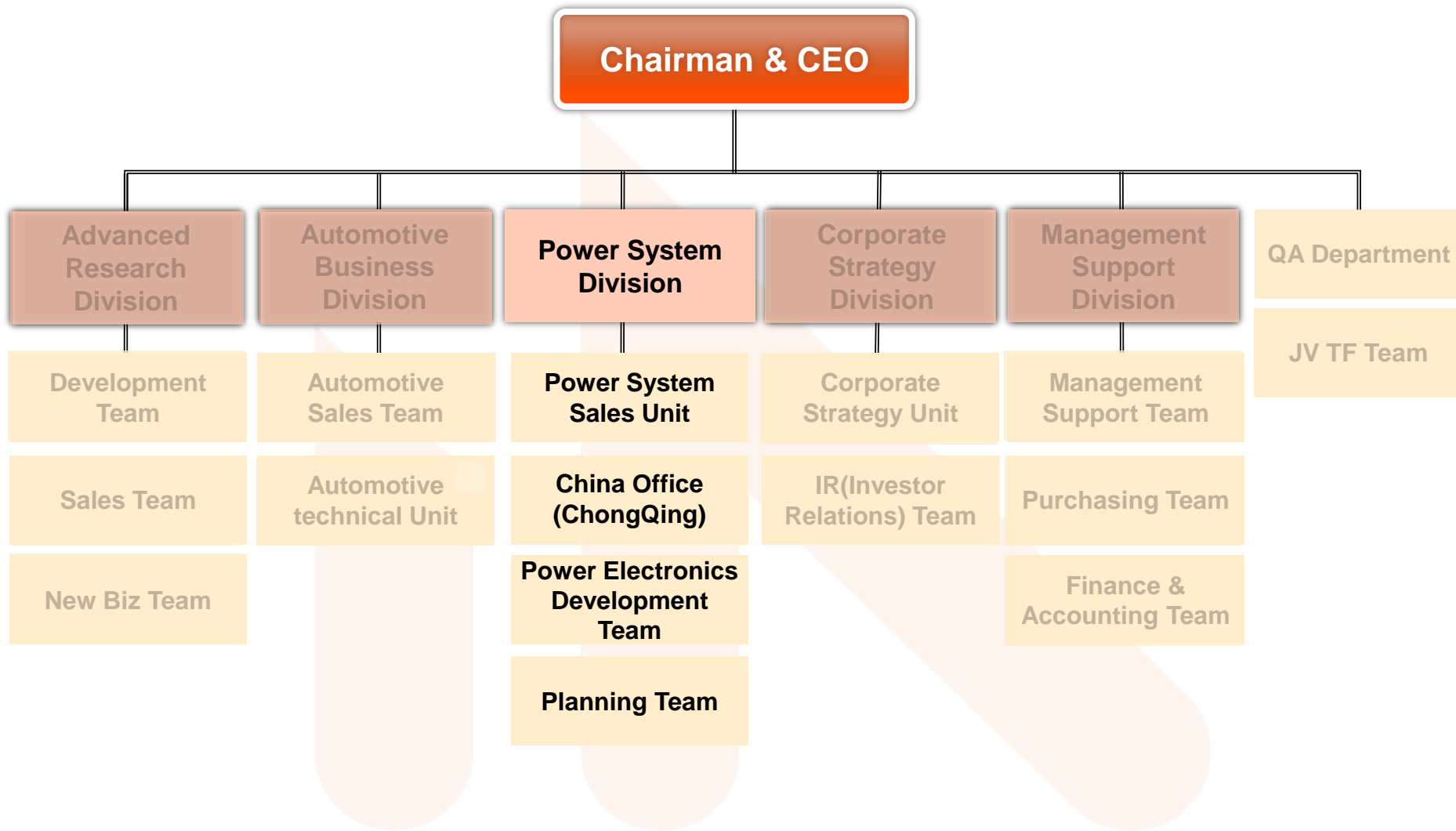


- SW Verification and Development for Automotive Sector
- SW development and debugging based on AUDIO/AVN platform

# 公司历史



(\*) HKMC : Hyundai-Kia Motors Cooperation  
 AVN : Audio Video Navigation  
 IVI : In-Vehicle Infotainment  
 CMMI : Capability Maturity Model Integrations  
 IBS : Intelligent Battery Sensor Module  
 HPM : High Power Module



# 工作简介

---



## Objective

## Development of Optimum Products

## Strategic Direction

### Semiconductor

- Acquire automotive semiconductor key technology
- Develop products including Chassis / PT

### Solution

- Expand infotainment sector domain
- Secure Body / Chassis system support level technology

### Production

- Module production based on our products
- Automotive module production base

### Quality Assurance

- Ensure zero defect automotive quality
- Establish quality assurance system through exhaustive quality management

## Code of Conduct

**Knock the Future!**



### ✓ **START** Together

- We are developing a full range of automotive semiconductors and system solution and will achieve the technical independence in the automotive semiconductor application.

### ✓ **SMART** Together

- We will make every effort to achieve outstanding synergy interaction through the harmony of business and technology alliance.

### ✓ **STRONG** Together

- We will stand at the center of automobile business, and will be positioned as 'Global Top 10 Non-memory Semiconductor Company'.



## HD-DMB

high-definition DMB module /solution



## T-DMB

Module for DMB image enhancement



## DAB+

European DAB+



## CMMB

Chinese Mobile TV

## IBS

Intelligent Battery Sensor module



## E-Relay module (Transfer Molding)

Backward voltage protection relay module for protecting the switching current of FET



## HPM Gen 2.0 / 2.5 (Gel-fill)

E3 phase inverter module for driving EPS motor  
40V/160A MOSFET module

## HPM Gen 4.0 (Gel-fill)

40V/160A MOSFET module + Current Sensor

## N3 Platform HPM-M (Transfer Molding) K3 Platform HPM-M (Molding)

40V/160A MOSFET module + Current Sensor

## iA Quality Objectives **Defect**

### Quality System

- **Process & Operation**
  - Development / Production / Support
  - Quality requirements satisfaction
- **Operating System**
  - ISO9001
  - IATF16949
  - ISO26262

### Development Quality

- **Project management procedures and requirements system**
  - Completion of development
  - Efficient use of resources
- **Operating System**
  - ICMMI-Dev
  - PMS
  - DFMEA

### Reliability Verification

- **Design Review & Test evaluation**
  - Ensuring product reliability in various operating environments
- **Operating Tool**
  - AEC-Q100
  - Burn-In
  - iA's operating standards

### Production Quality

- **Production quality management procedures and inspection**
  - Product Goal Function / Performance / Reliability Satisfaction
- **Operating Tool**
  - PFMEA
  - SPC
  - MSA

### Customer Response

- **Customer Response**
  - Various response systems during product life cycle and handling of defects
- **Operating Tool**
  - analyze defect
  - 8D Report
  - Audit

# 质量认证书现况



The only fabless company in Korea that acquired three quality process and standards(ISO26262, CMMI LV3, TS/ISO16949) for mass production satisfied standards of high reliability semiconductor

| Title  | Contents   | Date of acquisition | Institute                              |
|--|--|---------------------|--|
| ISO 9001   | Quality Management System  | 2009.10.11          | BSI                                    |
| ISO 14001  | Environmental Management System  | 2009.10.25          | BSI                                    |
| <b>SQ Certificate</b>                              | Certificate of quality assurance for HYUNDAI/KIA Motors partner  | 2012.08.20          | HYUNDAI Motor<br>HYUNDAI MOBIS         |
| CMMI   | Capability Maturity Model Integrations Development v1.3 (Level3)   | 2012.10.23          | TQMS                                   |
| IATF 16949   | Quality Management System for automotive industry  | 2018.08.05          | bsi                                    |
| K-BrainPower                                       | Selected and cultivated Professional Corporation in the brain industry to secure sustainable growth and high added value | 2015.09.01          | Ministry of Trade, Industry and Energy |
| <b>ISO26262</b>                                    | International standard for functional safety of electrical and/or electronic systems in production automobiles           | 2016.06.07          | TÜV-Rheinland                          |
| Inno-Biz   | Technological innovation Corporation Certificate   | 2016.09.01          | Small & Medium Business Administration |
| Material-Part Professional Corporation Certificate | Materials · Part Professional Corporation Certificate  | 2017.06.29          | Ministry of Trade, Industry and Energy |
| Hi-Seoul Brand                                     | Selected as a cooperative support brand company by Seoul Metropolitan Government and Seoul Industrial Promotion Agency   | 2017.09.13          | Seoul Metropolitan Government          |

# iA集团子公司简介

---



## 爱特微 (张家港) 半导体技术有限公司

|             |                          |
|-------------|--------------------------|
| Location    | ZhangJiaGang City, China |
| Established | March, 2018.             |
| Capital     | \$157 million            |
| Workforce   | 238                      |
| Area        | 33,334m <sup>2</sup>     |
| capacity    | 30,000/M                 |

## Capacity

- 8V-60V, 2um Bipolar technology
- 1.2um N channel CMOS technology
- 3.0um BICMOS technology
- PLANAR NPT 1200V IGBT technology
- PLANAR NPT 500V-600V IGBT
- 600V-1200V FRD technology
- 600V-1200V HVDMOS technology



IDM: Integrated Device Manufacturer



From Silicon based products (MOSFET, IGBT) to SiC products, TRinno supplies highly efficient and advanced power semiconductor solution to its customers

## Core Ability



### The latest Power Semiconductor design technology

- Field Stop Trench IGBT
- Super Junction MOSFET
- Split Gate Trench MOSFET
- Silicon Carbide MOSFET & SBD



### High quality / Environmental management

- ISO/TS16949 (Electric Parts)
- ISO14001 (Environmental)
- Customer-specific quality control system



### Global supply chain

- Customer-specific quality control system
- Ultra-thin wafer process R & D center
- Securing domestic, overseas production assembly line chain

## Biz. Area



### Industrial Power Supply

- welding machines
- Inverter systems
- Uninterruptible power supplies
- communications electric power supply
- Motor drives



