

PM110TRP Data Sheet

Abstract

Firstack digital intelligent IGBT gate driver is specially developed for high power, high voltage IGBTs with powerful features and high reliability, suitable for 2-level converters, and its applications cover renewable energy, rail, industrial drivers and smart grid.

The PM110TRP is a 3-parallel plug-and-play gate driver for PrimePACK™ modules based on the Firstack digital intelligent IGBT gate driver.

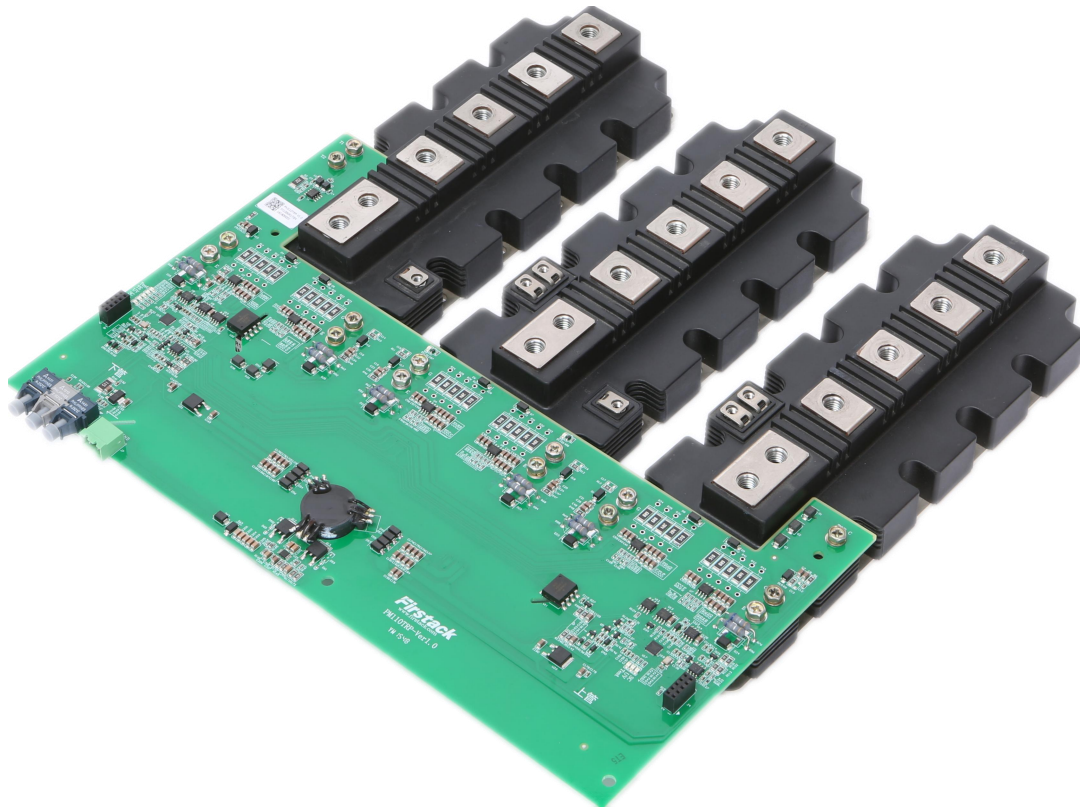


