PM120E Data Sheet

Abstract

The PM120E is a plug-and-play gate driver developed for the PrimePACK™ module with two parallel mirrored symmetrical heat dissipation structure based on the Firstack digital intelligent IGBT gate driver. The PM120E is designed based on the Firstack digital driver core 2FSC0435+, which has the characteristics of powerful function and high reliability.

The PM120E can be selected with either the left or right interface according to the structural design requirements.

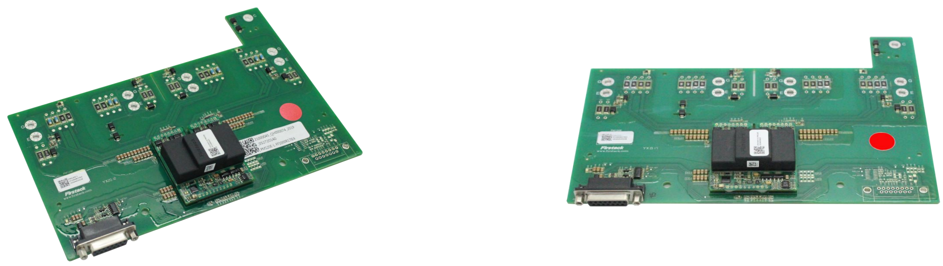

Fig. 1-1 PM120E-L-FF1000R17IE4

Fig. 1-2 PM120E-L-FF1400R17IE4

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Functional block diagram

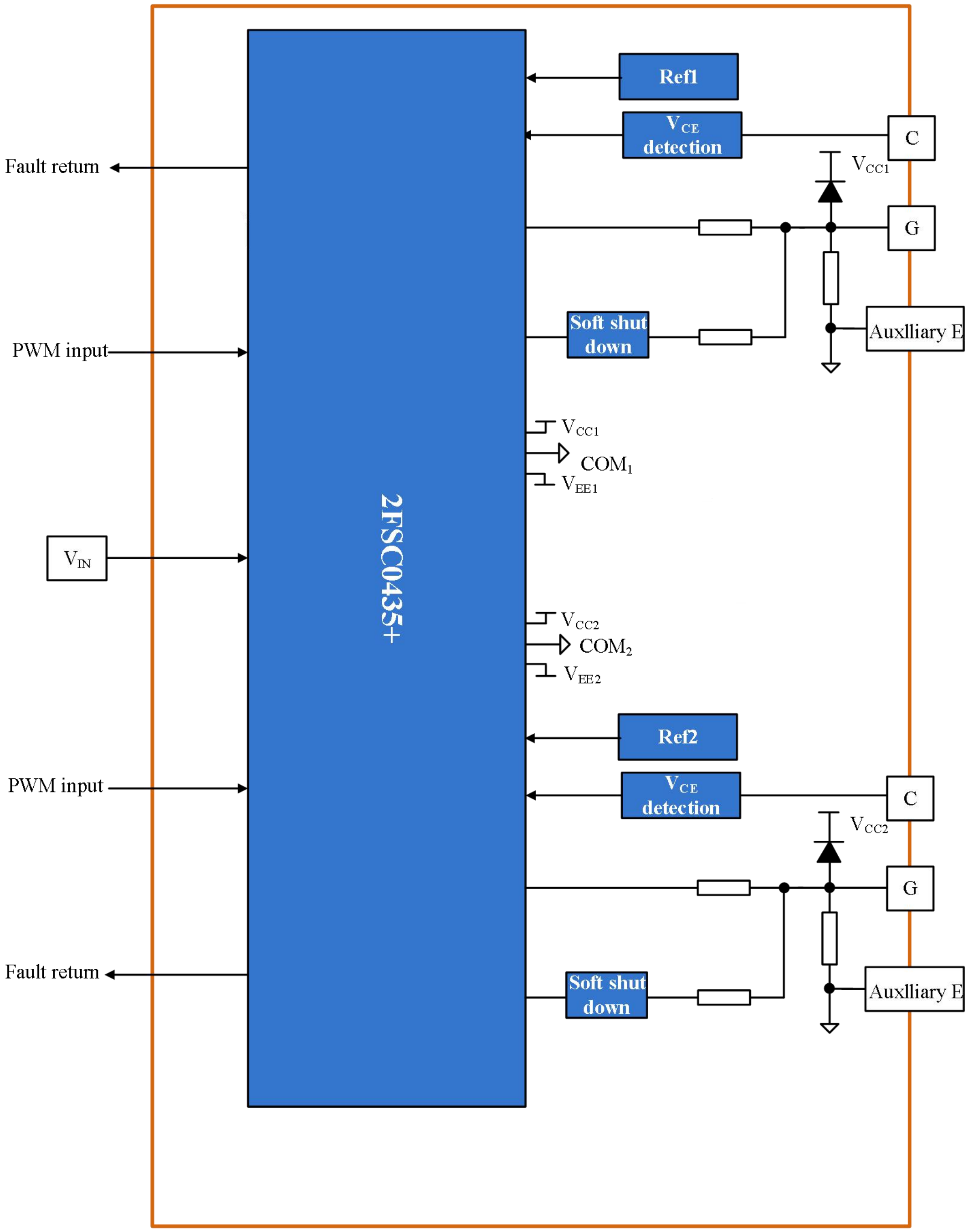

Fig. 2 Functional block diagram

The PM120E employs the digital driver core 2FSC0435+, which is powerful, reliable and fully protected, including short-circuit protection, soft shut down and undervoltage protection.

Use steps and safety notice

Simple use steps of the gate driver are as follows:

1. Choose suitable gate driver

When using the gate driver, pay attention to the model of the IGBT module that the gate driver is adapted to. It is invalid for non-designated IGBT modules. Improper use may cause the drive and the module failure.

2. Install the gate driver on the IGBT module

Any treatment of IGBT modules or gate drivers should follow the general specifications for the protection of electrostatic sensitive devices required by the international standard IEC 60747-1, Chapter IX or IEC60340-5-2 (which means the workplace, tools, etc. must comply with these standards).

If these specifications are ignored, both the IGBT and the gate driver may be damaged.

3. Connect the gate driver to the control unit

Connect the gate driver connector to the control unit and provide a suitable power supply voltage for the gate driver.

4. Check the function of the gate driver

Check the gate voltage: for the turn-off state, the rated gate voltage is given in the corresponding data sheet; for the turn-on state, the voltage is 15V. Please also check the input current of the gate driver with and without a control signal. For Firstack's digital gate drivers, the driver status LED (green LED on the driver core) is always on when the gate driver is supplied with the suitable voltage.

These tests should be performed before installation, because the gate terminal may not be accessible after installation.

5. Set up and test the power unit

Before starting the system, it is recommended to check each IGBT module with single pulse and double pulse test method separately. In particular, Firstack recommends that users ensure that the IGBT module does not exceed the operating range specified by SOA even under the worst conditions, as this is strongly dependent on the specific converter architecture.