### Renewable Energy

- Solar inverter
- Energy storage
- Battery power management



### Home Appliance

- Induction cooker
- Air conditioner
- LED lighting

## Strengthening Biz. Capabilities

### High efficiency semiconductors for automotive commercialization

- DC / DC converter
- Battery management system
- Motor drive
- Charging device

### Compound Semiconductor early commercialization

- 1200V, 1700V SiC MOSFET
- 650V, 1200V, 1700V SBD

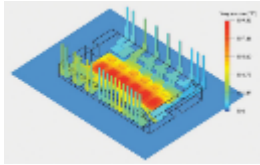
### Unit process service business

- Ultra-thin wafer process (< 70μm)
- Wafer back grinding process
- Ion implantation process
- Metal deposition process



Developed and mass-produced optimized power semiconductor module for customer's system performance improvement

## Core Ability



### Simulation

- Thermal analysis
- Mechanism analysis
- Circuit analysis



### Module Design

- PRO-E
- CATIA
- AUTO CAD



### Process development

- Vacuum soldering
- Sintering
- Ultrasonic welding



### Exclusive Production Line

- Gel-fill type
- Transfer molded type



### Quality management (Automobile safety parts management standard)

## Biz Area



### Automotive

- EPS system
- MHSB
- Charging system
- Power conversion device



### Industry

- Inverter system
- Power conversion device
- Welding, induction heating
- Medical Equipment



### New Renewable Energy

- Solar inverter
- ESS

## Certification



TS16949



ISO14001



SQ (Hyundai)



## History(Joint Venture)

|                                 |  |                 |                 |
|---------------------------------|--|-----------------|-----------------|
| <b>Contract Date</b>            | 18 <sup>th</sup> of Jun. 2019  | <b>Location</b> | Yancheng(China) |
| <b>Purpose of Establishment</b> | China's specialized power controller / Power Module R&D and Production<br>→Strengthening business related to EV and eco-friendly cars in China   |                 |                 |
| <b>Main Issue</b>               | <ul style="list-style-type: none"> <li>• Signed a contract to establish a joint venture (JV) with a capital of US\$ 93M with the Chinese government in Yancheng</li> <li>• iA acquires a 51.6% stake in management and China acquires 48.4%</li> <li>• iA will receive a total of US\$ 21M technology development service fee from the joint venture over the next three years.</li> </ul> |                 |                 |



Development of D-AUDIO  
High-quality Micom S/W  
Development and verification of  
Cluster GUI  
CAN simulation tool  
ECU logic evaluation tool  
Tool for ECU evaluation  
Development of ECU  
for Automotive products  
Verification simulation environment  
Acquisition and analysis of  
CAN signal and image

**SW  
Development  
for  
Automotive  
Products**

**SW  
Verification  
for  
Automotive  
Products**

D-AUDIO wide, D-AUDIO products  
6 generation for High-quality  
1/2 generation for High-quality  
3/4 generation for standard AVN  
BT / compatibility verification  
CAN simulation  
Module verification (DAS)  
Verification of Black & White Box  
& Automation

## Know-how in Verification

- Professionals in the field of SW Testing
- Building up the capability of Test
- Development of Test working processes
- Test based on tools,  
Verification report review

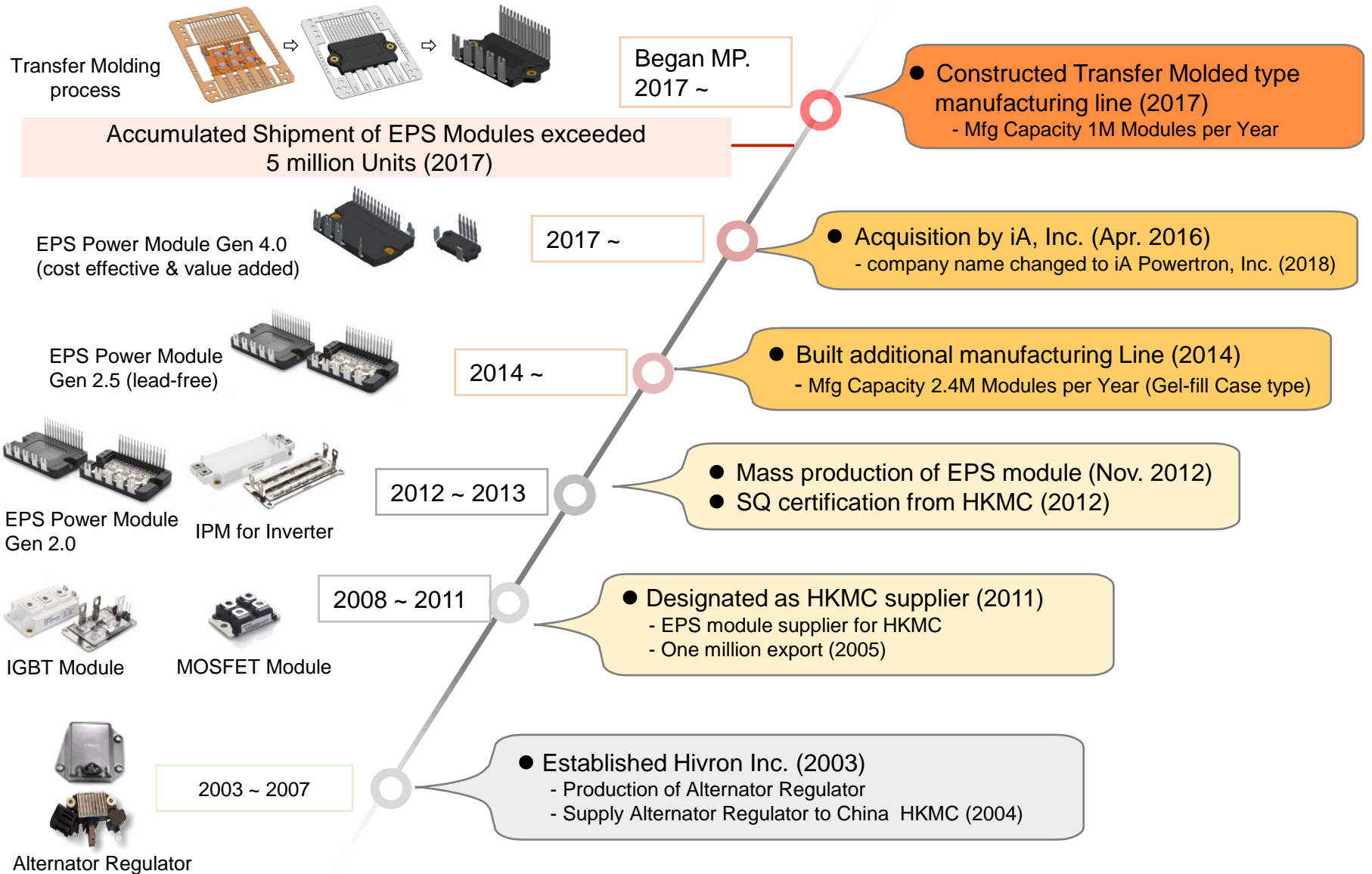
## Verification Environment

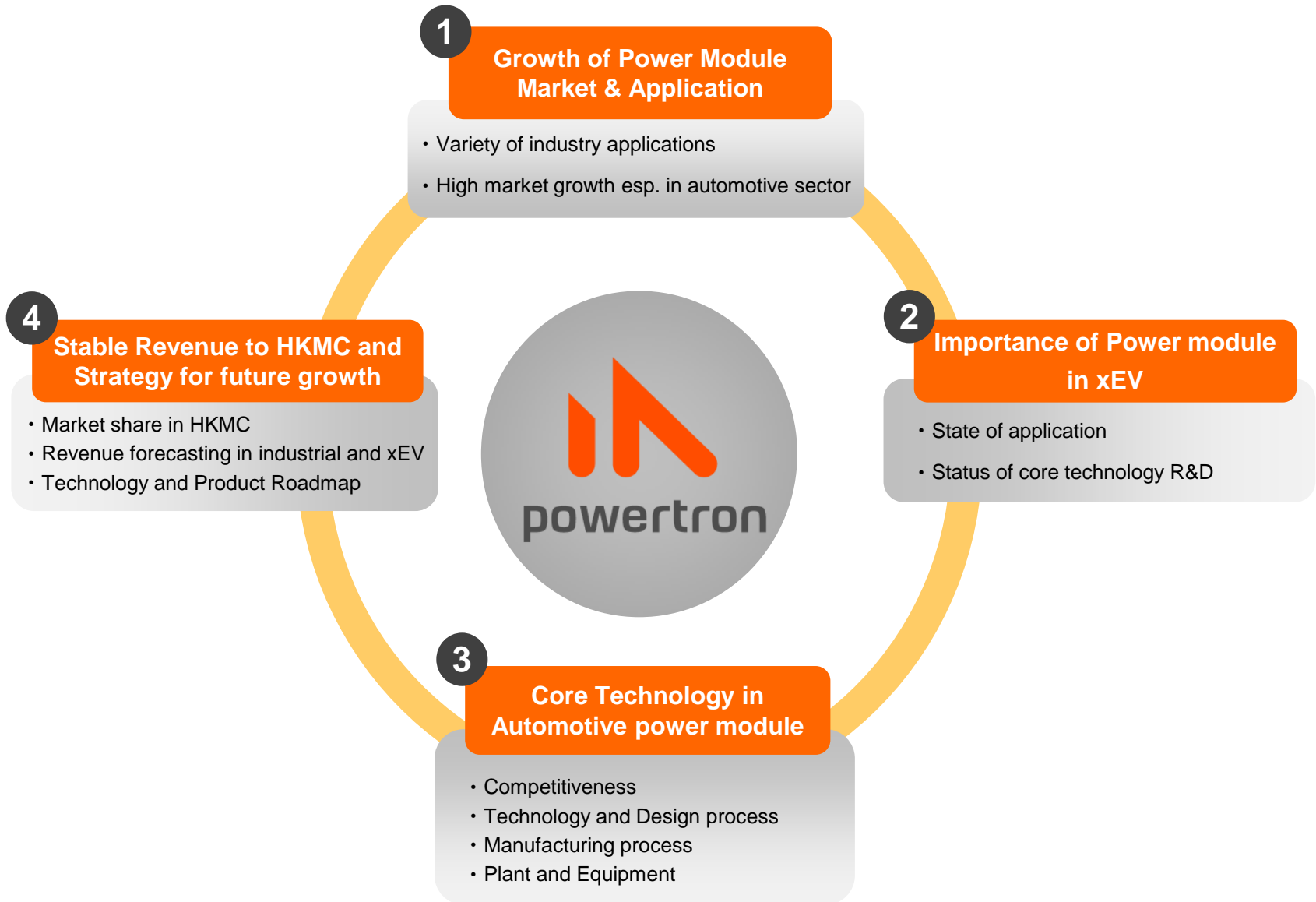
- Broadcasting sender towards  
Europe/America
- Disaster broadcast and traffic report sender
- GPS, DMB, FM emission system
- Automated test bench equipment

