

Market Research on Power Control Unit for EV -Heat Dissipating and Cooling Technology-

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* The above prices limit the data use range to the same corporation

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1. Forecast of market size and changes of the heat dissipation and cooling types of PCU (2017 to 2030)
2. List of the numbers of motors and others, and heat dissipation and cooling technologies of major EV manufacturers and major EV models
3. Supply chain relationship for each major EV
(IGBT module - Cooler - Inverter - Entire PCU)
4. Technology trends
 - Electro-mechanical integration and Electric drive system
 - SiC semiconductor introduction
 - Integration and simplification of cooling system
5. Case study of major EV manufacturers and major electric parts manufacturers (11 companies)
 - EV manufacturers: Toyota, Honda, Nissan, Hyundai, BYD, BAIC, Chery, SAIC, Tesla
 - Electric parts manufacturers: Denso, Hitachi Automotive Systems

Subject and classification of survey

Subject of survey and Companies surveyed

Subject of survey		Companies surveyed
Power control unit (PCU)		<p><EV manufacturers> Toyota Motor, Nissan Motor, Honda Motor, BYD, BAIC BJEV, Geely, SAIC, Tesla, GM, BMW and others.</p> <p>< Electric parts manufacturers > Aisin Group, Calsonic Kansei, Keihin, Denso, Toshiba, Toyota Industries, Hitachi Automotive Systems, Meidensha, Yaskawa Electric, Continental Automotive, Delphi Technologies, Delta Electronics, DANA, GKN Group, Hyundai Mobis, Jing-Jin Electronic Techonologies, Magna International, Mahle Behr, Robert Bosch, Schaeffler, Semikron International, Shanghai Dajun Technologies, Shanghai Edrive, Simens, Valeo, ZF and others.</p>
Related device	Inverter/ Cooling unit	TDK(TDK Automotive Technologies), Mitsubishi Heavy Industries, Mitsubishi Electric, LG Electronics, Ningbo Lu Run Cooler Manufacturing, Shenzhen Inovance Technology and others. (except with above PCU manufacturers)
	DC-DC converter	Calsonic Kansei, Keihin, Shindengen, TDK, Denso, Toyota Industries, Nichicon, Panasonic, Hitachi Automotive Systems, Mitsubishi Motors, BYD, Continental Automotive, Delphi Technologies, Delta Electronics, Dias Automotive Electronic Systems, Dongah, Hangzhou EV-tech, Hella, Hyundai Mobis, LG Electronics, Magna International, Mahle Behr, Nanjing ZG Power Supply, Robert Bosch, Shenzhen Shinry Technologies, Tesla, United Automotive Electronic Systems, Valeo and others.

Classification of cooling technologies of PCU as surveyed objects

- 1)by the cooling structure : Single sided type, Double sided type
- 2)by coolant : Air cooling, Water cooling
- 3)by connection and insulation type : Direct type, Indirect type
 - Direct type : The insulation substrate (or insulation material), on which the power semiconductor is mounted, provides adhesion or connection function.
 - Indirect type : The insulation substrate (or insulation material), on which the power semiconductor is mounted, provides no adhesion or connection function and the connection is made through material such as TIM.

Summary of the PCU market trends

by types of the heat dissipation and cooling

- 1) Trends of major methods of heat dissipation and cooling of PCU...A
- 2) Adoption trends of heat dissipation and cooling technology of PCU by types of electric vehicles...B
- 3) Trends in heat dissipation and cooling technologies of major EV and PCU manufacturers...C

I. PCU technology and market trends

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 - 2) Classification of heat dissipation and cooling technologies of power modules which constitutes inverters, with types and summaries
 - 3) Heat dissipation and cooling methods of DC-DC converters and their overviews
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 - 3) Electric drive system
 - 4) Technology of SiC semiconductor introduction
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 - 1)Entire EV(HEV/PHEV/EV), 2)For HEV, 3)For PHEV, 4)For EV

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Aisin Group / Calsonic Kansei / Keihin / Denso / Toshiba / Toyota Industries / Nidec Group / Panasonic / Hitachi Automotive Systems / Meidensha / BorgWarner / Continental Automotive / Delphi Technologies / DANA / Magna International / Robert Bosch / Valeo/Siemens / ZF

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V. Case studies of the manufacturers (EV manufacturers and electric parts manufacturers)

Toyota Motor Corporation...125 / Honda Motor Co., Ltd. ...149
Nissan Motor Co., Ltd. ...171 / Hyundai Motor Group...186
BYD Company Ltd....196 / BAIC Group...207
Chery Automobile Co., Ltd....216 / SAIC Motor Corporation Limited...225
Tesla, Inc. ...234 / Denso Corporation...241
Hitachi Automotive Systems, Ltd....246

Report Sample (from I , II and III)