Mechanical dimensions

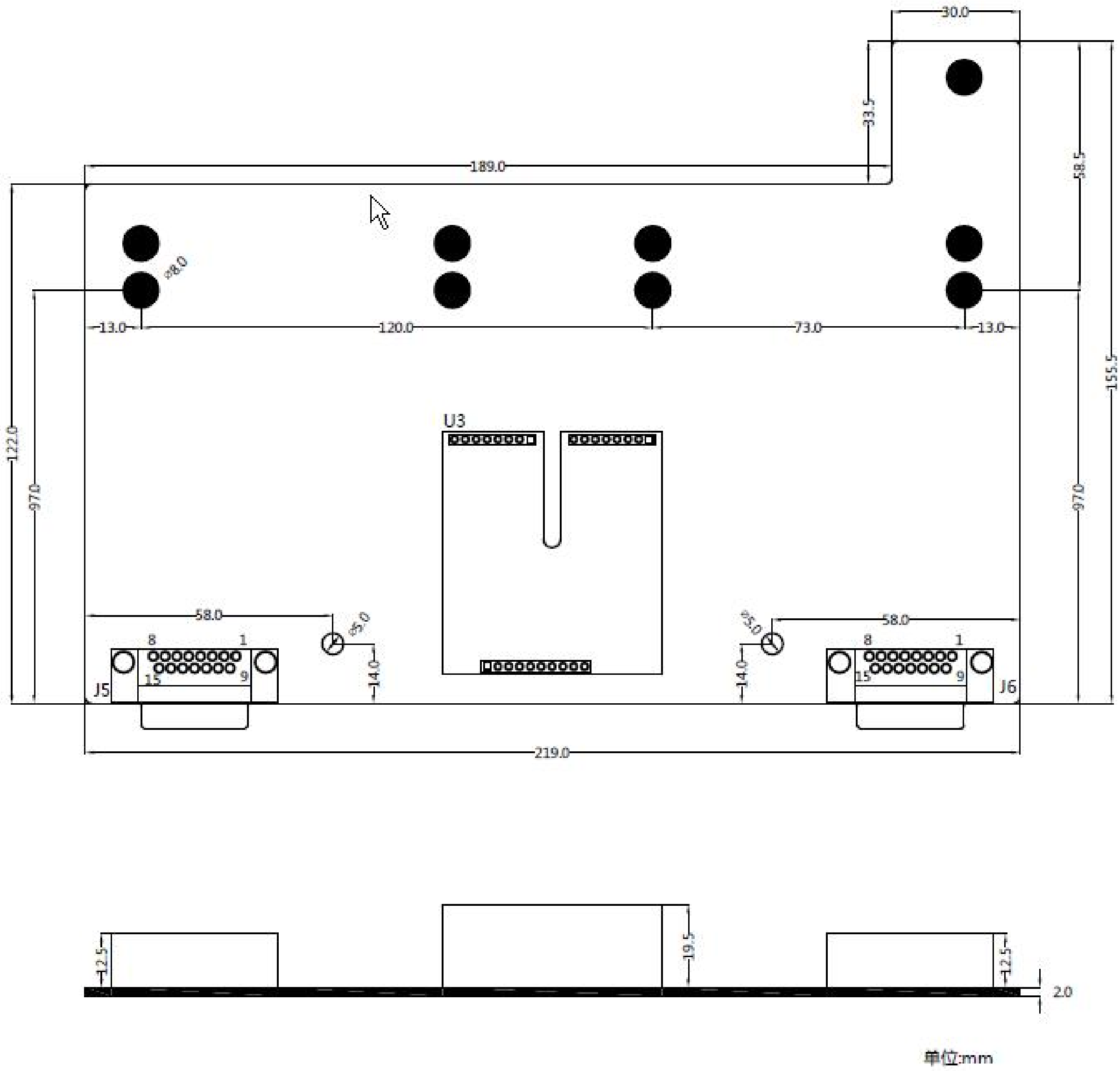

Fig. 3 Mechanical dimensions(unit: mm)

Connector manufacturer and part number

Number	Ref	Manufacturer	Part number	Recommended matching terminals
1	/	WCON	6223-15FSNS0B02	

Pin functional description

J5, J6 pin definition:

Pin	Name	Note	Pin	Name	Note
1	V_{IN}	Primary side power supply	2	TOP IN	Top IBGT PWM signal
3	NC	Vacant	4	FAULT	Fault return signal
5	NC	Vacant	6	BOT IN	Bottom IGBT PWM signal
7	V_{IN}	Primary side power supply	8	V_{IN}	Primary side power supply
9	GND	Primary side ground potential	10	GND	Primary side ground potential
11	GND	Primary side ground potential	12	GND	Primary side ground potential
13	GND	Primary side ground potential	14	GND	Primary side ground potential
15	GND	Primary side ground potential			

