AC PROPULSION INC

BEIJING EMOTOR ADVANCE

GLOBAL LEADER OF EV TECHNOLOGY

AC Propulsion Inc., San Dimas, CA

Founded in 1992, specializing in EV motor drive technology.

Beijing eMotor Advance, Beijing, China

Located at Yizhuang Economic Technical Development Zone. The 300,000 sq. ft. complex includes R&D, Manufacturing, Sales and Customer Services Center.

Shanghai Office, Shanghai, China

Located in Shanghai Hongqiao Business District. It is responsible for the sales and technical services of power modules and electronic motor control products.

A HISTORY OF PIONEERING EV TECHNOLOGY

- AC Propulsion developed the tZero™ sports car in 1996. 0-60 mph in 4.6 seconds with lead-acid batteries; upgraded with Li-Ion cells in 2003, 1st vehicle to use 18650 cells.
- In 2004, AC Propulsion tZero™ patented technology was licensed to TESLA.
- In 2008, AC Propulsion and BMW Group jointly developed the MINI-E to provide BMW with motor, electric control and battery complete electric drive system products. 620 MINI-E were demonstrated for 3 years in 12 cities in 6 countries around the world.
- Beginning 2012, 350 FOTON Midi BEV taxis with eMotor supplied drivetrain and batteries started trial operation in Beijing Huairou and Changpin District. The accumulated mileage has exceeded 300,000 kilometers per vehicle – this was the very first EV Trial Operation in China.

