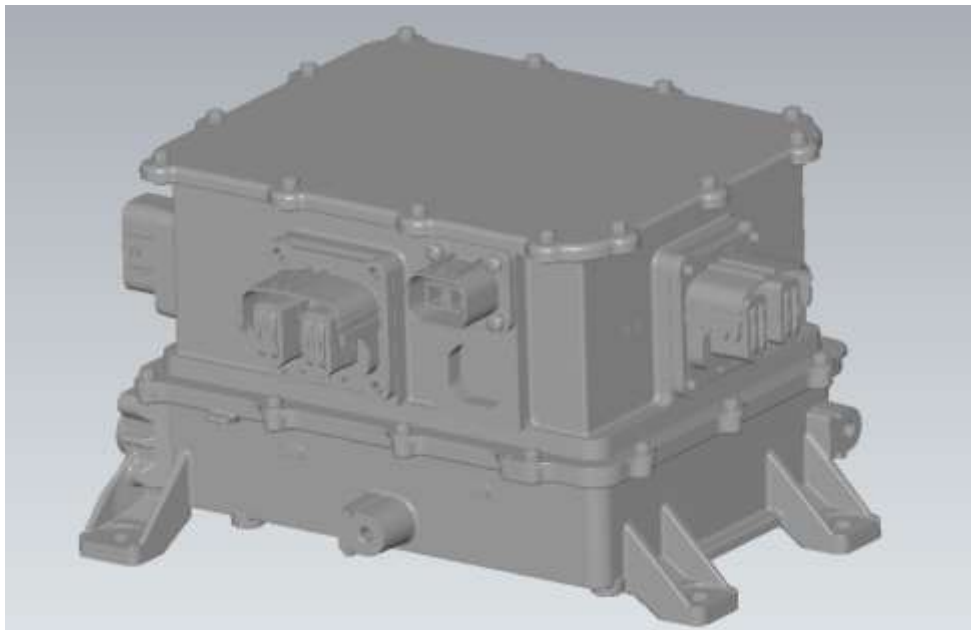




## **3 in 1 1.8KW DC/DC converter+6.6KW OBC + PDU Liquid Cooled System Model No.: AT3-D1K8C6K6-D14C350-W**

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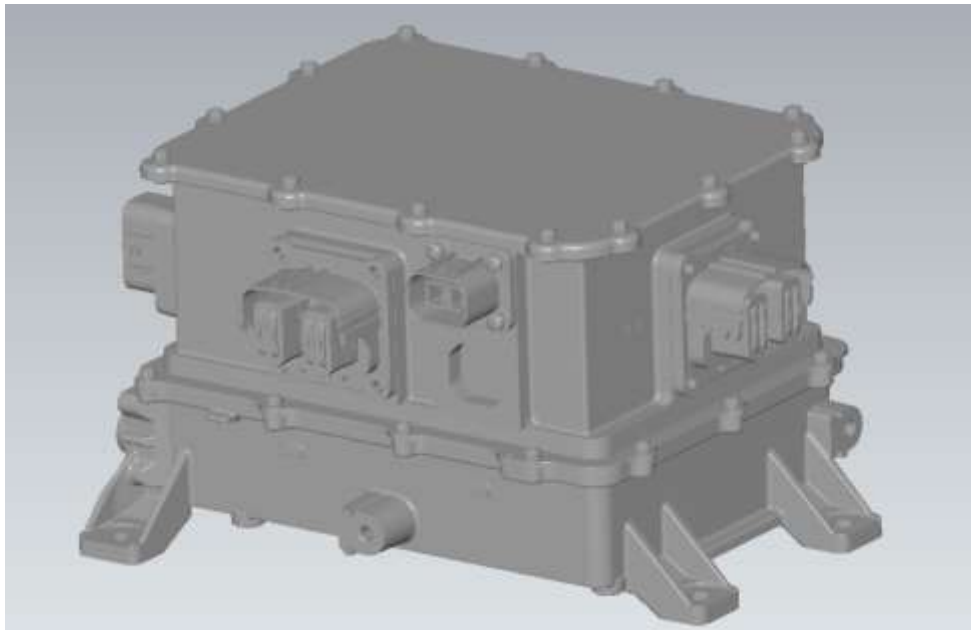