LED status indicator

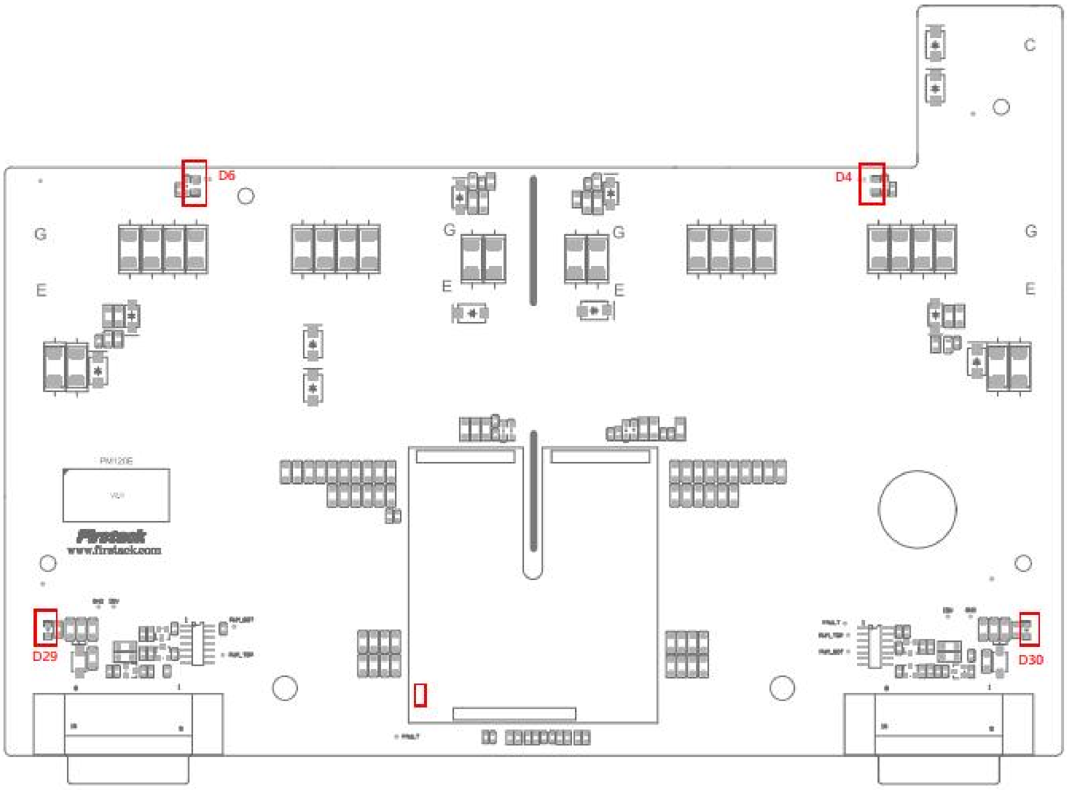

Fig. 4 LED status indicator

For the convenience of customers, several LED status indication are added on the Firstack gate driver board to facilitate customers to know the operating status of the gate driver board and converter. The specific explanation is as follows:

LED status indicator

Number	Bit number	Interface	Note
1	D4	GE	Top IGBT GE signal indicator, light on when turned on, otherwise off
2	D6	GE	Bottom IGBT GE signal indicator, light on when turned on, otherwise off
3	D29, D30	/	Power supply indicator, always on when powering up, off when powering down
3	/	/	Refer to the 2FSC0435+X description for the gate driver core indicator

Driving parameters

Absolute Maximum Ratings

Parameter	Note	Min.	Max.	Unit
V_{DC}	V_{DC} to GND		16	V
Logic input and output voltages	(Primary side)To GND		16	V
SOx current	Non-fault condition		7.5	mA
Gate peak current	Note 1		35	A
Output power per channel	T_A≤85℃		4	W
Test voltage(50Hz/1min)	Primary to secondary side	5000		V_{RMS}
	Secondary to secondary side	4000		V_{RMS}
Operating temperature		-40	+85	℃
Storage temperature		-40	+85	℃
Creepage distance	Primary to secondary side	18		mm
	Secondary to secondary side	8		mm
Clearance distance	Primary to secondary side	18		mm
	Secondary to secondary side	10		mm

Recommended Operating Conditions

Parameter	Note	Min.	Typ.	Max.	Unit
V_{DC}			15		V
IN_X			15		V

Electrical Characteristics

Power supply	Note	Min.	Typ.	Max.	Unit
Supply current	Without load, Note 1		0.15		A
Coupling capacitance	Primary to secondary side		5		pF
Power Supply Monitoring					

Threshold			12.5		V
Logic Input & Output Voltages					
Turn-on threshold		3.3			V
Turn-off threshold				1.3	V
SOx output potential	Fault condition		0.7		V
Short-circuit Protection					
V_{CE} monitoring threshold			11.7		V
Response time	Note 2		5		us
Blocking time			100		ms
Timing Characteristics					
Turn-on delay	Note 3		952		ns
Turn-off delay	Note 4		928		ns
Rise time	Note 5		4.8		ns
Fall time	Note 6		140		ns
Fault hold time	Top IGBT short-circuit fault		20		ms
	Top IGBT short-circuit fault		40		ms
	Undervoltage fault		80		ms
Output voltage					
Turn-on voltage		14.5		15.5	V
Turn-off voltage		-7.8		-7.1	V

Unless otherwise specified, all data are based on tests at +25℃ ambient temperature and V_{DC}=15V.