# 功率模块事业部简介

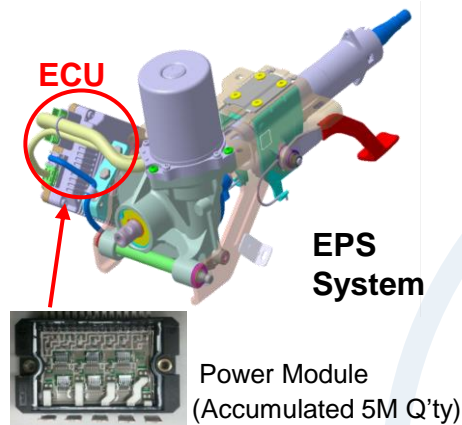
---

# iA PowerTron 公司历史





## Highest quality manufacturing excellence and high technology design capability in automotive power module application



- Quality assurance
  - Quality certified : SQ, TS16949, ISO
  - Expert quality resources
  - Secure zero defect quality
- Customer service
  - Exclusive responsibility for customer satisfaction
  - Expert analysis resources for C/S



- Experience in automotive field with significant R&D capability
  - Expert engineering resources
  - Electrical, thermal, mechanical design expertise for automotive
- Robust module package design
  - Reliable structure
  - Better performance
  - Cost effective design and less loss
- Manufacturing based on industry-leading edge technology
  - Better manufacturing information
  - Screening defective process



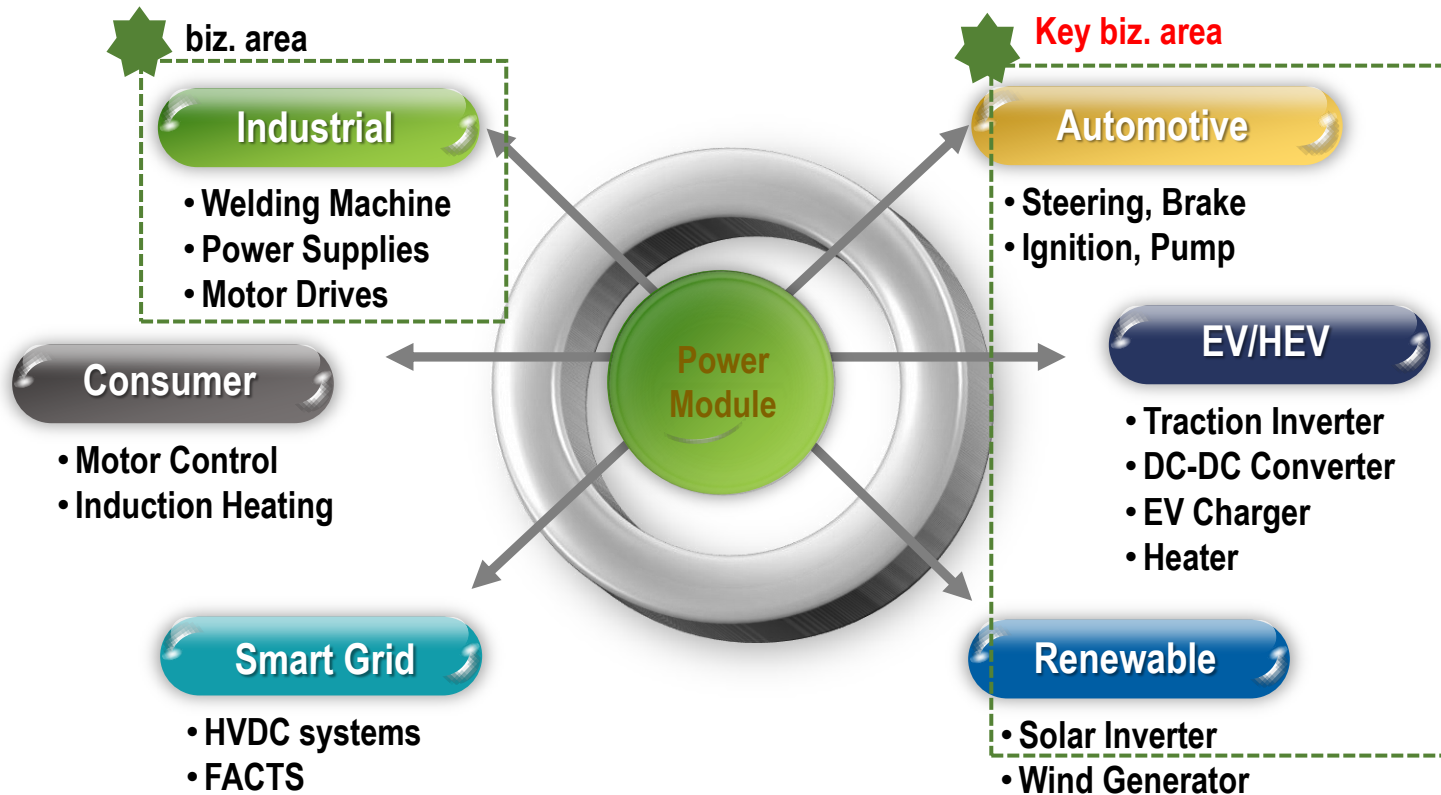
## Static Application

DC Power Supply, Un-interruptible Power Supply, Power Generation and Transmission(HVDC), Electroplating, Welding, Heating, Cooling, Electronic Ballast



## Drive Application

Electric Vehicles, Electric Trains, Air-conditioning System, Pumps, Compressors, Factory Automation



## Power Modules in PowerTron:

### (1) Fuel efficiency technologies - Motor control (2) Power Conversion

#### Electric Power Steering (C-assist)

- 3 Phase Full Bridge module
- MOSFET (40V/160A)



#### Electric Power Steering (R-assist)

- 3 Phase Full Bridge module
- MOSFET (40V/180A)

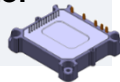


#### E-Compressor

- 3 Phase Full Bridge Inverter
- IGBT (680V/24A)

#### E-Water Pump Inverter

- 3 Phase Full Bridge Inverter
- IGBT (600V/50A)



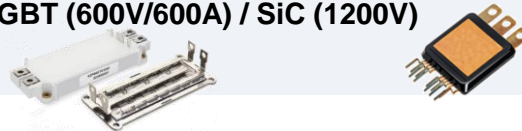
#### ISG(Integrated Starter Generator)

- 48V MHS6 6-Pack module
- based GaN(100V/270A)



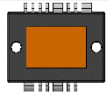
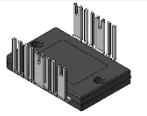
#### Electric Traction Motor control

- 6-Pack IPM / 2-Pack DSC module
- IGBT (600V/600A) / SiC (1200V)



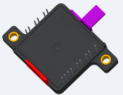
#### On-board Charger

- PFC Boost
  - 1200V/90A SiC MOSFET
  - 1200V/50A SiC Diode
  - 900V/38A SiC MOSFET
- Isolated DC-DC converter
  - 900V/66A SiC Full Bridge
  - 650V/120A GaN Full Bridge
  - 650V/50A Si Diode Full Bridge



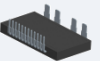
#### High Voltage DC-DC

- Buck & Boost converter
- IGBT (650V/200A)



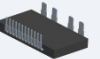
#### Low Voltage DC-DC converter

- Switching
- MOSFET (100V/180A)



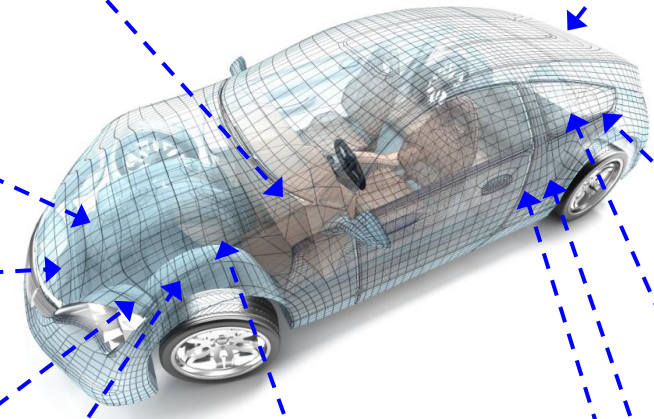
#### Low Voltage DC-DC converter

- Back to Back
- MOSFET (40V/270A)



#### BMS in 48V Battery pack

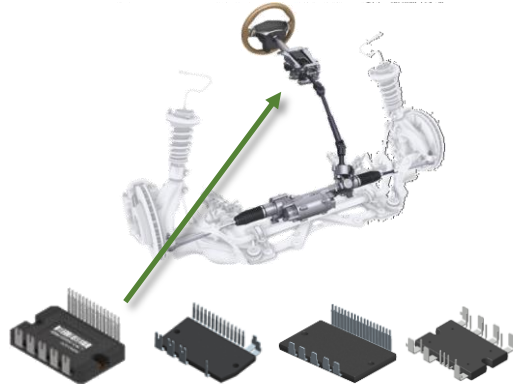
- Electric Relay
- MOSFET





## EPS Applications

- Power Module for electric power steering



### Products

- HPM2/0/2.5/4.0, DN8 HPM-M (Mobis)
- Standard EPS Module/APRIM21N04ICP (Several EPS system company)

### Main Customer

- Korea: Hyundai Mobis
- China : SouthernDare, Autonics
- Johnson Electric, Hegnlong

### Business Status

- Cumulative production to 5.6 M
- Self Promotion power module for China market

## E-Comp Applications

- Power Module for xEV electric compressor controller



### Products

- 600V 6-PAK IGBT Module (190 ~ 420V battery voltage)
- 100V 6-PAK MOSFET Module (48V BV)