## 1. Summary

### 1.1 Abstract

This product is three-in-one assembly of a bi-directional on-board charger and a DC/DC converter and Power Distribution Unit developed for electric vehicles. It has the characteristics of high integration and high power density. The on-board charger (OBC) obtains energy from 220V AC power supply to charge the high-voltage power battery in the vehicle. During the charging process, the power battery management system monitors the charging status in real time. OBC responds to the voltage and current commands given by BMS, and carries out state feedback to realize self-diagnosis. In addition, the OBC also has the bi-directional inverter function, which can output 220V AC voltage to supply power to equipment with different characteristics. The main function of DC/DC is to convert the high voltage DC of the power battery pack into 13.8V low voltage DC to supply power to the automobile accessory system.

Picture 1. Outline drawing





## 1.2 Industry terminology

No.	Terms or abbreviations	Explanation
1	BMS	Battery Management System
2	ADS	Auto-Disconnect System
3	SOC	State of Charge
4	CAN	Controller Area Network
5	ECU	Electronic Control Unit
6	EV	Electric Vehicle
7	OBC	On Board Charger
8	DCDC	DC-DC Converter
9	HV	High Voltage
10	LV	Low Voltage
11	CC	Constant Current
12	CV	Constant Voltage
13	MCU	Motor Control Unit
14	VCU	Vehicle Control Unit
15	CAN	Controller Area Network
16	UDS	Unified Diagnostic Services
17	ASIL	Automotive Safety Integrity Level
18	HVIL	High Voltage Interlock Loop

## 1.3 Introduction to main functions of the system

### 1.3.1 OBC module function

Conduct constant current and constant voltage charging of the battery in different states within the adjustable range according to the BMS instruction;

According to BMS instructions, the OBC can charge also resistive load with different power requirements within the adjustable range to realize battery heating;

Carry out AC inverter output within a certain voltage range to supply AC load according to BMS instruction;

It can realize the diagnosis, self-check and protection functions of the OBC module according to the CAN information of the whole vehicle and the information monitored by itself;

### 1.3.2 DC-DC Converter Function

DC / DC is mainly used to convert high voltage DC of power battery into low voltage DC to charge 12V battery and supply power to low-voltage electrical appliances in the car.



The main functions include: power adjustment function, on and off control function, temperature detection function, current power supply detection function, CAN communication function, Bootloader program brush and UDS diagnosis function, fault handling function, self-maintenance function and energy saving/ sleep function.

#### 1.3.3 PDU Function

Power distribution for the vehicle high voltage power equipment (air conditioning, PTC, OBC & DC / DC), integrated PTC relay, bus-bar, each high voltage module insurance, etc.

#### 1.3.4 Cooling Method

Liquid-cooled

#### 1.3.5 User Diagnostic Support

It can realize the functional diagnosis of OBC and DCDC and report to the vehicle system. It can also realize offline writing by remote brushing program to reduce after-sales maintenance costs.

#### 1.3.6 Self-diagnosis and multiple protection functions

With self-diagnosis, input and output overvoltage, under voltage protection, output short-circuit protection, hardware fault protection, over temperature protection and recovery functions;



## 2. Reference standards

No	Standard/Document No.	Standard/Name of Document	Note
1	GB 14023	Limits and methods of measurement of radio-nuisance characteristics of vehicles, ships and internal combustion engines for the protection of off-board receivers	The latest version
2	GB/T 17619	Electromagnetic radiation immunity limits and measurement methods for electrical and electronic components of motor vehicles	The latest version
3	GB/T 18384.1	Electric vehicles, safety requirements Part 1: On-board energy storage devices	The latest version
4	GB/T 18384.2	Electric vehicles, Safety requirements Part 2: Functional safety and fault protection	The latest version
5	GB/T 18384.3	Electric vehicles, safety requirements Part 3: Personnel electric shock protection	The latest version
6	GB/T 18387	Limit and measurement method of the electromagnetic field emission intensity of electric vehicles, width, 9KHz~30MHz	The latest version
7	GB/T 18487.1	Electric vehicle conduction charging system Part 1: General requirements	The latest version
8	GB/T 2423.1	Environmental tests of electrical and electronic products Part 2: Test Method Test A: low warm	The latest version
9	GB/T 2423.2	Environmental tests of electrical and electronic products Part 2: Test Method Test B: high warm	The latest version
10	GB/T 2423.10	Environmental tests of electrical and electronic products Part 2: Test methods Test Fc: Vibration (sinusoidal)	The latest version
11	GB/T 2423.17	Environmental Testing Part 2: Test Method Test Ka: Salt mist	The latest version