Note:

1. **Supply current: no PWM input, but connected to the IGBT;**
2. **Response time: the time from the occurrence of the fault to the start of soft shut down;**
3. **Turn-on delay: the time required to transmit the rising edge of the PWM signal input from the primary side to the rising edge of the secondary side of the gate driver when the IGBT is not connected;**

4. **Turn-off delay: the time required to transmit the falling edge of the PWM signal input from the primary side to the falling edge of the secondary side of the gate driver when the IGBT is not connected;**
5. **Rise time: the amount of time from 10% of the gate turn-off voltage (-8V) to 90% of the gate turn-on voltage (+15V);**
6. **Fall time: the amount of time from 90% of the gate turn-on voltage (+15V) to 10% of the gate turn-off voltage (-8V).**

Function description

◆ Short-circuit protection

The drive circuit judges whether the IGBT is in a short-circuit state by detecting the collector voltage V_{CE} when the IGBT is turned on.

The collector voltage is detected by high voltage diodes. When the V_{CE} voltage exceeds the set threshold, the gate driver determines that the IGBT is in a short-circuit state, starts the soft shut down to slowly turn the IGBT off, and returns the fault to the master computer at the same time.

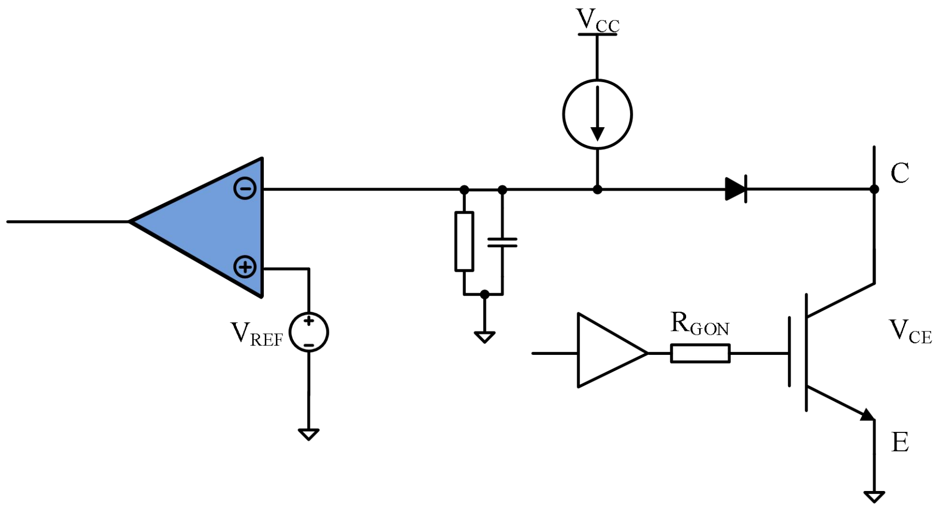

Fig. 5 V_{CE} desaturation sensing circuit

◆ Undervoltage protection

The gate driver board monitors the positive and negative power supplies on the secondary side at the same time. When the positive or negative voltage on the secondary side is lower than the threshold voltage, the drive circuit will determine that an undervoltage fault has occurred, it will block the IGBT automatically and feed back a fault signal to the master computer at the same time. When the fault is removed, the fault terminal of the primary side will reset after a blocking time.

For IGBT bridge arms, Firstack intelligent gate driver strongly suggests that any IGBT should not operate undervoltage. Because of the existence of C_{GC}, when an IGBT in the bridge arm is turned on, its high dv/dt can be coupled to another IGBT through C_{GC}, which leads to a slight conduction of IGBT. At the same time, low gate voltage will increase the switching loss of IGBT.