Fig. 1 Product picture

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Functional block diagram

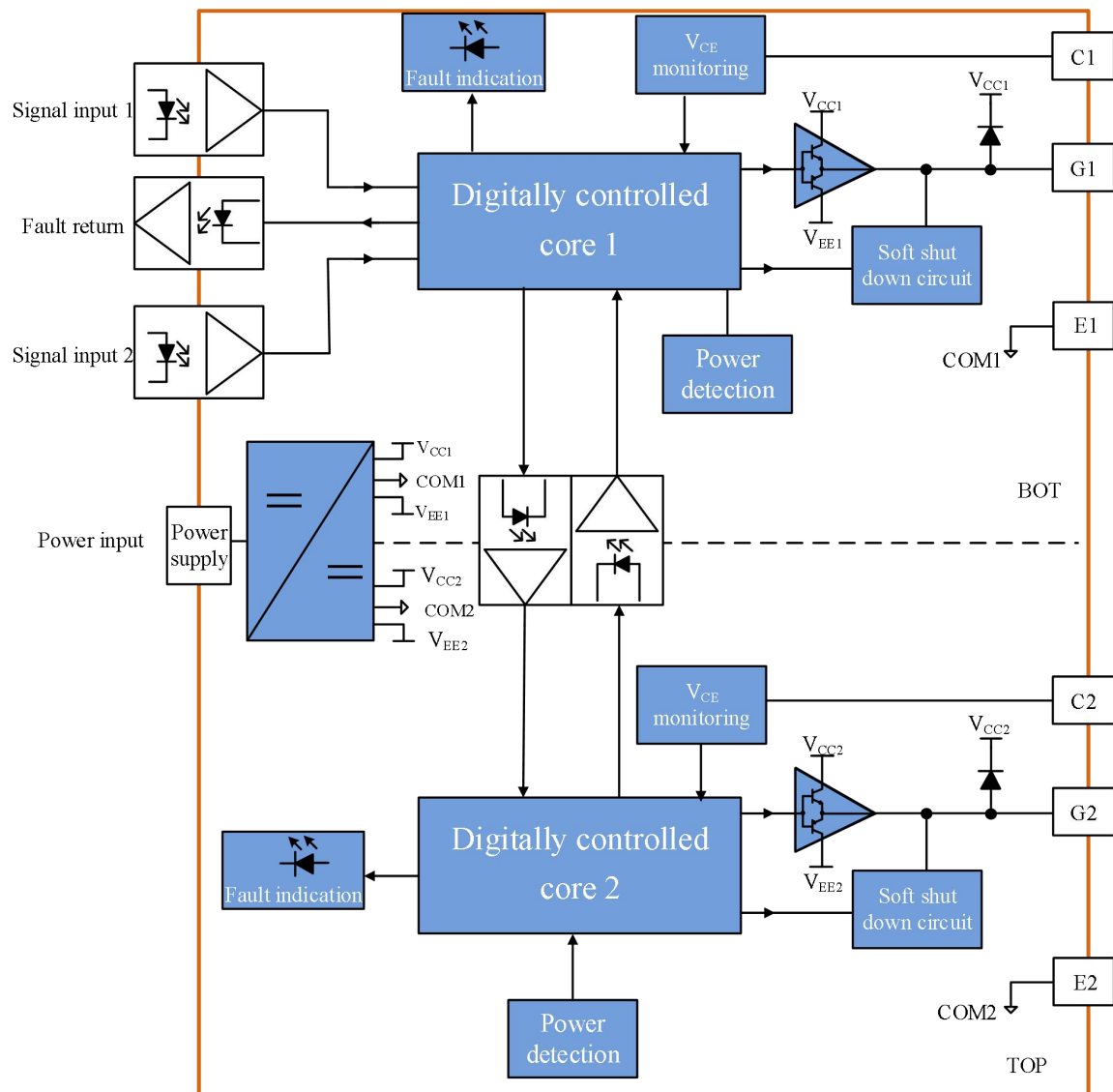


Fig. 2 Functional block diagram

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(fibre-optic) 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 digital gate drivers, the driver status indicator TEST (green) is always on when the gate driver is supplied with the proper supply 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