PASSENGER CAR / LDV APPLICATIONS

BMW MINI

Foton MIDI

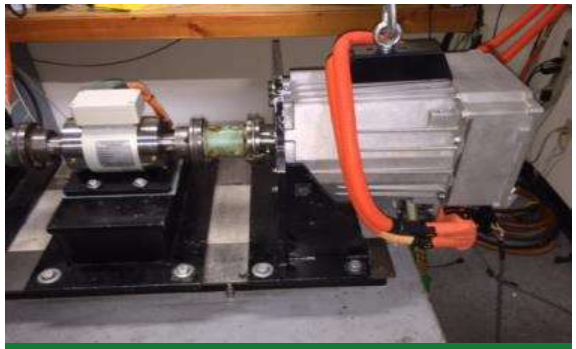
Yulon Luxgen 7

COMMERCIAL VEHICLE APPLICATIONS

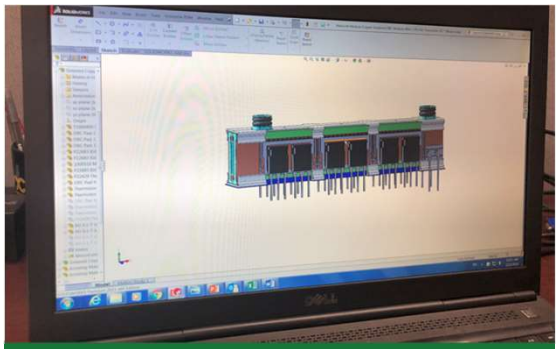
Medium Duty Truck

Heavy Duty Truck

ACP DEVELOPMENT CENTER SAN DIMAS



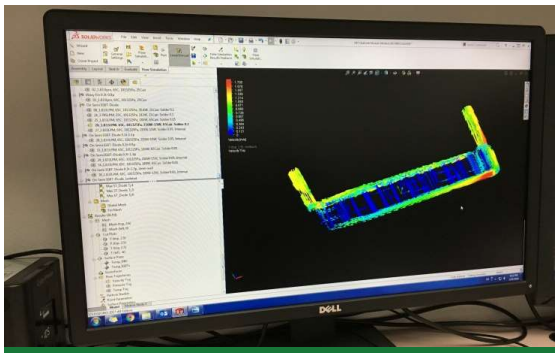
Dynamometer



Mechanical Design

Environmental Test Facilities

Design and Build Power Electronics Test Equipment



Thermal simulation analysis

Performance Testing

EMOTOR FACILITIES BEIJING

eMotor R&D and Manufacturing Facility

R&D Office Building

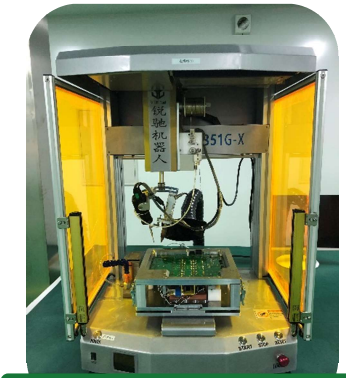
Manufacturing Facility

MANUFACTURING EQUIPMENT

Laser marking machine

PINK Vacuum welding machine

Screen printing machine



Welding Robot

Three anti-coating production line

Stress tester

eMotor SHANGHAI CENTEr

Automatic welding production line

Automatic assembly line

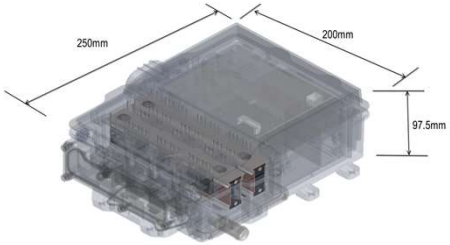
Automatic test line

Electronic laboratory

POWER MODULE OVERVIEW

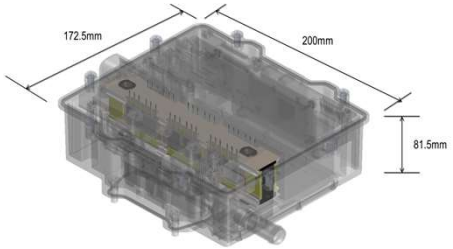
SiC carbide power module

Suitable for electric vehicles
Silicon carbide controller use



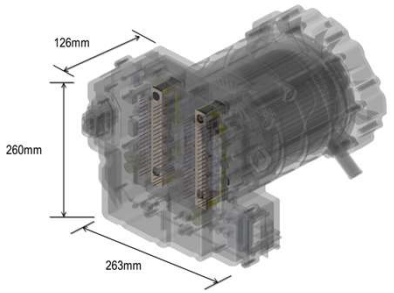
IGBT Power Module

Suitable for electric vehicles
controller use



48V MOSFET Module

Suitable for hybrid
Motor controller use

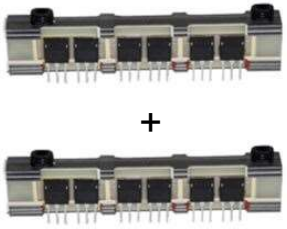
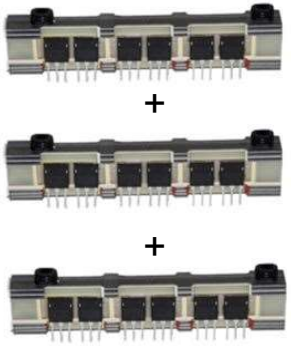


ACP INVERTER MODULE CERTIFICATION

According to the AQG324 standard, it is certified and recommended by well-known American chip companies.