◆ Soft shut down

When a shoot-through occurs, IGBT will quickly desaturate, and the voltage V_{CE} at both terminals will reach the DC bus voltage; while the current I_C flowing through IGBT will reach 4 times or more of the rated current (depending on IGBT type and gate voltage). At this time, the power consumed by IGBT will instantly reach megawatt level. If the short-circuit current cannot be reduced in a short time, the IGBT will be burned down due to overheating of the chip. However, if the turn-off speed during short-circuit is as fast as normal turn-off, a large di/dt will be generated. Due to the existence of parasitic inductance, this di/dt will bring a large voltage peak at both terminals of IGBT, which will cause IGBT overvoltage breakdown.

In order to suppress the turn-off peak in short circuit, the Firstack intelligent drive circuit introduces soft shut down technology. In case of direct short-circuit of IGBT, on the premise of ensuring that the short-circuit time under 10us, by slowly reducing the gate voltage V_{GE}, the IGBT chip will not be burned out due to overheating, and the di/dt will be effectively reduced, thus avoiding the voltage peak when the IGBT is turned off, which ensures the safety of the IGBT.

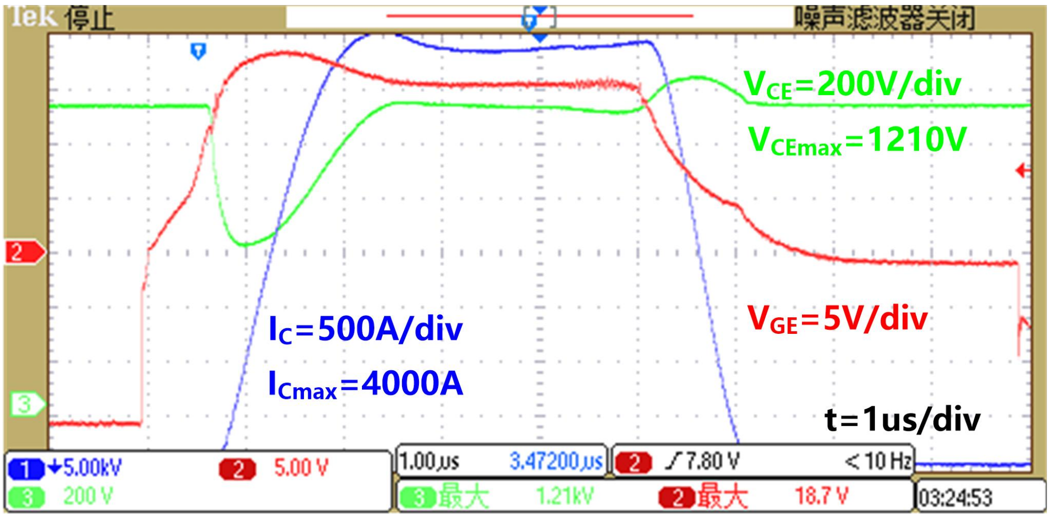

Fig. 6 Short-circuit waveform of FF1000R17IE4 at 1100V

Fig.6 shows the short-circuit waveform of the 1700V/1000A IGBT(FF1000R17IE4) controlled by the Firstack IGBT drive circuit when the DC bus is 1100V. The peak value of short-circuit current is 4000A(4 times of rated current). Under the action of soft shut down, I_C drops slowly, V_{CE} has almost no overshoot, and IGBT is safely turned off.

◆ Prevent shoot-through of the top & bottom IGBT

When there is command confusion of the master computer, the top and bottom IGBT PWM command signal that the drive circuit board received may make the top and bottom IGBT turn on at the same time. In order to prevent this from happening, the drive circuit board (software) performs the logic operation on the received PWM signal, so that the top and bottom IGBT will not be turned on at the same time, so as to avoid the shoot-through of the top and bottom IGBT.