### Main Customer

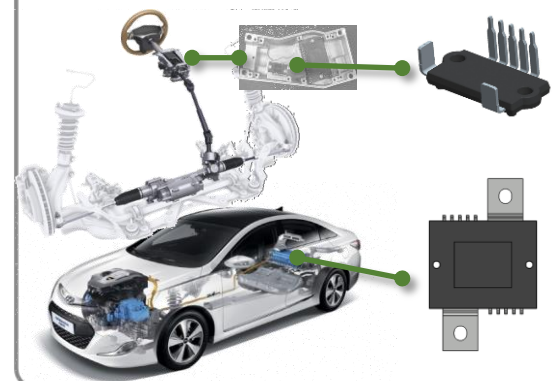
- China : internal Use

### Business Status

- China Company A :End of 2019 SOP Award
- China Company B :
  - 1) Develop 300V controller for SOP 2020 – 34CC
  - 2) Advanced co-develop 48V Controller – 34CC(Same Package with 100V FET)

## E-Relay Applications

- E-Relay Power Module which can be replaced from mechanical relay



### Products

- 40V FET E-relay for EPS system
- 100V FET E-Relay for 48V Li-ion Battery

### Main Customer

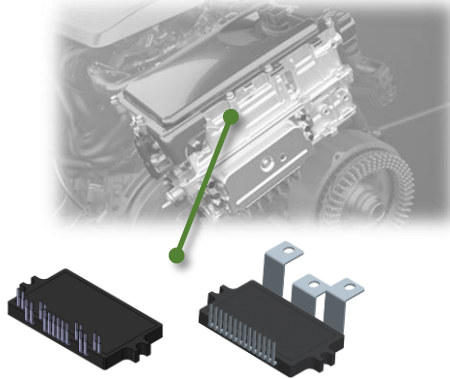
- Korea: Mobis, Battery Company
- China: CAMEL, GEELY

### Business Status

- Supply E-relay to Mobis
- “A” sample award 100V FET E-relay with Korea Battery company for German OEM
- Early Satge to CAMEL and Geerly

## HV LDC Applications

- FET Power module for DC to DC Converter



### ▪ Product

- Primary : 650V Full-Bridge MOSFET Module
- Secondary : 100V SR MOSFET Module

### ▪ Main Potential customer

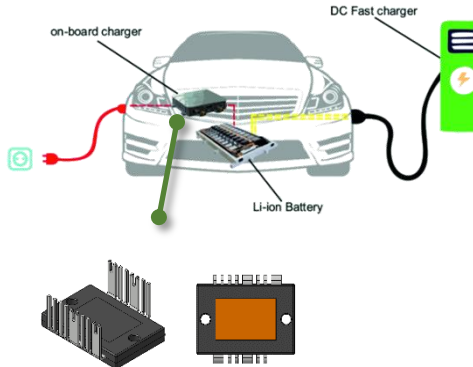
- Korea : LG Innotek, Mando
- China : Tier1
- Global : Continental, Sevcon

### ▪ Business Status

- Proto supplying to LG Innotek LDC Project for GM North America

## OBC SiC Applications

- SiC MOSFET Power Module for On Board Charger (OBC)



### ▪ Product

- 650, 900 1200V Series Full-Bridge SiC MOSFET Module
- 900, 1200V Series Bridgeless PFC SiC MOSFET Module

### ▪ Main Potential customer

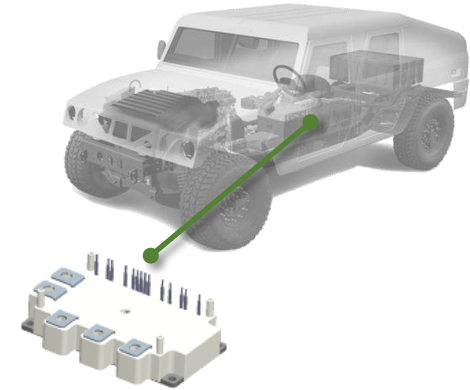
- Korea : Hyundai Mobis, Mando, LG Electronics
- China : MEGMEET
- Global : Tier1

### ▪ Business Status

- ER Sample to Mobis
- 650V Full-Bridge SiC MOSFET Proto sample to LGE

## GaN Applications

- GaN Power Module for Military



### ▪ Product

- 100V 270A GaN Module

### ▪ Main customer

- USA : MainStream

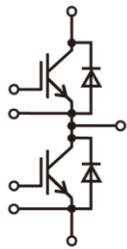
### ▪ Business Status

- Award for USA Military vehicle SOP 2020



## 2-PACK IGBT Module

- IGBT Power module for general industrial application



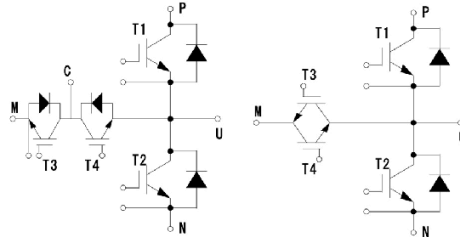
**Product**

- 650V 100A ~ 600A IGBT Module
- 1250V 100A ~ 600A IGBT Module

**Application**

## Multi-Level IGBT Module

- IGBT Power module for renewable energy market which needs high efficiency



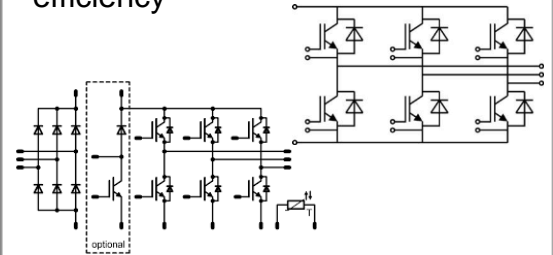
**Product**

- 650V 3-LEVEL IGBT Module
- 1250V T-Type IGBT Module

**Application**

## PIM / 6-PACK IGBT Module






- IGBT Power module for AC Motor controller market which needs high efficiency



**Product**

- 650V 10A ~ 150A IGBT Module
- 1200V 8A ~ 100A IGBT Module

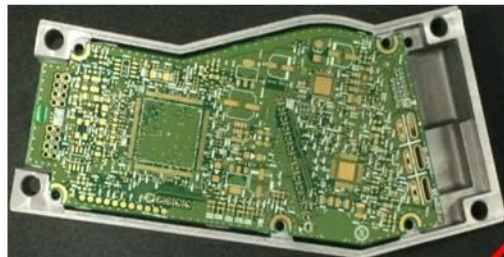
**Application**

| Product                            | Applied vehicle   | Sales Amount   |
|------------------------------------|---|--|
| <p><b>HPM-GEN</b><br/>2.0/2.5</p>  | <p><b>RV</b></p>  <p>MAXCRUZ      SANTAFE      SORRENTO</p> <p><b>Passenger</b></p>  <p>K5      K7</p> <p>LF소나타</p> <p>HG그랜저      i40</p> | <p>SOP : 2012.11<br/>Cumulative production :<br/>5,515K</p>            |
| <p><b>HPM-GEN</b><br/>4.0</p>      | <p><b>RV</b></p>  <p>SANTAFE(TM)      PALISADE(LX2)</p>   | <p>SOP : 2017.12<br/>Cumulative production : 32K<br/>FCST : 100K/Y</p> |
| <p><b>DN8</b><br/><b>HPM-M</b></p> | <p><b>RV</b></p>  <p>SORRENTO(UM)</p> <p><b>Passenger</b></p>  <p>SONATA(DN8)      K5(DL3)</p>   | <p>SOP : 2018.03<br/>FCST : 700K/Y</p>                                 |
| <p><b>E-Relay</b></p>              | <p><b>RV</b> : SANTAFE(TM) / PALISADE(LX2) / SORRENTO(UM)<br/><b>Passenger</b> : SONATA(DN8) / K5(DL3)</p>  | <p>SOP : 2017.12<br/>Cumulative production : 33K<br/>FCST : 800K/Y</p> |

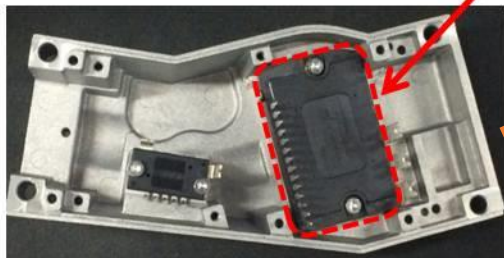
# EPS用功率模块产品\_参考图片及规格



## EPS ECU Assembly



DN8 HPM-M



## Configuration

| Feature     | Name       | Spec   |
|-------------|------------|--|
|             | Mold       | EMC(KTMC5400GP)  |
|             | Lead Frame | Cu(C1020)  |
| MOSFET      |            | Bare Die 40V(AUIRFC8407)   |
| Hall Sensor |            | 5V / 150A(ACS780KLR-150B-T)  |
| Thermistor  |            | 1608 NTC 10Kohm<br>3%(BV57342V5103)  |
| DBC Ass'y   |            | Ceramic Substrate (Al <sub>2</sub> O <sub>3</sub> )<br>Size : 40.7 * 24.65 * 1.235T<br>DBC Thickness : 0.3 * 0.635 * 0.3 |

## Specification

| Item                      | SPEC.                      | Remark                  |
|---------------------------|----------------------------|-------------------------|
| Operation Voltage Range   | 40V                        | Rated Voltage 12V       |
| Drain Current(continuous) | 160A                       | Tc = 25℃                |
| R <sub>DS(on)</sub> max   | 1.6mΩ                      | VGS = 10V,<br>ID = 100A |
| Operation Temperature     | -40 ~ 125℃                 |                         |
| Mounting Screw Torque     | 1.3 ~ 1.5N.m               | M3                      |
| Weight                    | 76g                        |                         |
| Dimensions                | 55 x 30 x 5.9T (W x D x H) |                         |
| Life Cycle                | 10 Years / 160,000km       |                         |

