

Automotive Power Electronics Technology

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ABSTRACT: Hitachi Astemo has design technology of high performance and compact size inverter with Generation-4(GEN4) power module which is Hitachi Astemo product of double-cooling power module (PM). Then, Hitachi Astemo has developed new high power, compact size dual inverter for hybrid vehicle (PHEV, HV, REEV) which applying Dedicated Hybrid Transmission (DHT) system.

KEY WORDS: EV and HV system, dual inverter, power module, Dedicated Hybrid Transmission,

1. INTRODUCTION

Hitachi Astemo's inverter has adopted by Geely Automobile Holdings Limited for the DHT global hybrid powertrain platform in December 2021. And the inverter has mounted high voltage DHT with two motors.

Hitachi Astemo's inverter is equipped with Hitachi's unique direct water-cooled and double-sided cooling power module, which achieves a compact size and high output.

2. Development high performance and compact inverter

2.1. Production summary and specification

Fig.1 and Table.1 shows the inverter component parts and main specification. The dual inverter has mainly PM, DC bulk capacitor, Busbar, Current sensor, Gate Driver(GD) board, Motor Control(MC) board, EMC filter, and almost components fixed to Main case. Main case has cooling channel, and it has cooled for PM with high temperature.

Almost main component parts can be assembled from upper side. The manufacturing process is simply and will be achieved mass production in spite of dual inverter. Hitachi Astemo's inverter has expected compatible high performance and high productivity.

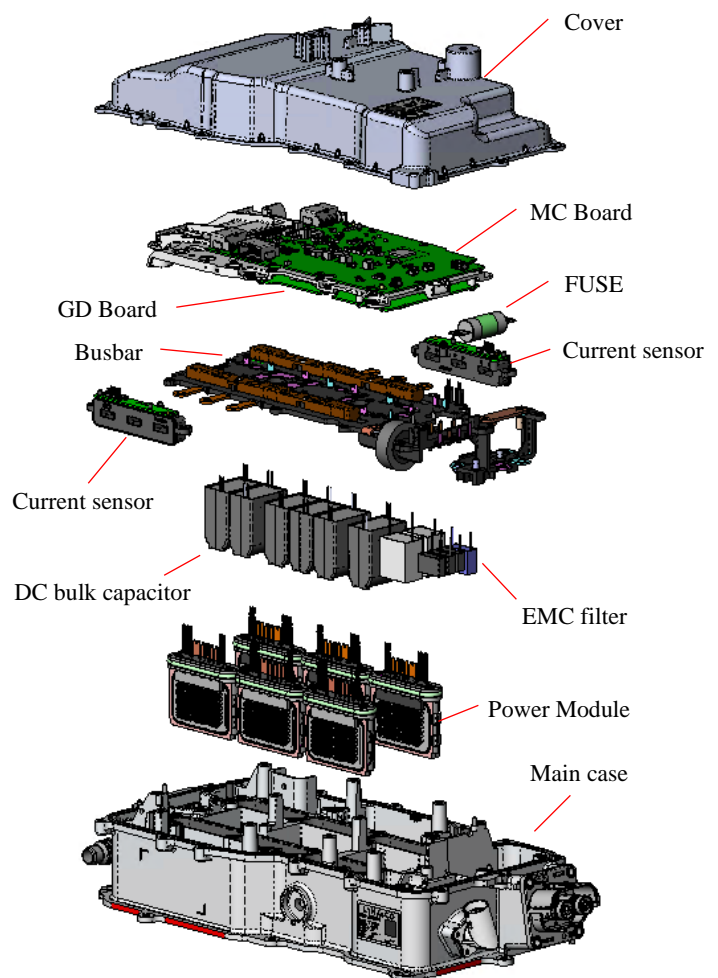


Fig.1 Dual Inverter exploded view for DHT

Table.1 Dual Inverter main specification

Inverter type	Dual inverter
System voltage	Max 420 [V]
Phase current	480 [A] (0.3[sec]) 240 [A] (continuous)
Volume	8.7 [L]
Weight	10.8 [kg]
Power density	39 [kVA/L]