Gate resistor indication

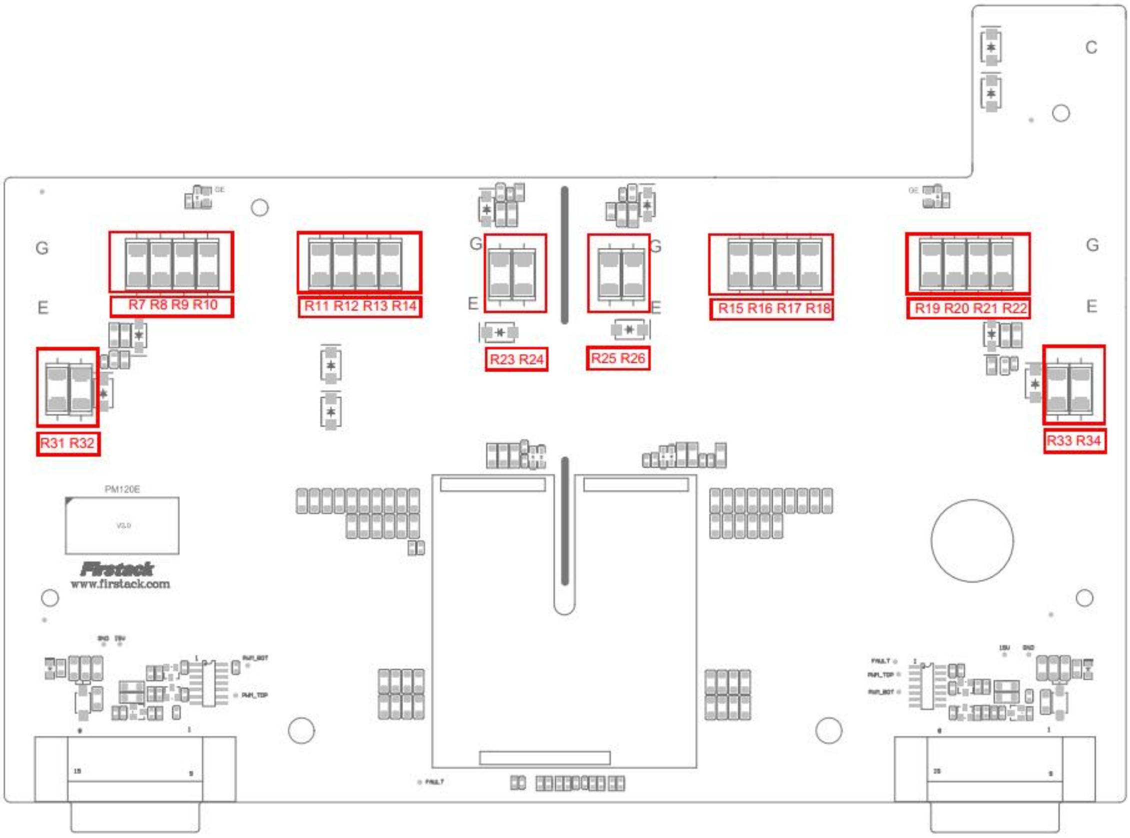

Fig. 7　Gate resistor indication

Calculation formula of gate resistor

	R_{GON}	R_{GOFF}	R_E
Top IGBT 1	R13//R14	R11//R12	R23//R24
Bottom IGBT 1	R7//R8	R9//R10	R31//R32
Top IGBT 2	R21//R22	R19//R20	R33//R34
Bottom IGBT 2	R17//R18	R15//R16	R25//R26

Table of gate resistance values of commonly used modules

IGBT part number	R_{GON}	R_{GOFF}	R_E	C_{ge}
FF1000R17IE4	1.35Ω	2.04Ω	0.235Ω	NC
FF1400R17IP4	0.75Ω	1.35Ω	0.235Ω	NC
2MBI1000VXB-170E-54	2.04Ω	1.8Ω	0.235Ω	47nF

Change information

2020-3-9 Add the conformal coating method and standard

Conformal coating selective, dry film 60-130um.

Technical support

Firstack's professional team will provide you with business consultation, technical support, product selection, price and lead time and other related information, and guarantee to answer your questions within 48 hours.

Legal disclaimer

This manual gives a detailed introduction about the product, but cannot promise to provide specific parameters. No warranty or guarantee, express or implied, is given herein as to the delivery, performance or applicability of the product.

Firstack reserves the right to modify technical data and product specifications at any time without prior notice. Firstack's general payment terms and conditions apply.

Contact information

Tel: +86-571 8817 2737

Fax: +86-571 8817 3973

Postcode: 310011

Website: www.firstack.com

E-mail: fsales@firstack.com

Address: 4-5/F, Building/5, Xizi Wisdom Park, No.1279 Tongxie Road, Hangzhou, China