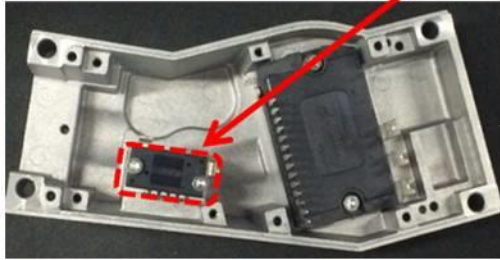
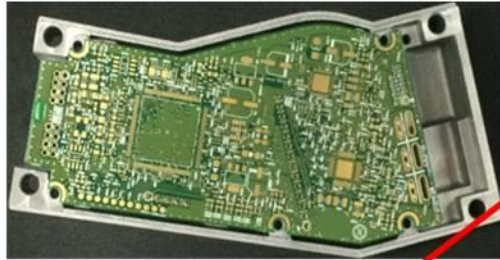
## TEST

| Test                               | SPEC.         | Remark |
|------------------------------------|---------------|--------|
| Environmental tests                | Customer Spec |        |
| EMC/EMI tests                      | Customer Spec |        |
| Function tests                     | Customer Spec |        |
| Lead-free solder reliability tests | Customer Spec |        |
| Durability tests                   | Customer Spec |        |

# EPS用功率模块产品\_参考图片及规格



## EPS ECU Assembly



E-Relay



Example

## Configuration

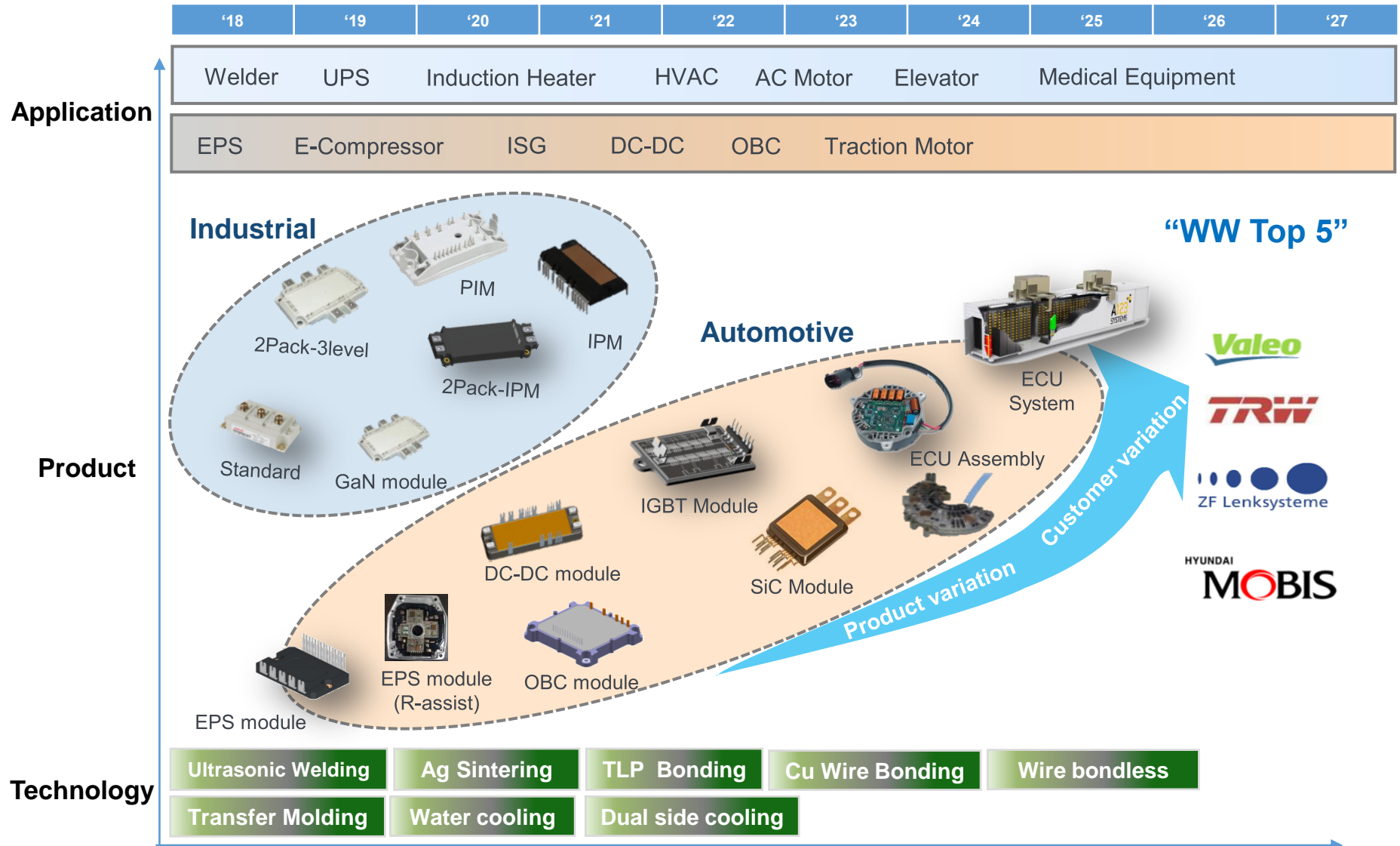
| Feature | Name       | Spec.  |
|---------|------------|--|
|         | Mold       | EMC(KTMC5400GP)<br>Size : 25.0 x 13.5 x 5.5T   |
|         | Lead Frame | Cu(C1020)  |
|         | MOSFET     | Bare Die 40V(IAUW62N04S4L)   |
|         | DBC Ass'y  | Ceramic Substrate (Al <sub>2</sub> O <sub>3</sub> )<br>Size : 16.2 * 8.2* 0.98T<br>DBC Thickness : 0.3 * 0.38 * 0.3T |

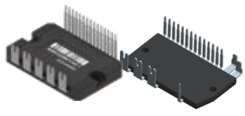
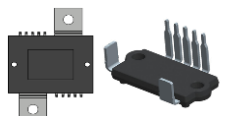
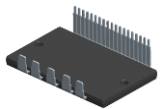
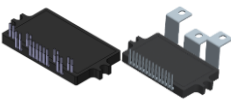
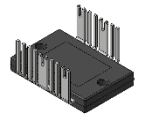

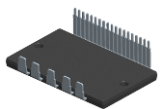
## Specification

| Item                      | SPEC.                         | Remark                  |
|---------------------------|-------------------------------|-------------------------|
| Operation Voltage Range   | 40V                           | Rated Voltage 12V       |
| Drain Current(continuous) | 180A                          | T <sub>c</sub> = 25℃    |
| RDS(on) max               | 0.9mΩ                         | VGS = 10V,<br>ID = 100A |
| Operation Temperature     | -40 ~ 125℃                    |                         |
| Mounting Screw Torque     | 1.3 ~ 1.5N.m                  | M3                      |
| Weight                    | 76g                           |                         |
| Dimensions                | 25 x 13.5 x 5.5 T (W x D x H) |                         |
| Life Cycle                | 10 Years / 160,000km          |                         |

## TEST

| Test                               | SPEC.         | Remark |
|------------------------------------|---------------|--------|
| Environmental tests                | Customer Spec |        |
| EMC/EMI tests                      | Customer Spec |        |
| Function tests                     | Customer Spec |        |
| Lead-free solder reliability tests | Customer Spec |        |
| Durability tests                   | Customer Spec |        |



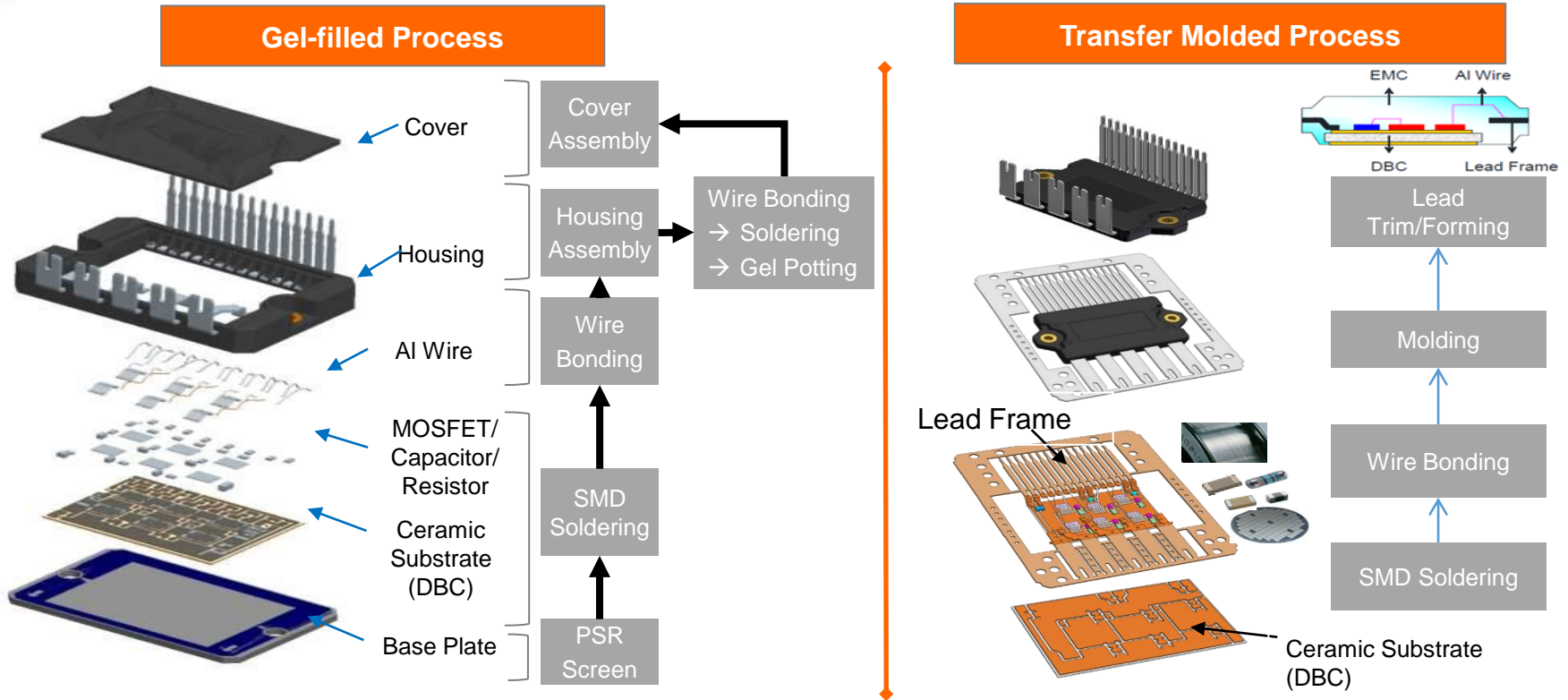
| Application  | EPS                      | Battery Pack          | 48V MH  | DC-DC  | OBC   | Traction Inverter                               | E-Comp. |
|--|--------------------------|-----------------------|---|--|---|---|---------|
|  EPS MOSFET Module                 | GF Package<br>TM Package | 40V 160A<br>40V ~210A |   | 80~100V ~150A  |   | MP<br>Under development                         |         |
|  E-Relay MOSFET Module            |                          |                       | 40V ~200A for 12V<br>80V/100V 140A~900A for 48V |  |   | In plan   |         |
|  MMSG MOSFET Module               |                          |                       |   | 80~100V ~400A  |   |   |         |
|  DC-DC Converter Module           |                          |                       |   | Primary<br>Secondary   | 650V ~70A SJ MOSFET<br>100V ~180A MV MOSFET |   |         |
|  OBC Module                      |                          |                       |   |  | PFC<br>Full Bridge                          | 650V 50A SiC MOSFET<br>650V 50A SiC / SJ MOSFET |         |
|  Dual Side Cooling (DSC) Module |                          |                       |   | 700V 400A IGBT Module<br>1200V 400A IGBT Module                    |   | 2-PACK<br>2-PACK                                |         |
|  E-Comp. Module                 |                          |                       |   | 600V 30A IGBT Module for xEV<br>100V 200A MOSFET Module for 48V MH |   | 6-PACK<br>6-PACK                                |         |