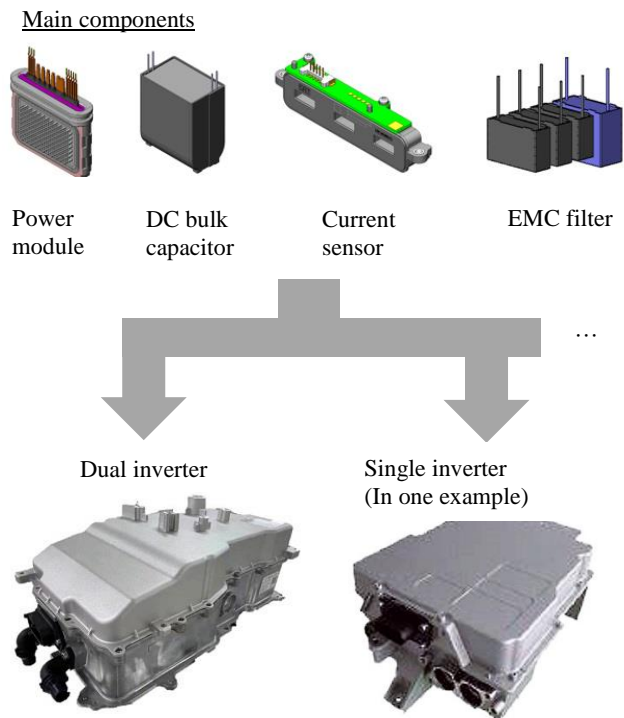


Fig.2 Inverter main components and modular concept

Hitachi Astemo has several main component parts for modular concept. In order to respond to the demand for various OEM production, it was necessary to develop various inverters with different requirement. In response to this, Hitachi Astemo adopted the modular concept as a development strategy that responds to various functional requirements by combining standardized parts in order to reduce the development cost and development period of parts as well as the unit price of parts by the volume effect. Under this strategy, Hitachi Astemo has developed the main inverter parts such as power modules, DC bulk capacitors, Current sensors, and EMC filters as standard parts for dual inverter. (Fig.2)

2.2. Coolant design layout in inverter

Hitachi Astemo’s inverter has coolant channel and mainly cooled PM and DC bulk capacitor such as Fig.3. Coolant will be flowed around each PM double side and turned bottom side on DC bulk capacitor, and DC bulk capacitor located between PM. As a result, PM can be cooled directly and DC bulk capacitor can be cooled not only bottom side but also both side surface, then Hitachi Astemo achieved high effectively cooling design and compact sizing.