5. List of companies having entered the market of PCU and related devices

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1) Japanese manufacturers

Manufacturers	PCU				Related Devices			
	Inverter	Cooler	DC-DC Converter	Power Module	Motor	Reducer		
Aisin Group	R&D	R&D	R&D					
Calsonic Kansei								
Keihin								
Shindengen								
Diamond Electric								
TDK								

10. Market size (2017) of the heat dissipation and cooling types of PCU by car manufacturers and motors

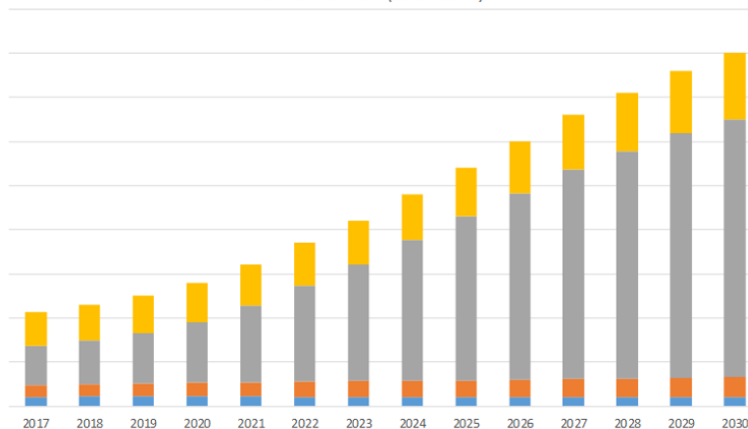
1) Entire EV (HEV/PHEV/EV)

Motor	1 motor					2 motors or more					Entire (1 motor + 2 motors or more)					Total				
	Coolant Structure	Air		Water		Air	Water		Air	Water		Air	Water							
		Indirect	Direct	Indirect	Direct		sub-total	Indirect		Direct	Indirect		Direct	sub-total	Indirect		Direct	Indirect	Direct	
Connection & Insulation type																				
BYD																				
BAIC																				
BMW																				

11. Forecast of market size and changes of the heat dissipation and cooling types of PCU (2017 to 2030)

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Forecast of market size and changes of the heat dissipation & cooling types of PCU for HEV (2017-2030)



*Volume base (Unit: 000 units) * Abbreviations SS: Single sided, DS: Double sided

12. Supply chain relationship

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Automobile Manufacturers	Car Name	EV type	Power Control Unit (PCU)				Related Devices	
			Entire PCU	Inverter	Cooler	DC-DC converter (Internal PCU)	IGBT Module for Inverter	DC-DC converter (external PCU)
Toyota Motor	Aqua	HEV	Toyota Motor/Toyota Industries	Toyota Motor/Toyota Industries	Toyota Industries	Toyota Industries	Toyota Industries	Toyota Motor/Denso
	Prius	HEV						
	Prius (4WD) *Rear Inverter	HEV						
	Estima Hybrid	HEV						
	LEXUS GS450h, RX450h	HEV						
	Prius PHV	PHEV						
	MIRAI	FCV						
	Fit Hybrid	HEV						
	Accord Hybrid	HEV						

P50

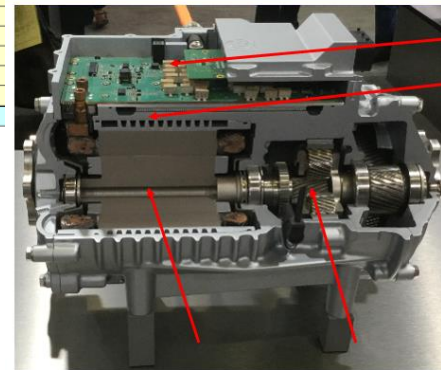
II. List of the numbers of motors and others, and heat dissipation and cooling technologies of major EV manufacturers and major EV models

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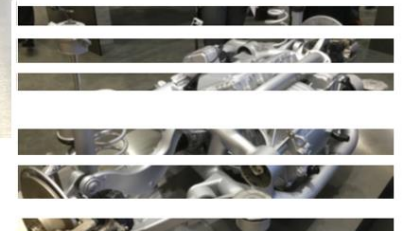
EV manufacturer	Name of the model	EV type	Number of Booster Motor/Generator in PCU		Power module structure for PCU		Heat dissipating & Cooling type			Connection & insulation type		Insulation material	Integration of other cooling system
			Transfer molding	case	Single sided	Double sided	Indirect	Direct					
			Air cooling	Water cooling	Air cooling	Water cooling	Indirect	Direct					
Toyota Motor	Aqua	HEV		A		A			AIN substrate	DC-DC converter	
	Prius												
	Prius (4WD type) *Rear inverter		*booster circuit in PCU Exist: Y, Not exist: N, *Symbol A: Adoption										

ZF <High-integrated Electric Central Drive>

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*The photo below shows
*A +++ kW type product.



*Shown above is
*The output
*The PCU
*The inverter and the motors adopt
*The inverter

About the report and how to order

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