| Application  | Welder/IH<br>                     | UPS<br> | ESS<br> | PV Inverter<br> | Motor drive<br> |
|--|--|---|--|--|--|
|  <p><b>34mm / 62mm<br/>Standard IGBT<br/>Module</b></p> | <p><b>650V 100A~450A 2-PACK</b></p> <p><b>1200V 100A~450A 2-PACK</b></p>   |   |  |  |  |
|  <p><b>EconoDUAL3 EconoPACK3</b></p>                    | <p><b>650V 225A~600A 2-PACK, 6-PACK, Multi Level</b></p> <p><b>1200V 225A~600A 2-PACK, 6-PACK, Multi Level</b></p> |   |  |  |  |
|  <p><b>EasyPIM1 EasyPIM2</b></p>                        | <p><b>650V 10A~50A PIM, Multi Level</b></p> <p><b>1200V 10A ~35A PIM, Multi Level</b></p>                          |   |  |  |  |
|  <p><b>EconoPACK4</b></p>                              | <p><b>650V/1200V 100A~200A 6-PACK</b></p> <p><b>650V/1200V 200A~400A 3-Level</b></p>                               |   |  |  |  |
|  <p><b>Transfer Molded PIM</b></p>                    | <p><b>650V 10A~30A PIM, Multi Level</b></p> <p><b>1200V 10A ~25A PIM, Multi Level</b></p>                          |   |  |  |  |

**MP**

**Under development**

**In plan**



| Gel-filled process           | Item          | Transfer molded process |
|------------------------------|---------------|-------------------------|
| Low                          | 开发费用          | High                    |
| Low                          | 模具费用          | High                    |
| High                         | 量产单价          | Low                     |
| Long                         | 生产时间          | Short                   |
| Easy                         | 定制            | Difficult               |
| Customizing and Small volume | Business type | Standard and Big volume |

## ► Power Module Design Capability

### - Core Technology

- **Aluminum Wire Bonding**
  - wedge bond
  - wire thick.: 6mil~ 20mil
  - ultrasonic-bonding
- **DBC technology**
  - direct bonded copper
  - copper plate on ceramic
  - excellent thermal conductivity
- **Vacuum Soldering**
  - Void free soldering with Vacuum
  - Zero Voids → best thermal conductivity and adhesion

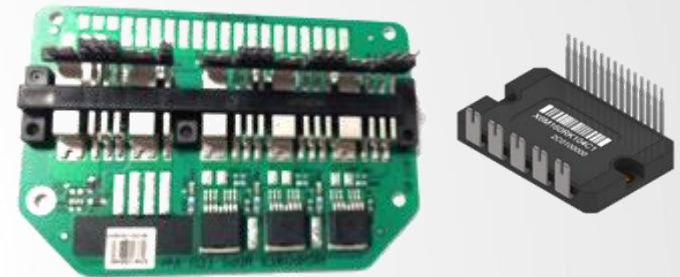


### - Design Process excellence

- ① **Electrical topology selection**
  - 3-Phase or H-Bridge, other
- ② **Power Switch selection**
  - IGBT, MOSFET, or GaN E-HEMT, and Breakdown Voltage & Current capacity
- ③ **Bond Wire design**
  - 6 mil Wire Bond for Gate
  - 8mil ~ 20mil for Source and Drain
- ④ **Package (Module) design**
  - Gel-fill(case) type or Transfer Mold
- ⑤ **Interconnection design**
  - Alum Wire Bonding, U/S welding, Soldering..

### - Performance Advantages

- **Superior thermal conductivity and power density**
  - Highest thermal conductivity via DBC (Direct Bonded Copper) Substrate
  - Highest current density via thick Copper metallization
- **Smallest Footprint Modules**
  - Integrated modules with footprint similar to Discrete layout, but with greater power density
- **System Cost Reduction**
  - Easy design and system manufacturing, compared to PCB-level design
  - Lower total cost (System BOM + Manufacturing) at higher power



Before

After

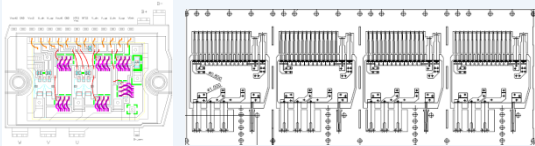
**>37% Footprint Reduction**

## ► Customized Design based on Automotive Product Background, Technical Background

⇒ Total solution available : Design & Analysis based on simulation and correlation through production

### Module Package Design Spec.

- **Electrical**
  1. Schematic Design
  2. Electrical Characteristic consideration(device & module)
- **Mechanical**
  1. 3D POD design based on Mass.
  2. Bonding Diagram Design
  3. Leadframe Design



### <BOM>

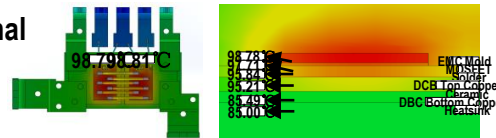
|              | item              | Shape |
|--------------|-------------------|-------|
| Elec.        | DBC               |       |
|              | MOSFET, Sensor IC |       |
| Mech.        | Mold, L/F         |       |
| Sub Material | Solder, Wire, Gel |       |

### Verification based on Simulation

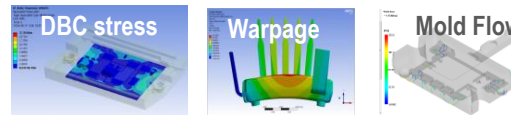
- **Mechanical Spec. Verification**
  1. Thermal Analysis
  2. Structure Analysis : Torque, Warp
  3. Mold Flow Analysis
- **Electrical Spec. Verification**
  1. parasitic effect Analysis
  2. DBC layout, pattern, material Analysis
  3. Wire fusing current, material Analysis

### <Simulation>

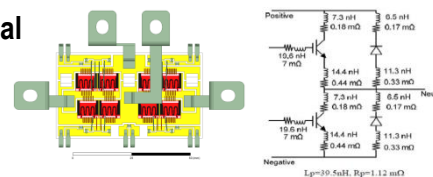
#### •Thermal



#### •Structure / Mold Flow



#### •Electrical



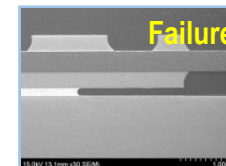
### Validation for Mass.

- **Advanced Quality**
  1. based on APQP
- **Prototype support**
  1. Functional Test
  2. Reliability Test
- **Pilot support**
  1. Functional Test
  2. Reliability Test
- **Customer Support**
  1. Failure Analysis

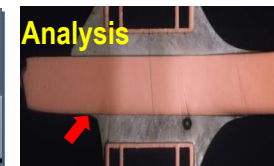
### <APQP & Customer Support>



- Durability Reliability Test (chamber condition)



#### •Module level



#### •Application level

Obtain a reliability verification process that meets the high reliability standards of automotive

#. iA Power Module : 33ea Test Item(included AEC-Q101 Test Item)