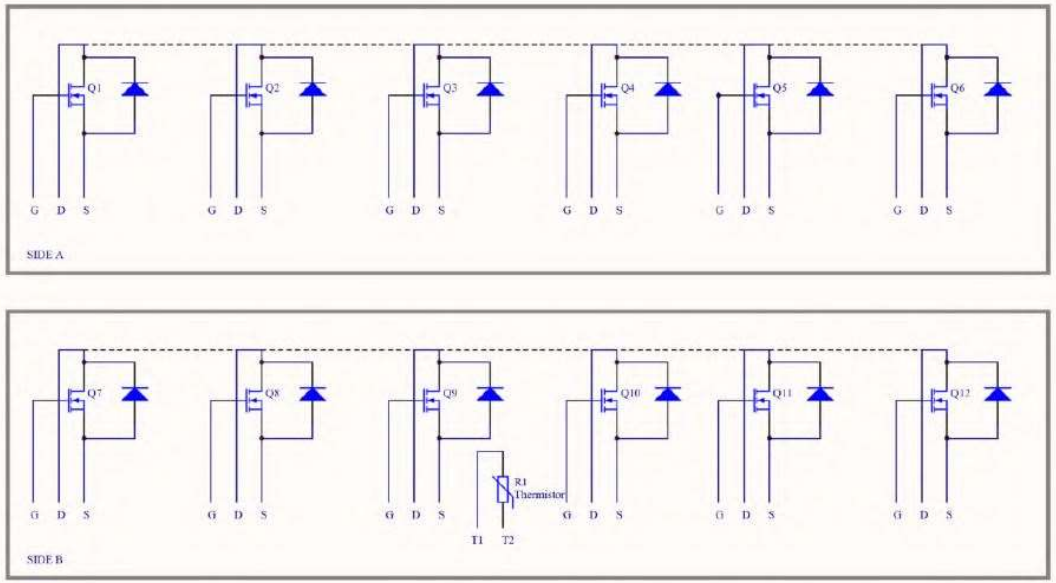
Stress Test					Completion Date	Results (Reject/Total)		Remark
Rel item		Standard	Stress Condition	Duration				
HTRB	High Temperature Reverse Bias	AQG324	TJ 175C, 520V, 80% rated bias	1008hours	9/28, 2018	0/72 discrete (6 ACP module *12discrete)	PASS	
HTGB(-)	High Temperature Gate Bias	AQG324	TJ 175C, -16V, 80% rated bias	1008hours	9/27,2018	0/36 discrete	PASS	FGY160T65SPD_F085 qual results can cover HTGB positive bias test
H3TRB	High Temperature High Humidity High Reverse Bias	AQG324	85C/85% RH, 80V	1008hours	9/08,2018	0/6 modules	PASS	
HTSL	High Temperature Storage Life	AQG324	Ta 125C, no bias	1008hours	9/08,2018	0/6 modules	PASS	
LTSL	Low Temperature Storage Life	AQG324	Ta -40C, no bias	1008hours	9/08, 2018	0/6 modules	PASS	
TS	Thermal Shock	AQG324	-40 to 125C, 1000cyc, no bias	1K cycles	9/15, 2018	0/6 modules	PASS	
				CSAM	9/18, 2018	0/6 modules	PASS	
				Rthjf drift	10/22, 2018	0/5 modules	PASS	
PC	Power Cycle	AQG324	delta TJ 100C, Ton 16sec Stress I > 85% of nominal current	TTF	10/31, 2018	1st12318cyc 2nd15228cyc 3rd18816cyc	PASS	Tested PC(min) of AQG324
MT	Mechanical test	AQG324		N/A	8/02	0/6 modules	PASS	
PKG shear				N/A	8/02	0/6 modules	PASS	

ACP SiC INVERTER MODULE STACK RATINGS

Model P/N	Configuration	Chips/ Phase	Chips/ Module	Symbol Picture	Imax @ 1200V
AIPM 12-20-6C	“Single” 1 Module per 3-Phase Inverter	4x	12		282A
AIPM 12-20-6C	“Double” 2 Modules per 3-Phase Inverter	8x	2x12		564A
AIPM 12-20-6C	“Triple” 3 Modules per 3-Phase Inverter	12x	3x12		864A

ACP SiC MODULE SCHEMATIC 900V & 1200V

Internal electrical connection of 6 discretes in parallel is shown in figure below.