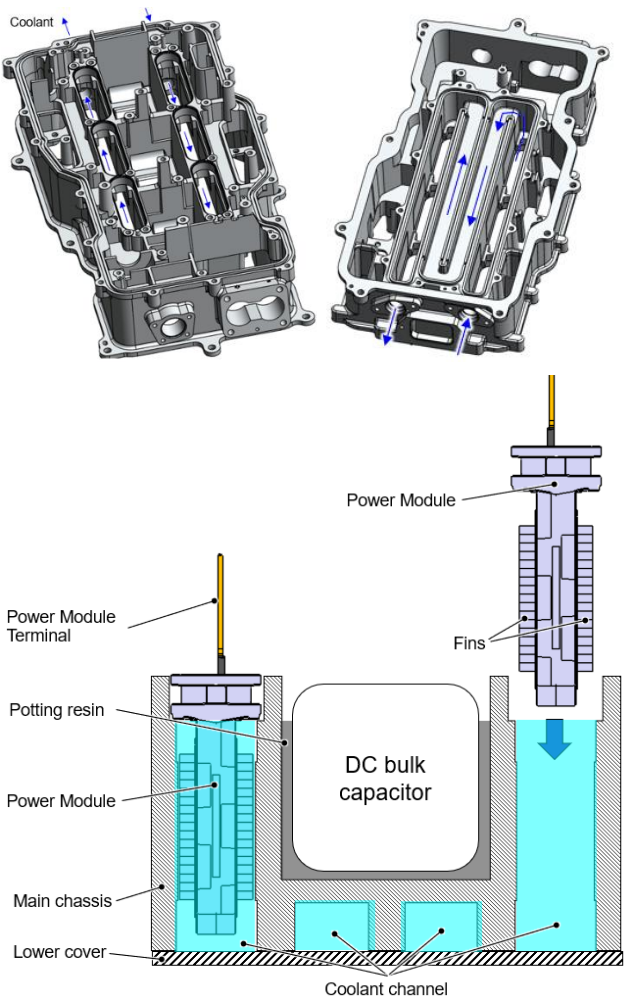


Fig.3 Coolant flow and coolant channel layout

In addition, Hitachi Astemo’s dual inverter having all PM terminal direction is same axis. As a result, the dual inverter can be mounted one Busbar and one GD board included two motor’s terminal and circuit, then it achieved more compacting size. (Fig.4)

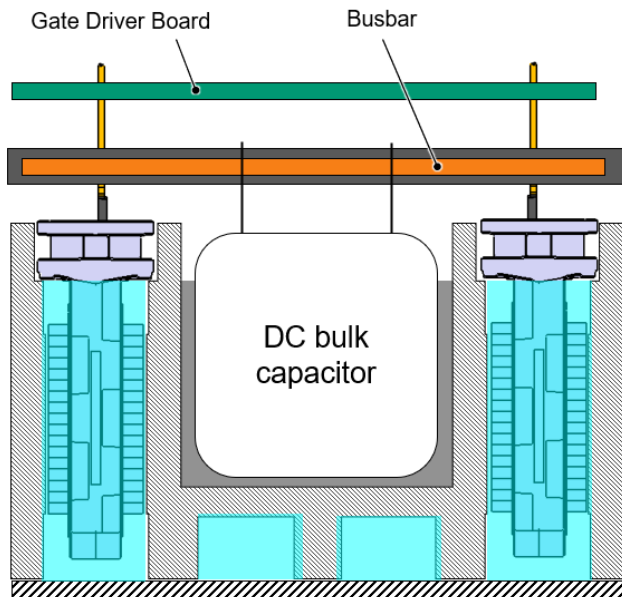




Fig.4 Layout of Busbar and GD Board

3. Benchmark comparison

Benchmarking comparison shows as Table.2. Each production is using same GEN4 PM by Hitachi Astemo, and these have similar specification. Hitachi Astemo's dual inverter has achieved -21% volume smaller than single inverter. However, the dual inverter's power density is lower than single inverter's specification, however it depends on production requirement. Hitachi Astemo's dual inverter has feasible increase power density about 20 to 30% (with DC bulk capacitance increased).

Table.2 Benchmark with GEN4 PM Hitachi Astemo Inverter

Appearance		
System voltage	450 [V]	420 [V]
Volume	5.5 [L] (Single) (x2 : 11 [L])	8.7 [L] (Dual) (-21% smaller)
Power density	43.4 [kVA/L]	39 [kVA/L]

4. CONCLUSION

This paper reported Hitachi Astemo's dual inverter for DHT in China market with not only general design and parts but also modular concept. From the developmental results, Hitachi Astemo has been achieved mass production for Chinese automobile manufactures.

REFERENCES

- (1) A. Hatanaka, T. Tokuyama, J. Kusakawa, T. Seki and K. Ooshima, "High Voltage and High Power Density Technologies for Inverter in Vehicle," JSAE Annual Congress (Spring), No. 14-20, 2020.
- (2) T. Tokuyama, J. Kusakawa, N. Tsuyuno, K. Suzuki, "1.2-kV Double-Sided Direct-Cooling Power Module for EV Traction Inverter," EVTec 2021, 5th International Electric Vehicle Technology Conference 2021.