Discrete(AEC-Q101) : 27ea Test Item

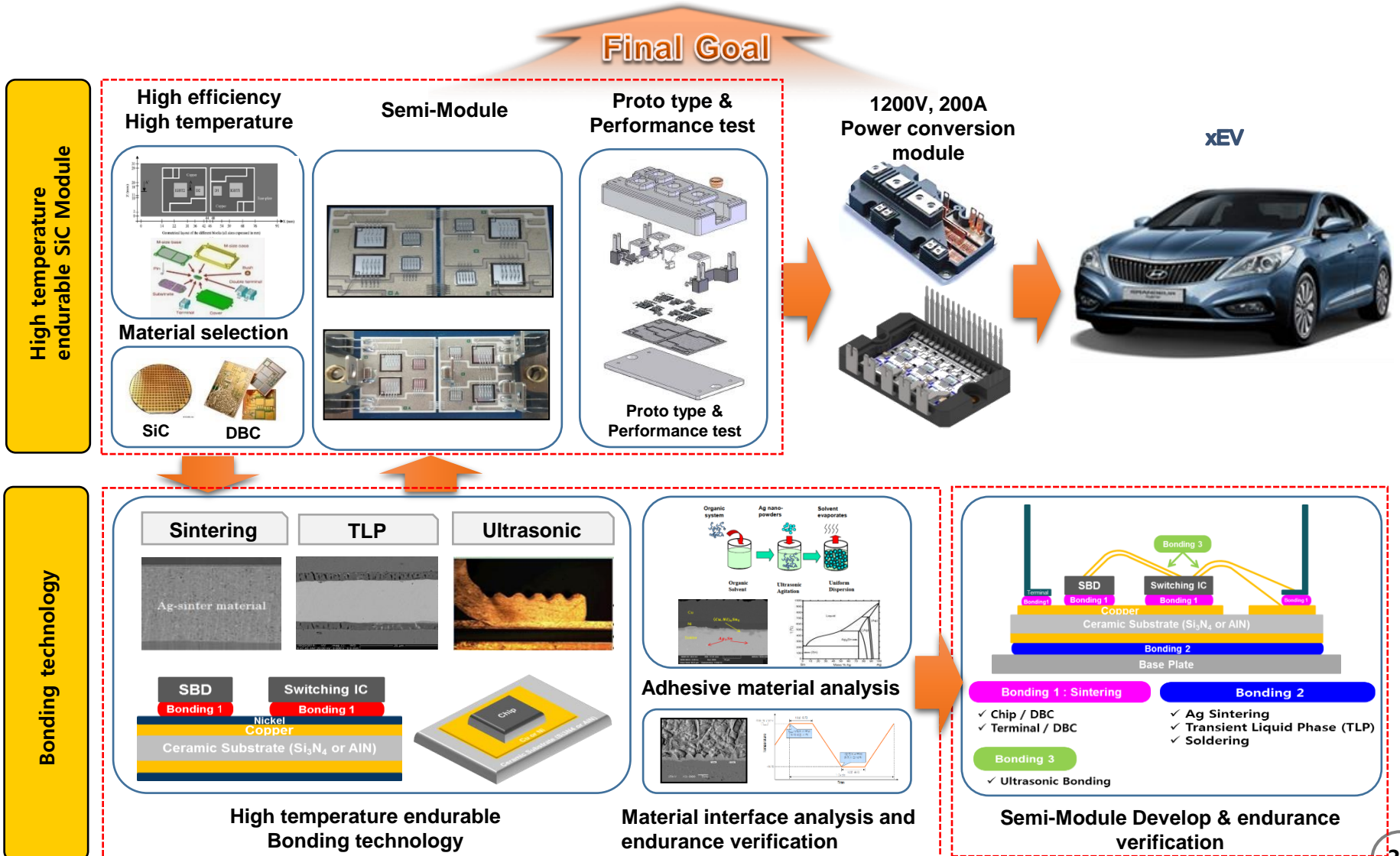
| No. | AEC-Q101                             |        | iA                                     |   |
|-----|--------------------------------------|--------|--|---|
|     | Test Item                            | Remark | Test Item                              | Remark  |
| 1   | Pre-and post- stress Electrical test |        | Basic Performance Test                 | Functional inspection   |
| 2   | Pre- conditioning                    |        | Not applicable                         | Performed on surface mount devices (SMDs)                           |
| 3   | External Visual                      |        | <-                                     |   |
| 4   | Parametric Verification              |        | Tri Temperature Electrical Performance |   |
| 5   | High temp. Reverse bias              |        | <-                                     |   |
| 6   | High Temp. Gate Bias                 |        | <-                                     |   |
| 7   | Temp. Cycle                          |        | Thermal Shock durability test          |   |
| 8   | Autoclave                            |        | Not applicable                         | Replaced by Highly Accelerated Temperature and Humidity Stress Test |
| 9   | High Hum. High Temp. Reverse Bias    |        | <-                                     |   |
| 10  | Intermittent Operational Life        |        | Power Thermal Cycle                    |   |

| No. | AEC-Q101                        |        | iA             |   |
|-----|---------------------------------|--------|----------------|---|
|     | Test Item                       | Remark | Test Item      | Remark                                    |
| 11  | ESD                             |        | <-             |   |
| 12  | D.P.A                           |        | <-             |   |
| 13  | Physical Dimension              |        | <-             |   |
| 14  | Terminal Strength               |        | <-             | Straight pull test                        |
| 15  | Resistance to Solvents          |        | Not applicable | Not required for laser etched Parts       |
| 16  | Constant acceleration           |        | Not applicable | Replaced by vibration and shock test      |
| 17  | Vibration variable Frequency    |        | <-             |   |
| 18  | Mechanical Shock                |        | <-             |   |
| 19  | Hermeticity                     |        | Not applicable | Performed on hermetic package             |
| 20  | Resistance to Soldering heating |        | Not applicable | Performed on surface mount devices (SMDs) |

| No. | AEC-Q101                      |   | iA                                       |   |
|-----|-------------------------------|---|--|---|
|     | Test Item                     | Remark  | Test Item                                | Remark  |
| 21  | Solderability                 |   | <-                                       |   |
| 22  | Thermal Resistance            |   | <-                                       | Evaluation at the product development           |
| 23  | Wire bond Strength            |   | <-                                       |   |
| 24  | bond Shear                    |   | <-                                       |   |
| 25  | Die Shear                     |   | <-                                       |   |
| 26  | Unclamped Inductive Switching |   | Not applicable                           | Power MOS and Internally clamped IGBTs only     |
| 27  | Dielectric integrity          | Performed to evaluate process change Robustness | Not applicable                           | Performed to evaluate process change Robustness |
| 28  |                               |   | Low Temperature Accelerated Stress Test  |   |
| 29  |                               |   | High Temperature Accelerated Stress Test |   |
| 30  |                               |   | Vibration Accelerated Stress Test        |   |

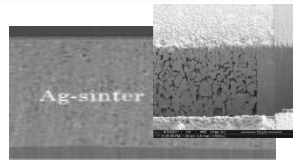
| No. | AEC-Q101  |        | iA  |  |
|-----|-----------|--------|---|--|
|     | Test Item | Remark | Test Item   | Remark                                       |
| 31  |           |        | Thermal and Vibration Compounded Stress Test            |  |
| 32  |           |        | Highly Thermal Shock Stress Test                        |  |
| 33  |           |        | Highly Accelerated Temperature and Humidity Stress Test |  |
| 34  |           |        | Condensation test                                       |  |
| 35  |           |        | Dust test   |  |
| 36  |           |        | Fluid resistant test                                    |  |
| 37  |           |        | Water resistant test                                    |  |
| 38  |           |        | Salt Atmosphere test                                    |  |
| 39  |           |        | Solder Joint inspection                                 |  |
| 40  |           |        | Delamination inspection                                 |  |
| 41  |           |        | Full load durability test                               | EPS application only (EPS power ON/OFF test) |

## “Development of SiC Power Module bonding technology over 300°C junction temperature”



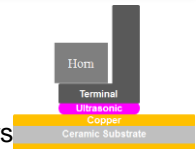
## Ag Sintering

- Ag Paste Composition / blending
- Bonding technology based on low temperature profile & pressure-less sintering
- Optimal bonding process



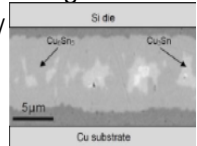
## Ultrasonic

- Terminal/DBC Ultrasonic welding
- Optimized ultrasonic horn design
- Material interface & thermal aging analysis



## TLP

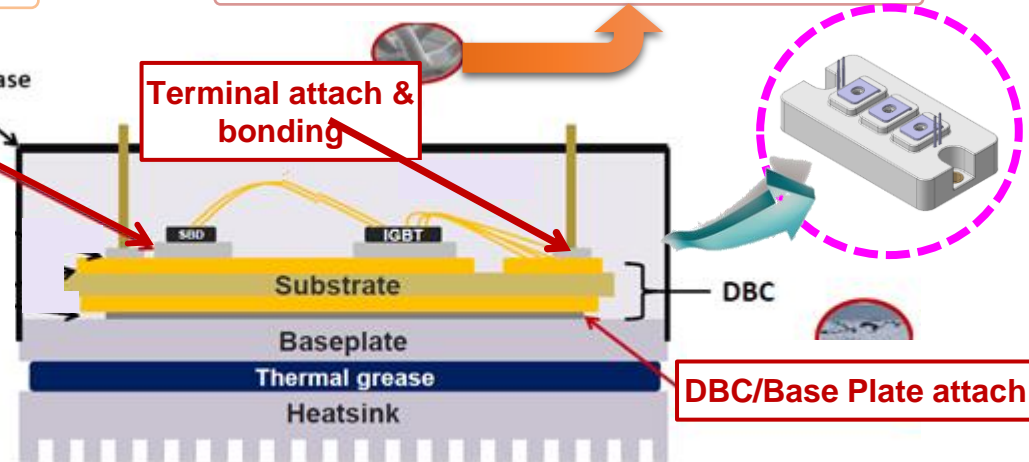
- develop optimized material for TLP bonding
- Analysis of TLP bonding mechanism/ evaluation of bonding process
- Optimization of bonding process and verification of Reliability



Chip attach

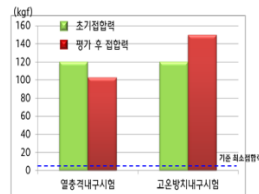
Terminal attach & bonding

DBC/Base Plate attach



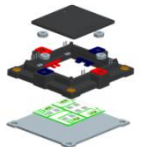
## Proto type Evaluation

- Development of operating environment and requirements
- Bonding performance/endurance evaluation and feedback
- Trial module performance/ endurance evaluation
- Analysis of junction/ module performance impact



## Proto type production

- SiC 1200V, 200A Module for EV
- Develop & optimize module manufacturing process
- Proto type manufacturing



# 开发SJ MOSFET 4-pack 功率模块



## High temperature/reliability SJ MOSFET 4-Pack for Industry application

Final goal

Package development

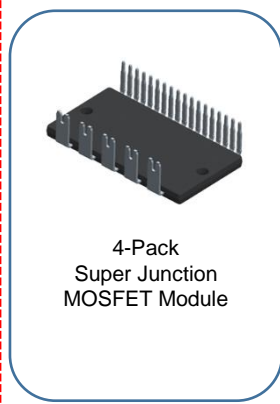
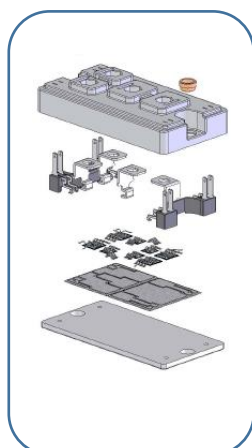
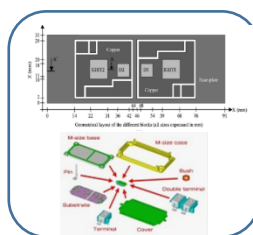
Module design