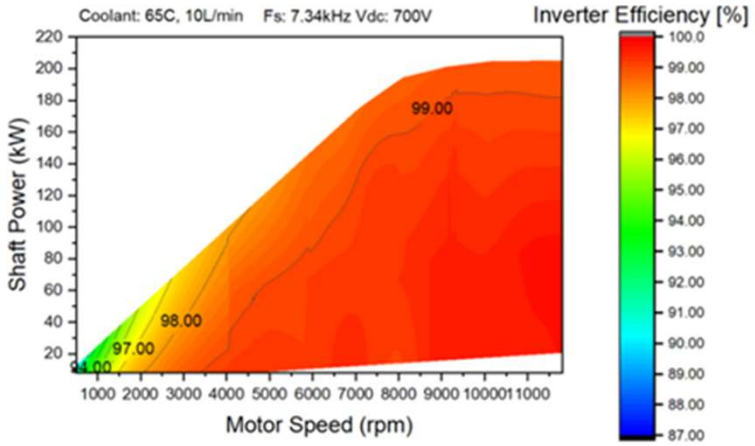
NOTES

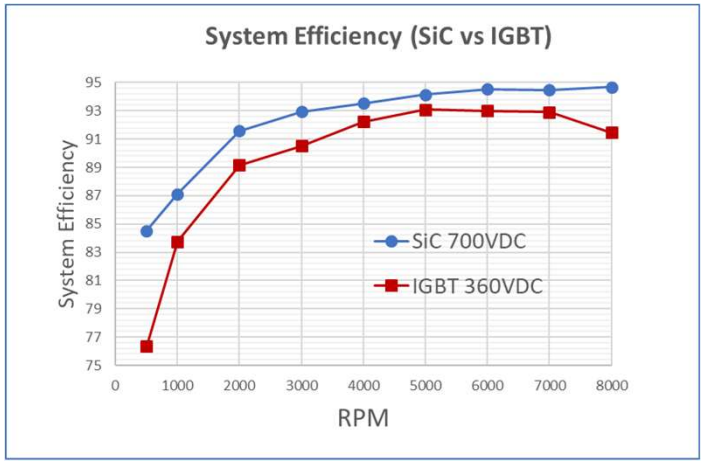
1.DRAIN CONNECTIONS SHOWN BY DASHED LINES ARE OPTIONAL.

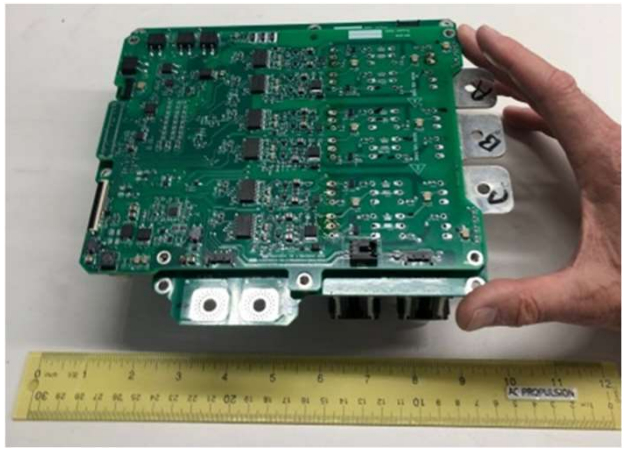
2.NUMBER AND LOCATION OF THERMISTOR(S) IS OPTIONAL.

3.DEFAULT IS ONE THERMISTOR CENTRALLY LOCATED WITH FLYING LEAD CONNECTIONS.

SiC INVERTER PERFORMANCE & FORM FACTOR







ACP SiC INVERTER MODULE ADVANTAGES AT A GLANCE

Cost Advantage

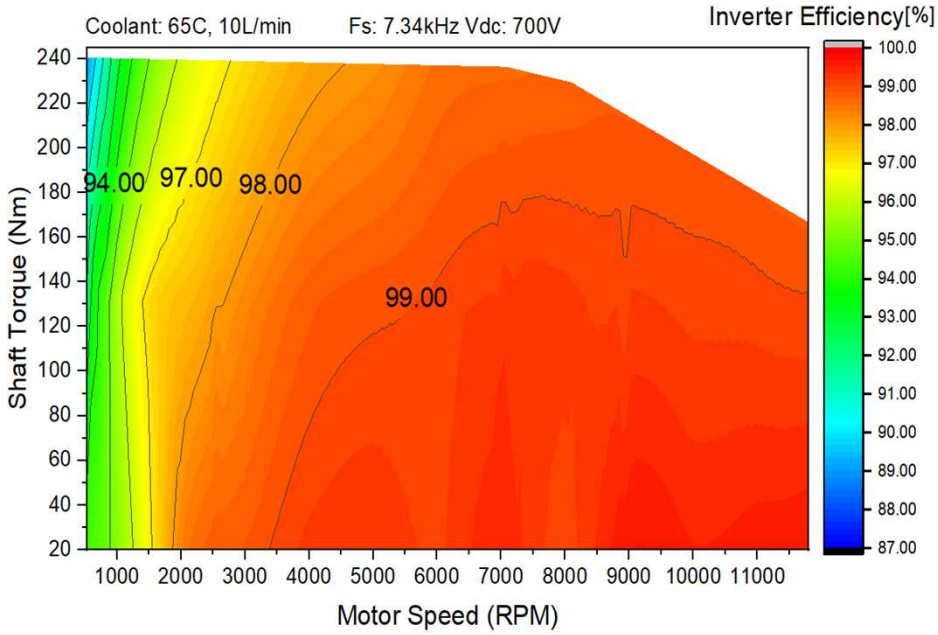
Efficiency Advantage
Peak efficiency 99%