12	GB/T 2423.22	Environmental tests of electrical and electronic products- - Part 2: Test methods Test N: Temperature Degree change	The latest version
13	GB/T 24347-2009	Electric vehicle DC / DC converter	The latest version
14	GB/T 25085	Road vehicles 60V and 600V, single-core wire	The latest version
15	GB/T 28046.2	Road vehicles 60V and 600V, single-core wire Environmental conditions and tests for electrical and electronic equipment for road vehicles Part 2 Electrical load	The latest version
16	GB/T 31465.6	Road vehicle fuses- -Part 6: Bolted-type high-voltage fuses	The latest version
17	GB/T 37133	Technical requirements for high voltage and high current wiring harness and connectors for electric vehicles	The latest version
18	GB/T 4094.2	Mark of EV controls, indicator and signal device	The latest version
19	QC/T 1037	Road vehicle high-voltage cable	The latest version
20	QC/T 29106	Technical conditions of automobile wire harness	The latest version
21	QC/T 413-2002	Basic technical conditions of automotive electrical equipment	The latest version
22	QC/T 895-2011	Conductive on-board charger for electric vehicles	The latest version
23	IEC 61851-1	Electric road Vehicle Technical Committee- -General requirements for charging system	The latest version



### 3. Environmental requirements

The environmental conditions for the assembly are shown in the table below:

No.	Term	Value & standard	Unit	Remark
1	Inlet coolant temperature	-40~+85	°C	The power is reduced when the temperature exceeds 85°C
2	Storage temperature	-40~+95	°C	No operated
3	Relative humidity	5~95	%RH	No condensation, no frost
4	IP Grade	IP67		
5	Cooling method	Liquid-cooled		
6	Vibration level	Meet QC/T 895-2011		
7	Noise level	≤65	dB	Meet QC/T895-2011
8	Salt fog grade	Meet QC/T 2423.17-2011		
9	Altitude	≤4500	m	
10	Change of temperature	Meet GB/T 2423.22		
11	Drop	Wiring harness according to QC/T 417.1 2001 shell according to GB/T 2423.7 2018		Appearance, structure and performance are normal





## 4. Technical Specifications

### 4.1. OBC Electrical Performance Requirements

Item	Min	Typ.	Max	Unit	Condition	
OBC electrical characteristics (AC/DC)						
1、Input Characteristic						
Rated input voltage	-	220	-	Vac		
Input voltage range	90	-	264	Vac	Normal operating voltage range	
Maximum input current	-	-	32	A	input current not exceed 32A within all input voltage range	
AC input voltage frequency	45	50	65	Hz	Rated 50 Hz	
Power factor (PF)	0.98 0.94	-	-	-	@75%~100% load> 0.98 @50%~75% load> 0.94	
2、Output Characteristic						
High voltage output	Rated output voltage	350		Vdc	When 110Vac is input, the output will automatically reduce power for operation.	
	Output voltage range	250	470	Vdc		
	Output current range	0	21	A		
	Output rated power		6.6	KW	When 220Vac is input, output can operate at full power	
	Output ripple and noise		±5	%Vo		
	Startup rise time		4	S	After the OBC receives the BMS charging request, the output voltage rises from 10% to 90%	
	Output drop time		300	mS	The time when the output current decreases to 0A after the OBC receives the BMS stop instruction	
	Output constant voltage accuracy			1	%	Maximum not more than ± 1%
	Output current stabilization accuracy			5	%	Maximum not more than ± 0.5A
	Static loss current			2	mA	Hibernate without gun plugged in, draws KL30 constant current
	Overall efficiency	93	94	94.5	%	