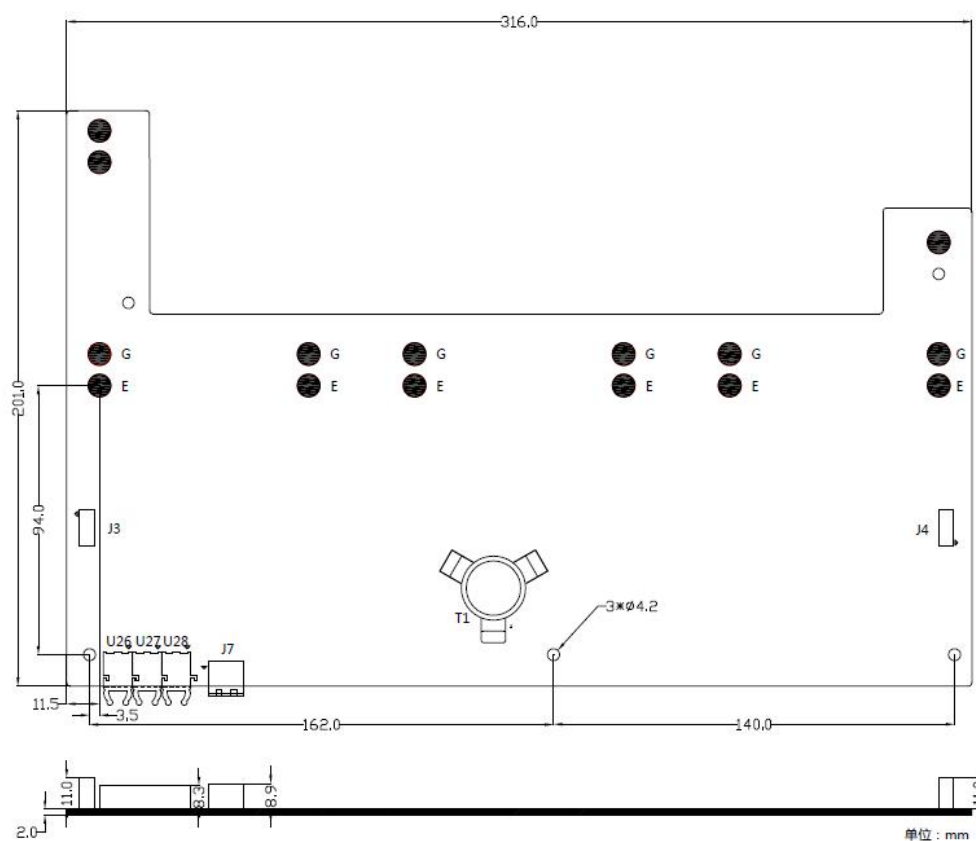


Fig. 3 Mechanical dimensions(unit: mm)

Note: 1. The thickness of the board tolerance is $\pm 10\%$;

2. Other dimensional tolerances refer to GB/T1804-m.

Connector manufacturer and part number

No.	Ref	Manufacturer	Part number	Recommended matching terminals
1	J7	phoenixcontact	MSTBA 2.5/2-G-5.08-1757242	MSTB 2.5/2-ST-5.08-1757019

Pin functional description

J7 pin definition:

Pin	Name	Note	Pin	Name	Note
1	VCC	+24V supply positive	2	GND	+24V supply negative