Patented Module Cooling Structure
Low thermal resistance - 30% wafer area reduction

Flexible Power & Voltage Range
Power range: 30kW - 300kW
Voltage range： 300V - 1200V

Low Stray Inductance
23% of conventional module stray inductance

Reputable OEM Chip Suppliers



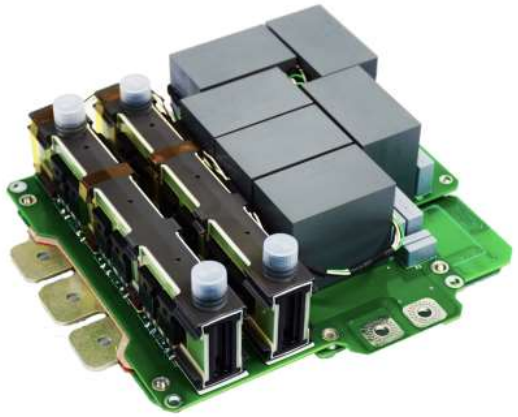
Inverter Configurations

AC PROPULSION eMotor

1 x Module

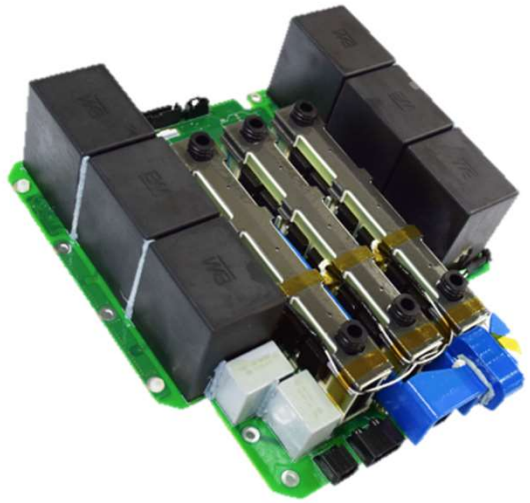
106kVA IGBT, 360VDC
132kVA SiC, 540VDC
171kVA SiC, 700VDC
1.27kg, 180x150x55mm^3

2 x Modules



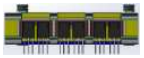
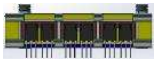
212kVA IGBT, 360VDC
265kVA SiC, 540VDC
343kVA SiC, 700VDC
2.2kg, 229x191x71mm^3