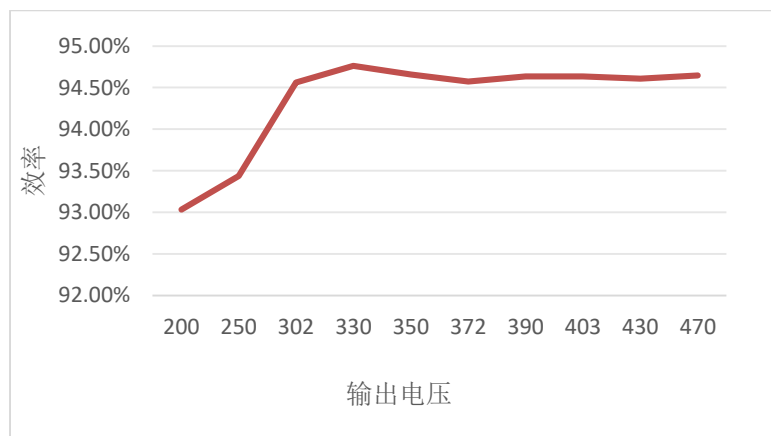


3、Protection characteristics						
Input Overvoltage Protection		265	270	275	Vac	Turn off output
Input overvoltage recovery		250	255	260	Vac	
Input undervoltage protection		80		90	Vac	Turn off output
Input undervoltage recovery		90		95	Vac	
Input overcurrent protection		-	-	32	A	Input maintenance input current is not more than 32A, and output power is automatically adjusted.
High voltage output	Output overvoltage protection	475	480	485	Vdc	Turn off the high voltage output and recover after the fault is rectified
	Output undervoltage protection	240	245	250	Vdc	
	Output overcurrent protection			21	A	
	Output short circuit protection	Yes			-	Before entering the charging process, do not start charging when the output short circuit is detected. In the process of charging the output short circuit, immediately turn off the high voltage output
	Output reverse connection protection	Yes			-	The output is reversed, the high voltage output does not start, and the normal operation is restored after the fault is rectified
Communication failure protection		Yes			-	When the charger does not receive the BMS command for 5 consecutive seconds, or the communication failure occurs during the work of the charger, the output of the charger will be turned off
Over temperature protection		OBC_MCU	95	100	°C	OBC_MCU temperature de-rating ranges from 95 °C to

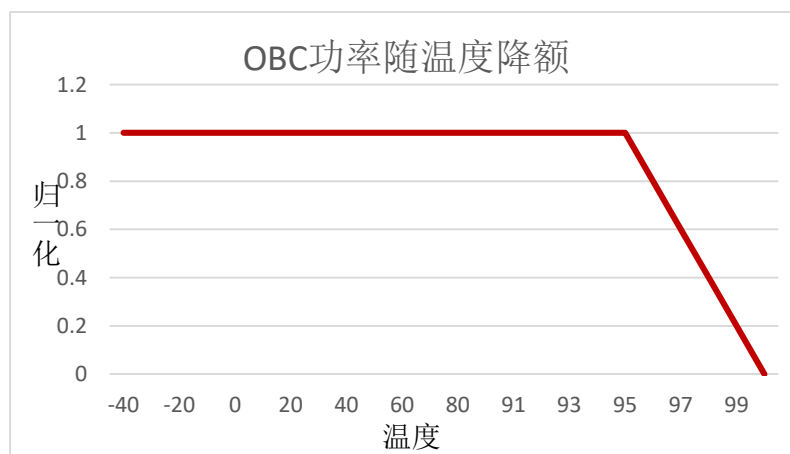


				100°C. The temperature de-rating of MOS tube at PFC ranges from 120 ° C to 124 ° C. The difference between MCU temperature and MOS tube temperature and initial de-rating was compared respectively, which difference was mainly based on which de-rating; MOS tube shuts down at 125°C	
	PFC_MOS	120	124		