LED status indication

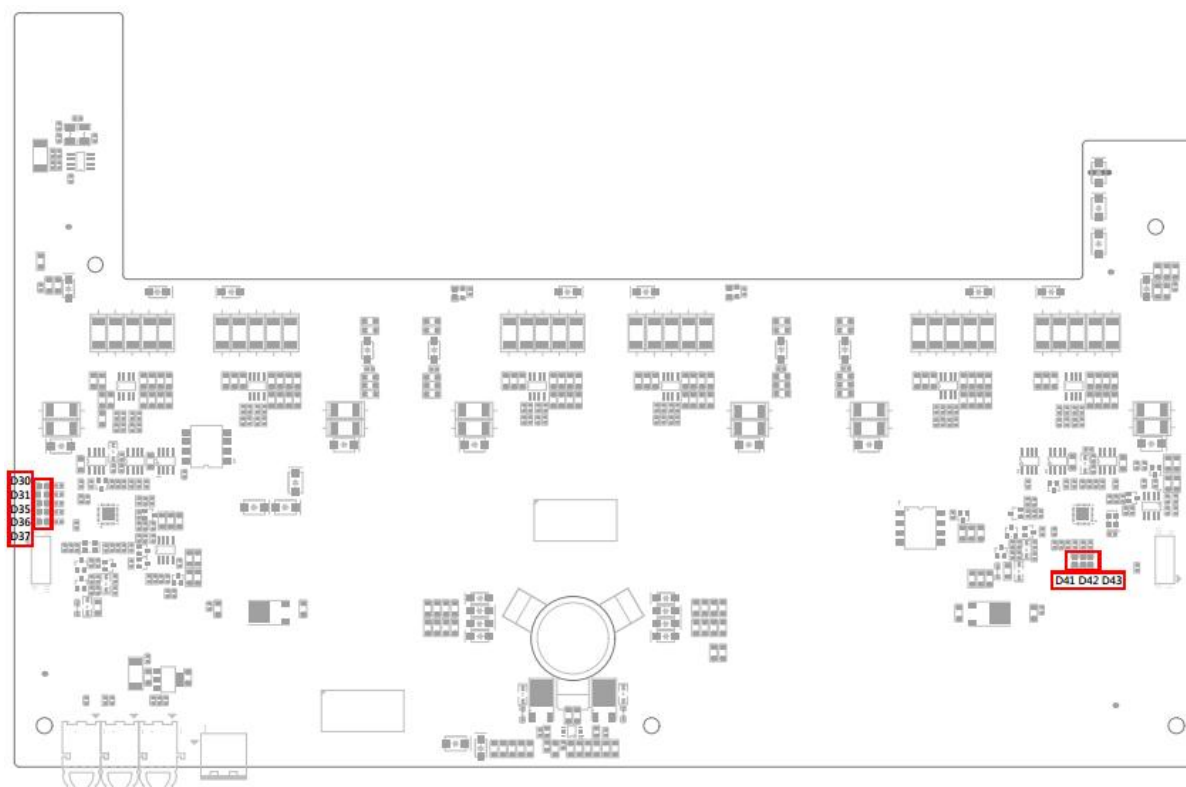


Fig. 4 LED status indication

LED Status Indicator

Number	Bit Number	Screen Printing	Description
1	D11	GE	Bottom IGBT GE signal indicator, on when turned on, otherwise off
2	D13	GE	Top IGBT GE signal indicator, on when turned on, otherwise off
3	D30	TEST	Always on when there is no fault, otherwise off
4	D31	TE	One top IGBT fault trigger is always on, unless restarted
5	D35	UV	One undervoltage fault trigger is always on, unless restarted
6	D36	SC	One short-circuit trigger is always on, unless restarted
7	D37	OT	One over-temperature trigger is always on, unless restarted
8	D41	TEST	Always on when there is no fault, otherwise off
9	D42	UV	One undervoltage fault trigger is always on, unless restarted
10	D43	SC	One short-circuit trigger is always on, unless restarted

Driving parameters

Absolute Maximum Ratings

Parameter	Note	Min.	Max.	Unit
V _{DC}	V _{DC} to GND		24.5	V
Gate peak current			38	A
Output power per channel	T _A ≤85°C		8	W
Test voltage(50Hz/1min)	Primary to secondary side	5000		V _{ACrms}
	Secondary to secondary side	5000		V _{ACrms}
Operating temperature		-40	85	°C
Storage temperature		-40	85	°C

Ambient temperature ≤25°C

Recommended Operating Conditions

Parameter	Note	Min.	Typ.	Max.	Unit
V _{DC}		23.5	24	24.5	V

Electrical Characteristics

Power supply	Note	Min.	Typ.	Max.	Unit
Power supply current	Without load, Note 1		0.24		A
Coupling capacitance	Primary to secondary side		8		pF

Power Supply Monitoring

Threshold		12.5		V
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Short-circuit Protection

V _{CE} monitoring threshold		12.5		V
Response time	TOP, Note 2	8		us
	BOT, Note 2	8		us
Blocking time		90		ms

Timing Characteristics

Turn-on delay	TOP, Note 3	1.1		us
	BOT, Note 3	1.1		us
Turn-off delay	TOP, Note 4	1.2		us

	BOT, Note 4	1.2	us
Rise time	TOP, Note 5	40	ns
	BOT, Note 5	40	ns
Fall time	TOP, Note 6	40	ns
	BOT, Note 6	40	ns
Fault hold time		13	ms

Output Characteristics

Gate turn-on voltage	15	V
Gate turn-off voltage	-15	V
Gate static impedance	2	kΩ

Electrical Isolation

Creepage distance	Primary to secondary side, Note 7	14	mm
	Secondary to secondary side, Note 7	14	mm
Clearance distance	Primary to secondary side, Note 7	9	mm
	Secondary to secondary side, Note 7	9	mm

Note:

1. Power 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;
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;
5. Rise time: the amount of time from 10% of the gate turn-off voltage (-15V) 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 (-15V);
7. Creepage distance: refer to IEC61800-5-1-2007, and meet the basic isolation requirements of below 2km altitude and pollution level 2.

Function description

◆ Short-circuit protection

The driving 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 V_{CE} voltage is detected by high-voltage diode. 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.