Sample making & Process evaluation

Manufacturing Proto

Energy Storage System

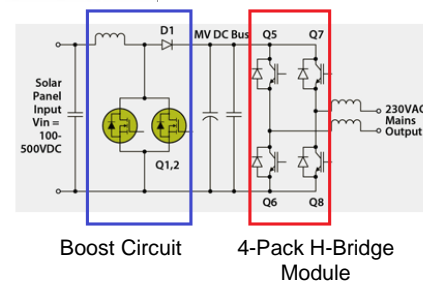
PV System



Material Selection



4-Pack Super Junction MOSFET Module

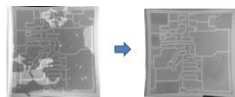
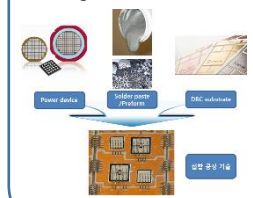


Boost Circuit

4-Pack H-Bridge Module

Pb Free vacuum soldering

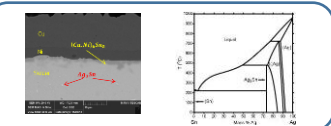
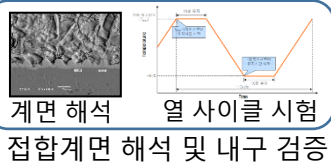
Sintering material DCB



Process development for void free

Optimal condition

Sintering material / Pb free soldering technology



Main developed technology

1. 4-Pack Super Junction MOSFET Module
  - Optimize MOSFET selection & high efficiency design
  - High temperature/reliability package material & structure
  - Package structural design with low leakage inductance
2. Pb Free Vacuum soldering technology
  - Method for minimum Void
  - Material junction reliability evaluation technology
3. Evaluation of module performance and reliability
  - IEC60068/60047 or JEDEC standard

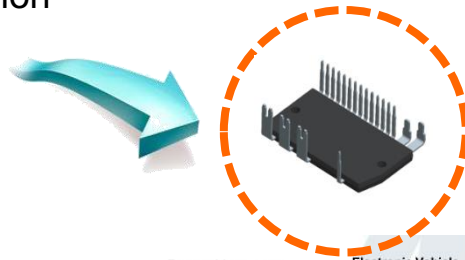
# 开发SJ MOSFET 4-pack 功率模块



## ▪ High temperature/reliability SJ MOSFET 4-Pack for Industry application

- 1<sup>st</sup> year : Super Junction MOSFET 4-Pack H-Bridge Power Module design
- 2<sup>nd</sup> year : Super Junction MOSFET 4-Pack H-Bridge Power Module Proto sample

✓ Design, prototyping and evaluation of 4-Pack H-Bridge power conversion module using Super Junction MOSFET



✓ Analysis and design of package structure to reduce parasitic resistance component and parasitic inductive component

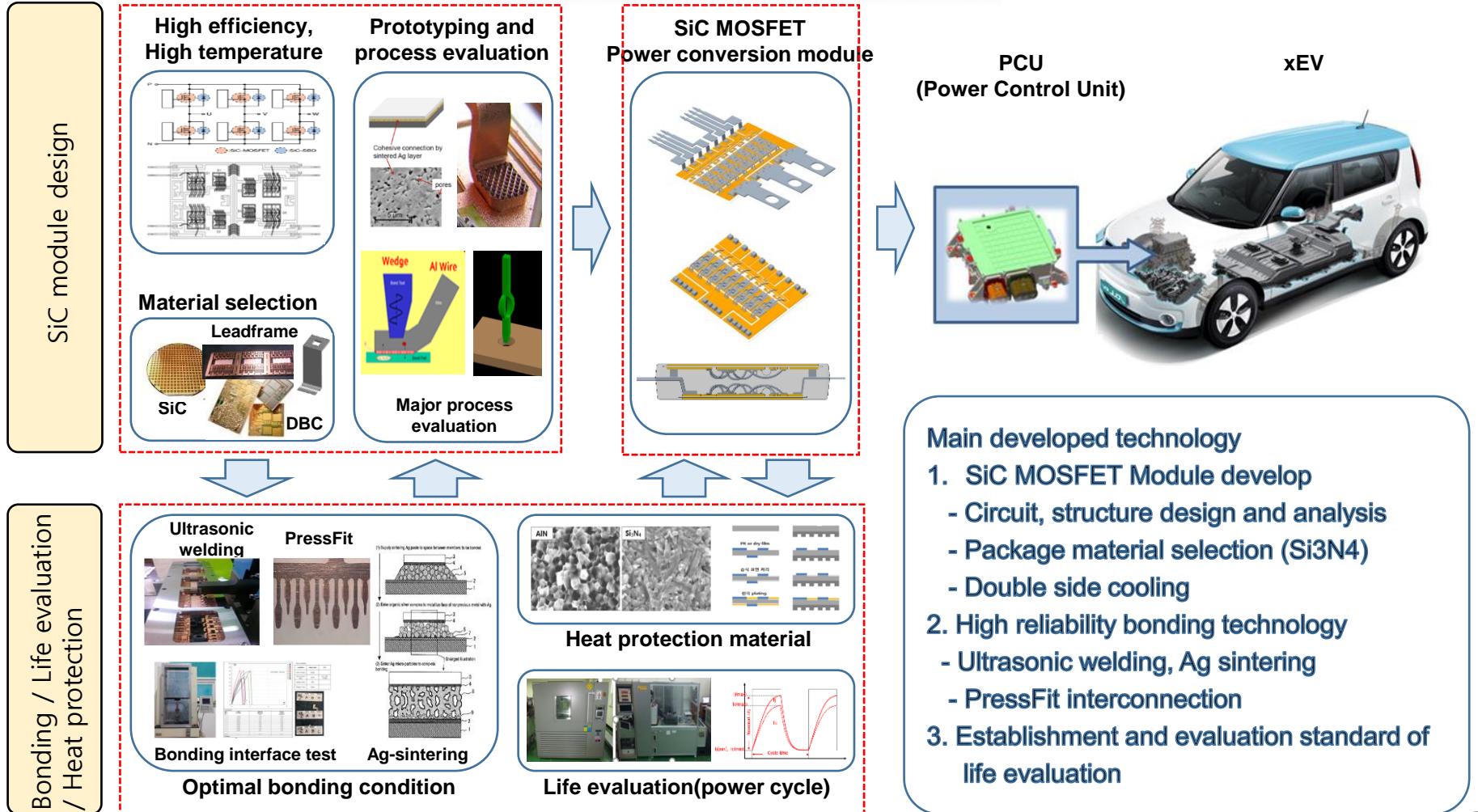
- ✓ Development of optimal lead-free solder vacuum soldering technology
- ✓ Evaluation of high temperature / high reliability package characteristics





## “1200V SiC MOSFET for EV Traction drive

Final Goal



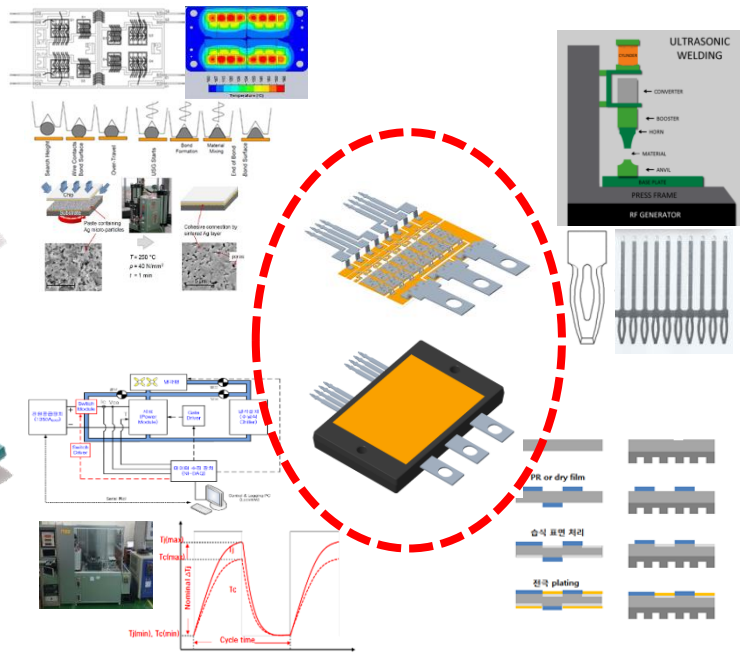
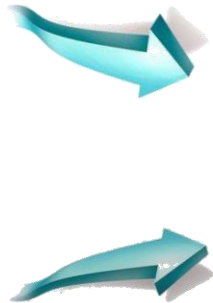
# 开发驱动电机 1200V SiC MOSFET 模块



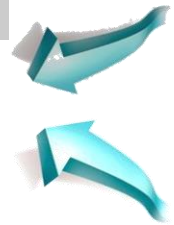
## EV Traction Motor Drive 1200V SiC MOSFET Module

- 1<sup>st</sup> year : 1200V 600A SiC MOSFET module design, PressFit/Junction technology develop
- 2<sup>nd</sup> year : SiC Power module proto type, evaluation of bonding process, heat dissipation material and of durability test
- 3<sup>rd</sup> year : 1200V/600A SiC Module develop, optimize bonding, set up evaluation of durability

- ✓ SiC power module design, analysis verification, prototype production and process evaluation, characterization
- ✓ 1200V 600A SiC Module (Double side cooling type)



- ✓ Development of ultrasonic welding heterogeneous bonding technology (tool making, condition setting)
- ✓ PressFit terminal design and stamping tool production



- ✓ Set up, evaluation and analysis SiC power module test evaluation environment
- ✓ Set up of life evaluation system

- ✓ Evaluation of characteristics of AlN / SiNx heat-radiating material
- ✓ Pin-Fin cooling plate design and substrate technology development



# 谢谢!