3 x Modules



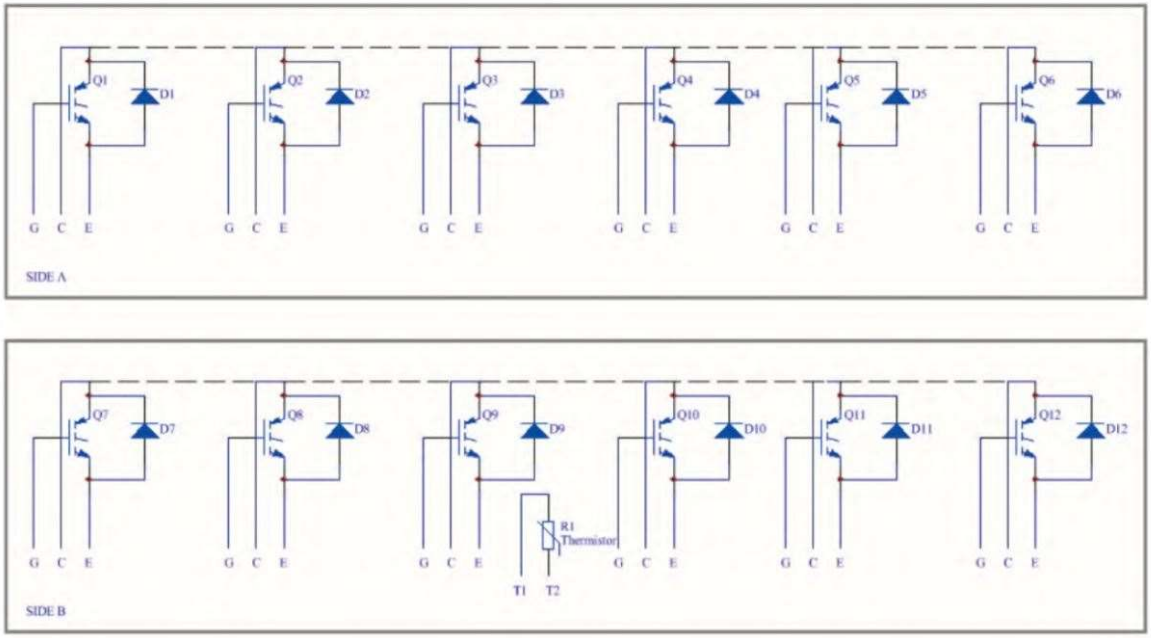
318kVA IGBT, 360VDC
397kVA SiC, 540VDC
514kVA SiC, 700VDC
3.1kg, 250x244x85mm^3

ACP IGBT INVERTER MODULES

Product Configuration	Current Density	Applicable Power Segment	Maximum Current
 X1	1500 A/L (185 A/0.12L)	30kW-40kW	185A
 X1	1900 A/L (370 A/0.19L)	60kW-80kW	370A
 X3	1500 A/L (550 A/0.36L	80kW-100kW	555A
 X3	1600 A/L (740 A/0.45L)	100kW-130kW	740A
 X3	1600 A/L (925 A/0.57L)	130kW-160kW	925A
 X3	1900 A/L (1100A 0.57L)	160kW and higher	1100A

ACP IGBT MODULE ELECTRIC SCHEMATIC

Internal electrical connection of 6 discretes in parallel is shown in figure below.



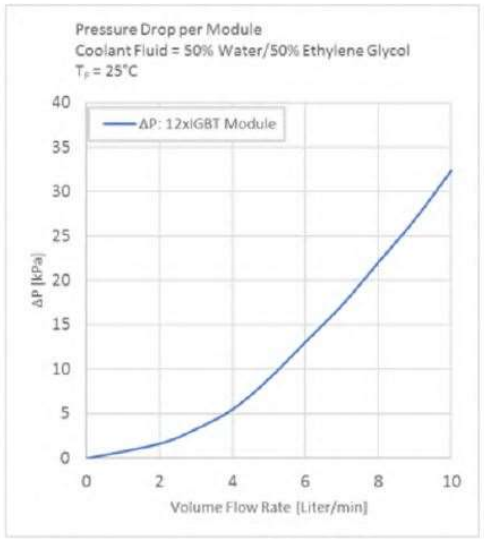
NOTES

1.COLLECTOR CONNECTIONS SHOWN BY DASHED LINES ARE OPTIONAL.

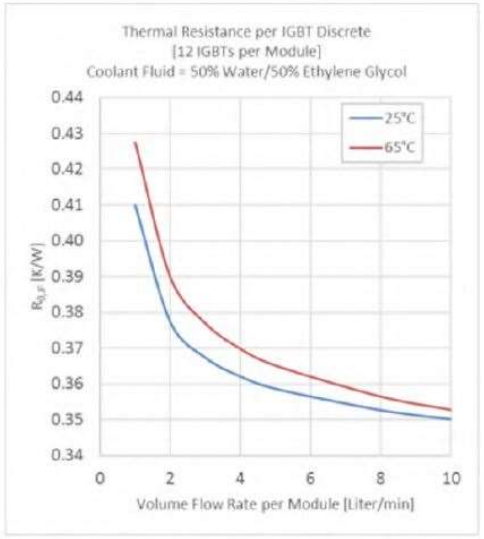
2.NUMBER AND LOCATION OF THERMISTOR(S) IS OPTIONAL.