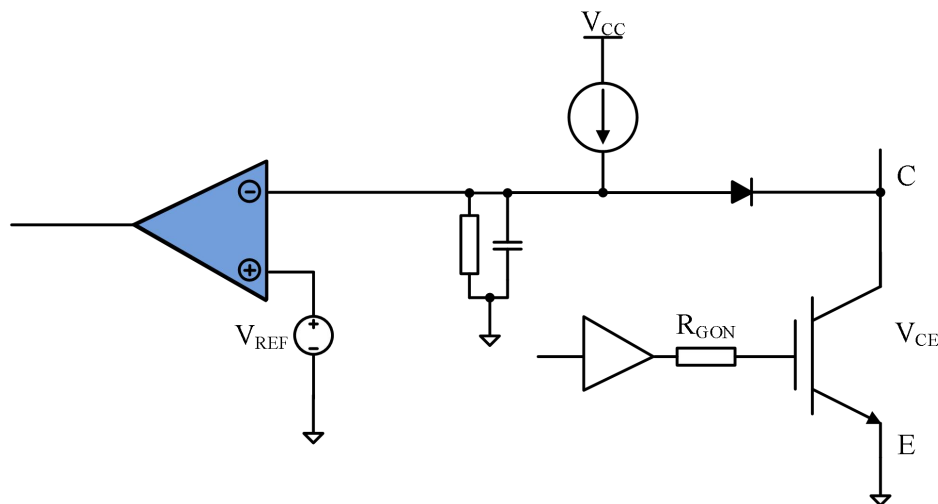


Fig. 5 V_{CE} desaturation detection circuit

◆ 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 driving circuit will determine that an undervoltage fault has occurred, and the driving circuit will automatically block the IGBT and feed back a fault signal to the master computer. After the fault is eliminated, the fault terminal on the primary side will automatically reset after the 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 turn-on of IGBT. At the same time, low gate voltage will increase the switching loss of IGBT.

◆ Soft shut down

When a direct short-circuit occurs, IGBT will quickly desaturate, and the V_{CE} at both terminals of the IGBT will reach the DC bus voltage; the short-circuit current I_C flowing through the IGBT can be 4 times the rated current or even more, which depends on the type of IGBT 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, the di/dt will bring a large voltage spike at both terminals of the IGBT, which will cause the IGBT overvoltage breakdown.

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

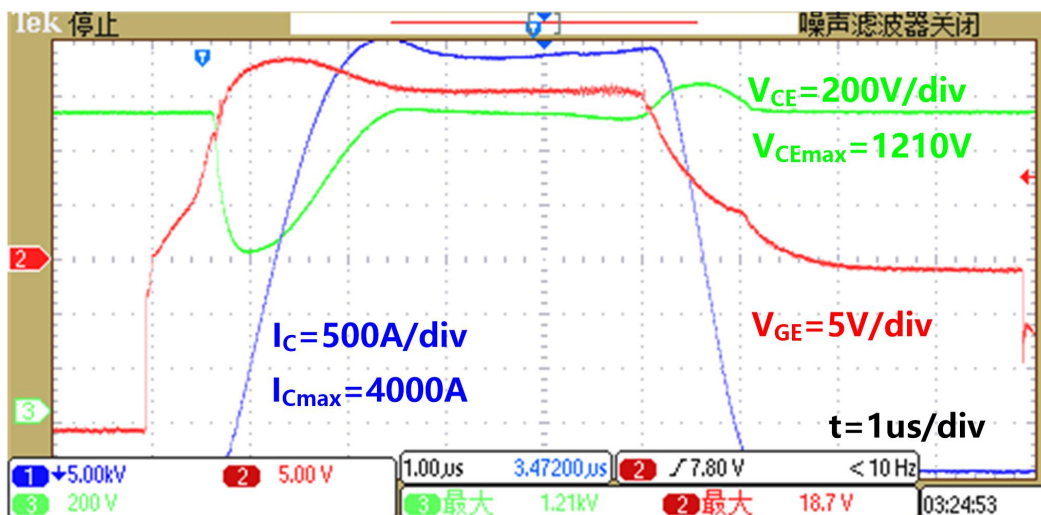


Fig. 6 Short-circuit waveform of FF1000R17IE4 at 1100V

Fig.6 shows the short-circuit waveform of a 1700V/1000A IGBT (FF1000R17IE4) controlled by the Firstack IGBT driving circuit when the DC bus is at 1100V. The short-circuit current peak value is 4000A (4 times of the rated current). Under the action of soft shut down, I_C

slowly drops, and V_{CE} has almost no overshoot, which safely turns off the IGBT.

◆ NTC temperature protection

With the advancement of module packaging technology, more and more modules are beginning to integrate temperature sensors inside, NTC is one of the ways, like PrimePACK™, EconoDUAL™ and other modules, NTC is integrated inside. NTC is located on the DCB, which is a few millimeters away from the chip, but when the chip fails and generates an arc, it may touch the NTC, therefore, when dealing with the NTC, it is necessary to meet the EN50178 specification for safety reasons.

Firstack intelligent gate driver has integrated a temperature protection circuit, when the resistance value of the NTC is lower (higher) than a preset value, it will be considered as over-temperature (low temperature) protection. Since the NTC is not far from the chip and the electromagnetic environment is harsh, the Firstack intelligent gate driver will filter the temperature protection signal through the intelligent fault management system, and after determining that it is a real temperature fault, it will return the over-temperature signal through the isolation device (optical coupler or fibre-optic) to the master computer.