#### 4.2 OBC output efficiency and temperature de-rating curve



Pic1 OBC Efficiency curve



Pic2 OBC Temperature de-rating curve

#### 4.3 DC Electrical Performance Requirements

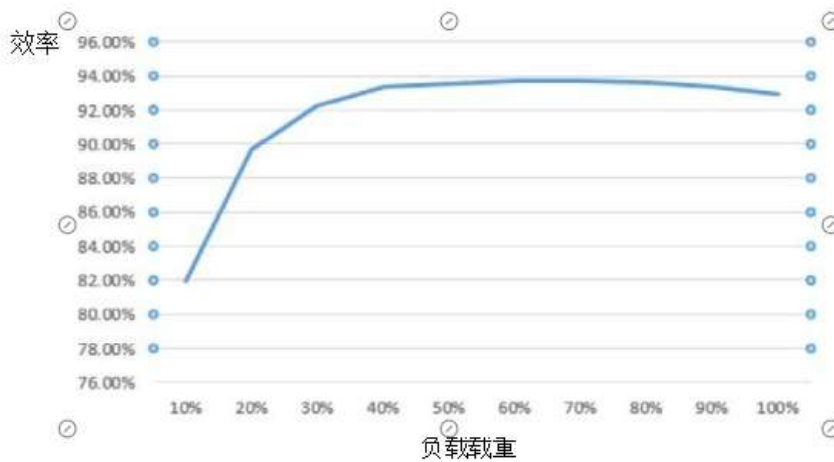
Item	Min	Typical	Max	Unit	Condition
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DCDC Electrical characteristics					
1、 Input Characteristic					
Input voltage range	270	-	470	Vdc	
2、 Output Characteristic					
Output voltage range	9	14.5	16	Vdc	
Rated output current	-	107	-	A	
Peak Output Current	-	125	-	A	
Output power	-	1800	-	W	
Efficiency	-	92	-	%	
3、 Protection characteristics					
Input overvoltage protection	475	480	485	Vdc	Close output
Input overvoltage recovery	465	470	475	Vdc	
Input undervoltage protection	260	265	270	Vdc	
Input undervoltage recovery	270	275	280	Vdc	
Output overvoltage protection		16		Vdc	
Output under voltage protection		8		Vdc	
Over temperature protection	100		109	°C	The MCU temperature de-rating ranges from 100 to 109. The temperature de-rating range of MOS tube was 115~124, and the difference between MCU temperature and MOS tube temperature and initial de-rating was compared respectively, which difference was mainly based on which de-rating; MOS
	120		124	°C	



					tube shuts down at 125°C
Output overcurrent protection		>125		A	The software output can be adjusted. The value is the hardware current limit
Communication fault protection		YES			When the charger does not receive the BMS command for 5S in a row, or the communication fails during work, the charger will turn off the output



DC 效率曲线图

#### DC efficiency curve

#### 4.4. Safety performance and others

Safety regulation characteristics				
Item		Technical indicators	Unit	Remark
Dielectric strength	Input to housing	2000VDC、3s、 Leakage current≤20mA		No breakdown and flashover
	Output to housing	2000VDC、3s、 Leakage current≤10mA		No breakdown and flashover
	Input to output	2000VDC、3s、 Leakage current≤10mA		No breakdown and flashover
insulation resistance	DC high voltage - DC low voltage (housing ground)	resistance≥20MΩ, Test voltage 500VDC		No breakdown and flashover
Grounding resistance	Ground wire to housing - DC low voltage (housing ground)	≤0.1	Ω	The resistance between the grounding point and the radiator is less than 100 milliohm, and the test current is 25A AC.



Creepage clearance		$\geq 4\text{mm}$		Meet the requirements of Table 3 of the GB/T18488.1-2001 standard
Electrical clearance		$\geq 3\text{mm}$		Meet the requirements of Table 3 of GB/T 18488.1-2001 standard
MTBF		150000H	h	The ambient temperature is 25°C