3.DEFAULT IS ONE THERMISTOR CENTRALLY LOCATED WITH FLYING LEAD CONNECTIONS.

ACP IGBT MODULE COOLING



Pressure Drop 12XIGBT Power

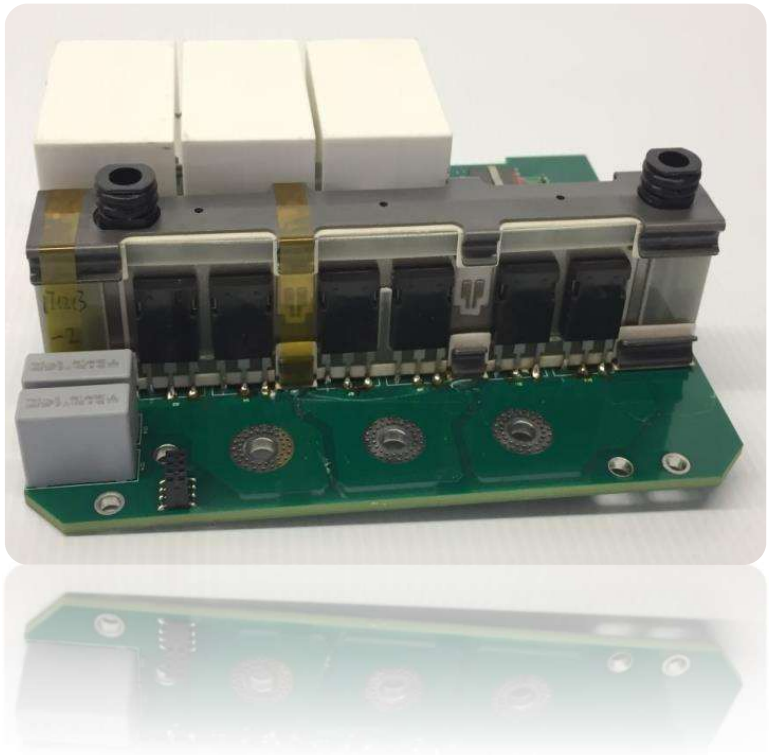


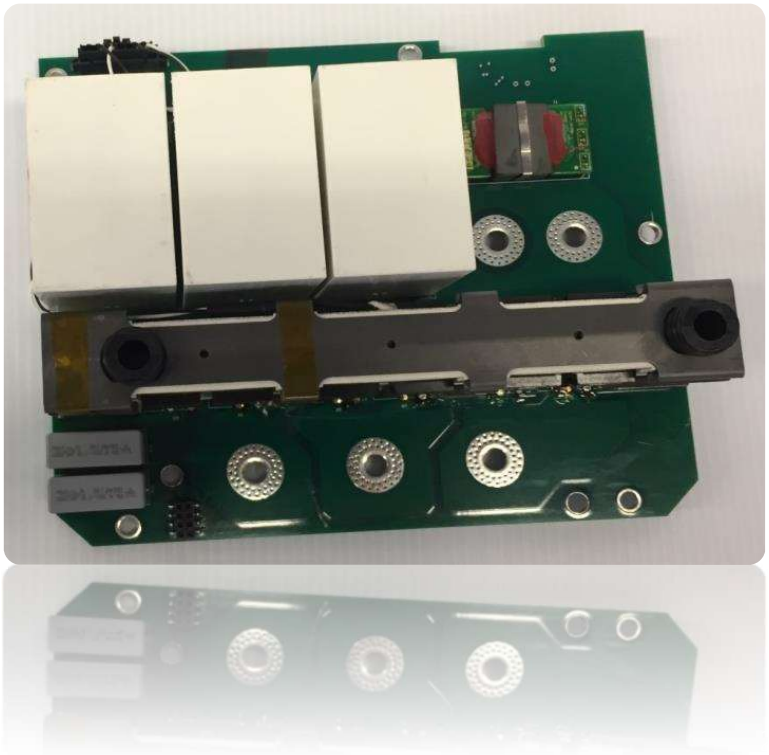
Junction to Coolant Flowrate

Parameter	Value
Coolant Type	50/50 Ethylene glycol / Water mix
Minimum module flow rate for max rated current	3.8 liters per minute (1.0gpm)
Typical pressure drop at rated flow	9kPa (1.3psi)
Absolute Maximum coolant pressure	250kpa (36.3psi)
Maximum inlet temperature for peak current	65˚C