#### 4.5 Electromagnetic Compatibility

Test items	Reference standards	Performance indicators	criterion	Remark
1、EMI test				
Conducted disturbance (CE)	GB/T 18487.3-2001			For OBC testing only
Radiation disturbance (RE)	GB/T18487.3-2001			
Conducted disturbance (CE)	GB/T 18655-2010	Level 3		For DCDC test only
Radiation disturbance (RE)	GB/T 18655-2010	Level 3		
EMC Test				
Surge	GB/T18487.3-2001GB/T 17626.5-2008	Input differential mode 1KV 1.2/50us Input common mode 2KV 1.2/50us	B	For OBC testing only
EFT	GB/T18487.3-2001GB/T 17626.4-2018	2KV/5KHz/1min	B	
ESD	GB/T18487.3-2001 GB/T 17626.1-1998	Contact 4KV/air 8KV	B	
CS		10LIVE3 0.15-80MHz	A	
RS	GB/T 18487.3-2001 GB/T 17626.3-2006	3V/m 80-1000MHz	A	



		10V/m 80-1000MHz	B	
DIP	GB/T 18487.3-2001	Drop to 70%U(T), time 10ms; Drop to 50%U(T), time 100ms; Drop to 95%U(T), time 5000ms;	B	
Voltage fluctuation and flicker		Voltage fluctuation and flicker limit of Class A products		
Current harmonic emission	GB/T 18487.3-2001	Harmonic current limit of Class A products		
Electrostatic immunity (ESD)	GB/T 19951-2005	Contact discharge of complete machine (power on): $\pm 6\text{KV}$ Air discharge: $\pm 8\text{KV}$	B	
		Contact discharge of the whole machine (not powered on): $\pm 6\text{KV}$	C	
		Air discharge: $\pm 15\text{KV}$		
Radiated electromagnetic field immunity free field method (RS)	GB/T 17619-1998		A	
Radiated electromagnetic field immunity Large current injection (BCI)	GB/T 17619-1998		A	
Electrical transient conducted interference immunity along the power line (CS)	GB/T 21437.2-2008 (ISO 7637-2)	level 4	Pulse1, Pulse2b 为 D, Puls2a , Pulse 3a/3b 为 A	
Electrical fast transient	GB/T 17626.4-2008	$\pm 4\text{KV}$ , 5KHz/100KHz	B	

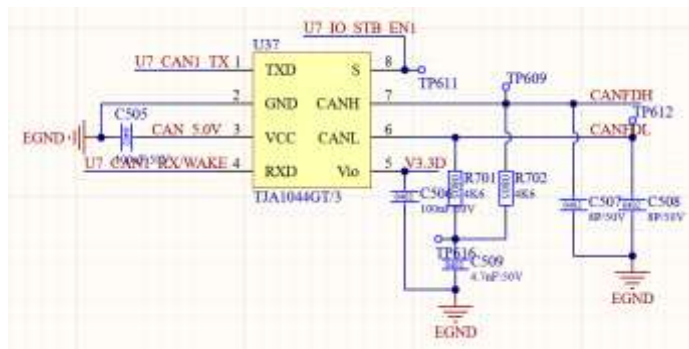


burst immunity (EFT)	(IEC 61000-4-4)			
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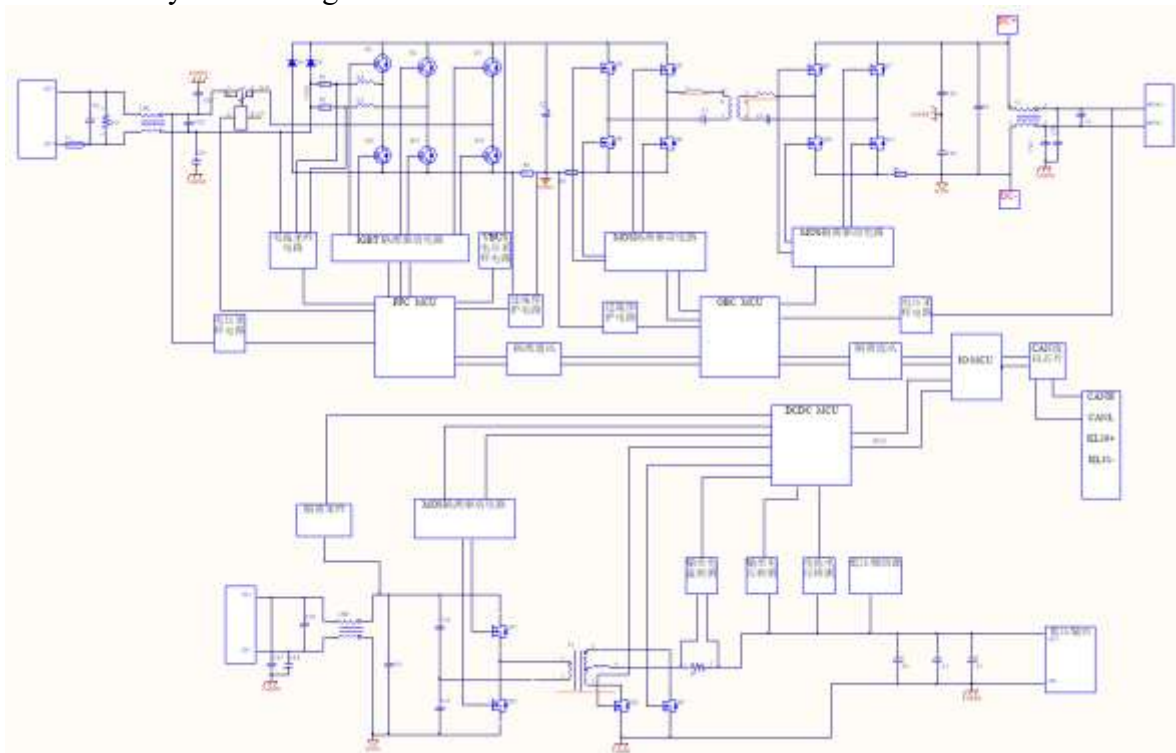
Criteria definition:

- A: Test process indicators are within the specification range
- B: It can automatically recover to the specification after the test
- C: After the test, it can be restored to the specification range manually

4.6 Assembly Block Diagram (example, PDU portion not actual situation)  
 CAN circuit is as follows:



4.7 Assembly Block Diagram



## 5. Interface requirements

### 5.1 General interface requirements

The 3-in-1 consists mainly of a low voltage interface and a high voltage interface. The





interface connector type and position on the part are defined in accordance with the vehicle layout.

## 5.2 Low-voltage connector information of on-board charger

5.2.1 Viewing direction of the low-voltage signal connector (component side): (TBD)

5.2.2 Pin definitions of the low-voltage signal connector of the assembly: **(TBD)**

5.3 Interface definition of the high-voltage connector assembly: TBD

## 6. Mechanical parameters

### 6.1 Installation size and specification

See the last page: engineering drawings

### 6.2 Appearance

a) The surface quality of the shell should meet the technical requirements for surface treatment in the drawings, and at the same time there should be no bubbles, damage, edge defects or other defects, the outer surface of the assembly should be free of obvious wounds, knocks, puckering, pulling and burrs and other defects, and the coating and plating layer should be uniform and free of cracks, peeling, flow hanging, bottoming out and other defects.

b) Fastener connections should be firm.

c) The lead wires and terminals should be intact and undamaged, and the color and marking should be correct.

d) Shell markings, should be correct, clear, firm and durable. The writing and content of the nameplate should be clear and unambiguous, and should not fall off.

(e) interface marking, there should be a clear input and output interface marking, marking installation is correct and firm, clear handwriting.

(f) input and output interfaces and ancillary components, fasteners should be firmly connected, no corrosion, burrs, cracks and other defects and damage. Connector sheath and pin intact, no damage, the components are firmly connected.

(g) Shell color: color mixing according to the color palette provided by Party A (the color is subject to the final results of the actual vehicle review); orange high-voltage electrical connector color number: RAL2003; metal connectors and shell color to maintain consistency.

### 6.3 Weight

No.	Part name	Part code	Weight (kg)	Remark
1			≤6.5	



## 7. Nameplate, packaging, transportation and storage

### 7.1. Nameplate bar code (nameplate label should have traceability)



Pic7 High voltage safety identification

a) Position: High-voltage safety marking is pasted on the surface of the upper housing b)

Design size: 78mm \* 45.5mm

### 7.2 Packaging and packaging diagram

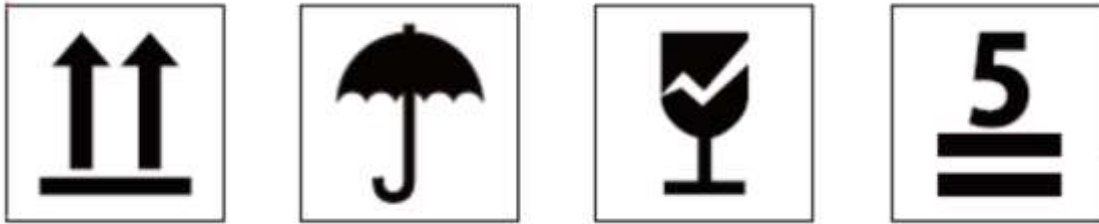
Gross weight of the product; (3) the name and address of the consignee unit; (4) the name and address of the manufacturer; (5) the location of the sign "↑" and write in the arrow on the upper part of the word "up"; (6) the box dimensions; (7) the date of packaging. Product packaging must comply with the requirements of the relevant packaging and transportation specifications to ensure that the product is not subject to mechanical damage during transportation and storage, and have the ability to prevent rain and dust.

There is a list of accessories in the packing box:

No.	Name	Quantity	Unit	Remark
1	High-voltage 3-in-1 Assembly	1	set	
2	Test report	1	pc	

### 7.3 Transportation

When transporting products, there should be a solid packaging box, and the outside of the box should comply with the relevant national standards and should be marked with "Handle with Care", "Moisture Proof", and other signs. The packing box containing the product is allowed to be transported by various means of transportation. Direct rain and snow attack and mechanical impact shall be avoided during transportation.



Pic 9 Transportation marks

#### 7.4 Storage

The products shall be stored in the packaging box when not in use. The ambient temperature of the warehouse shall be - 10-40 °C and the relative humidity shall not be greater than 80%. There shall be no harmful gases, flammable and explosive products and corrosive chemicals in the warehouse, and there shall be no strong mechanical vibration, impact and strong magnetic field. The packaging box shall be padded at least 20 cm from the ground, and at least 50 cm from the wall, heat source, window or air inlet, The storage period under the specified conditions is generally 2 years, and the inspection shall be conducted again after more than 2 years.

The product should be stored in a ventilated and dry place. At the same time, it is necessary to avoid high temperature sources, fire sources and chemicals. Store neatly and avoid throwing and smashing.

#### 8. Security Guide

Warning: remind the user that the operation is dangerous

\* ☐ It is forbidden to disassemble and refit the on-board charger for repair or commissioning without authorization.

\* ☐ Do not place the parts in the rain.

\* ☐ Before installation, please confirm that the housing is intact. If it is damaged, please replace it immediately or contact after-sales service

\* ☐ All plugs and sockets shall be firmly connected. If they are damaged or loose, please replace them immediately.

\* It is forbidden to plug and unplug the connector with power on the product, otherwise personal injury may be caused.

\* It is forbidden to open the product housing during the power-on operation of the product, otherwise personal injury may be caused.

\* ☐ It is strictly prohibited to touch the high-voltage live parts of the product with bare hands. Please wear insulating gloves, insulating shoes, and insulating clothing during testing and maintenance. Live maintenance and testing are strictly prohibited.

\* During the replacement of fuses and contactors, barbaric operation is strictly prohibited to avoid damaging the product and causing potential safety hazards.

\* ☐ For AC power supply, select a three-core cable with a ground wire and install the ground wire correctly.

\* ☐ If the charger has abnormal sound or smell during operation, please unplug the power plug.

\* ☐ Please keep away from ignition sources and flammable and explosive substances when the battery is charged normally.

\* ☐ Do not charge damaged or non-rechargeable batteries.

Note: Remind the user that the following operations are important for this product.

\* ☐ Do not block the water inlet and outlet of the charger to prevent overheating.

\* ☐ Please ensure that the output cable is not too long to avoid the impact of line voltage drop on charging.

\* ☐ Please disconnect the power cord and charging plug when moving the charger.



- \* ☐ The battery voltage must match the nominal voltage of the charger.
- \* ☐ Avoid collision, pressure, pulling, twisting or shaking the charging cable.
- \* ☐ The product should be placed in a safe, ventilated, dust-free and rain-free environment.
- \* ☐ Please pack and store if not used for a long time.