Maximum inlet service temperature	75˚C
Operational ambient temperature range	-40 ˚C to +85 ˚C
Storage ambient temperature range	-40 ˚C to +125 ˚C
In-line coolant filter	50 to 150 micron recommended

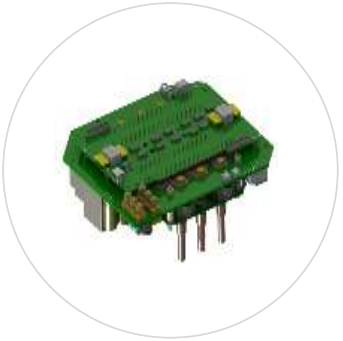
APPLICATION MOTOR CONTROLLER

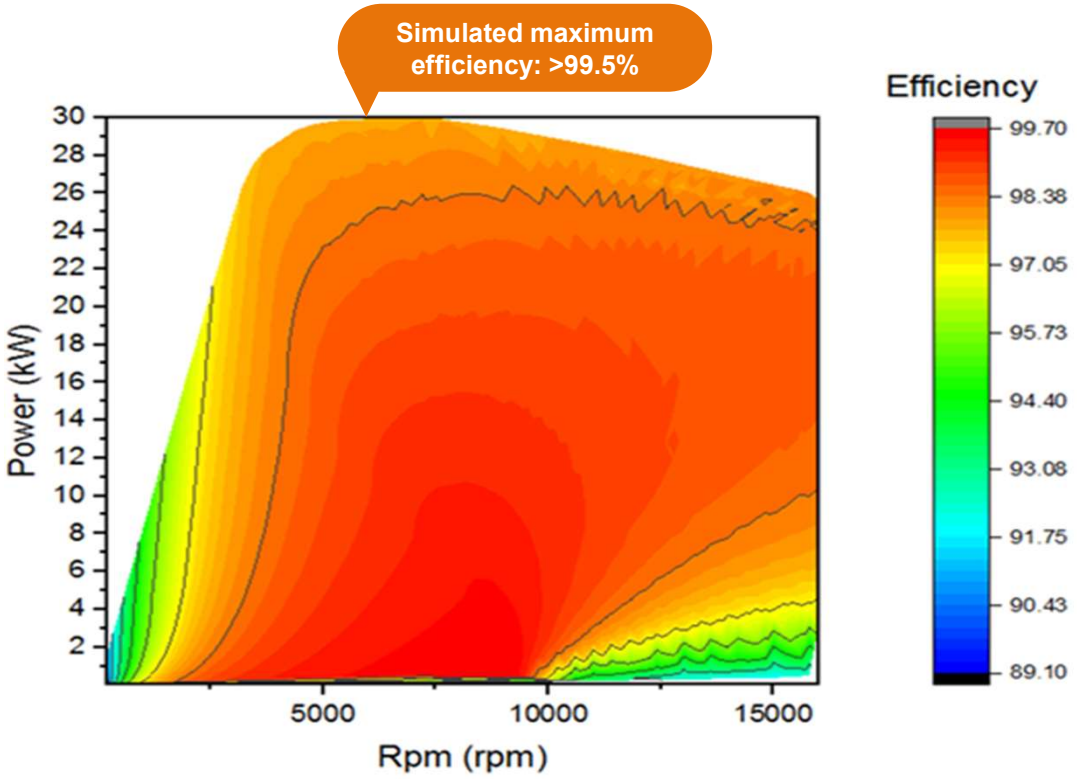
62kW-80kW Motor Controller Adopting our 370A IGBT module. Controller power density can reach up to 50kW/L (without housing).





APPLICATION 48V HYBRID MOTOR CONTROLLER





P4-25, 48V 25kW Drive Unit using ACP MOSFET module