For water-cooling system, the default protection threshold of NTC is 85°C; for air-cooling system, the default protection threshold of NTC is 105°C.

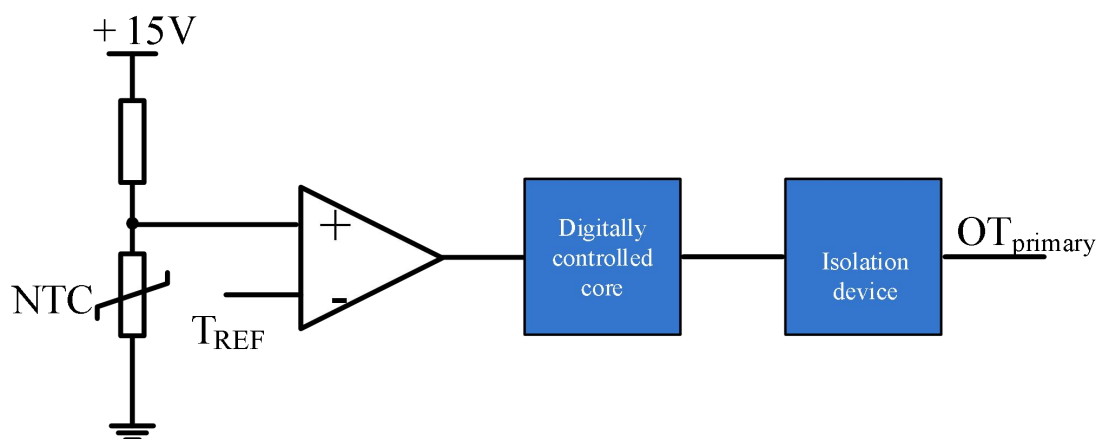


Fig. 7 Over temperature protection schematic

◆ Minimum dead time

The gate driver board has a minimum 3.3us dead time function. When the dead time of the top and bottom IGBT PWM signals is less than 3.3us, the gate driver generates a 3.3us dead time.

And when the top and bottom IGBT PWM signal dead time is greater than 3.3us, the gate driver retains the control signal dead time.

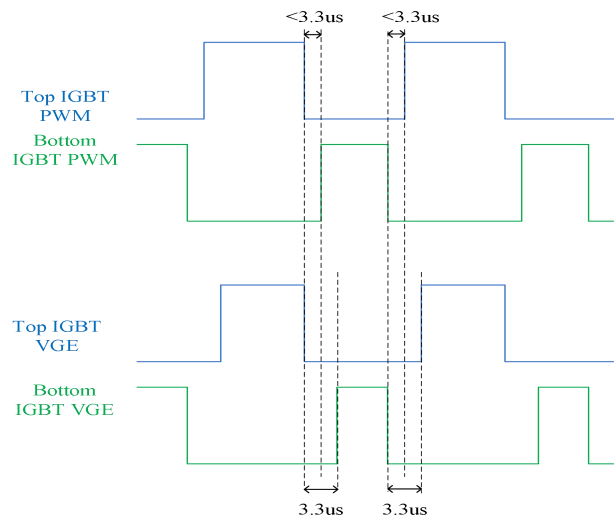


Fig. 8a Input dead time less than 3.3us, generate a 3.3us dead time

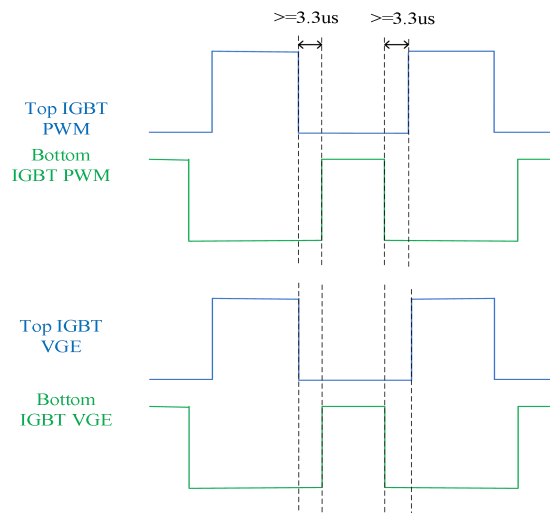


Fig. 8b Input dead time larger than 3.3us, retain the dead time of the control signal

Gate resistor indication

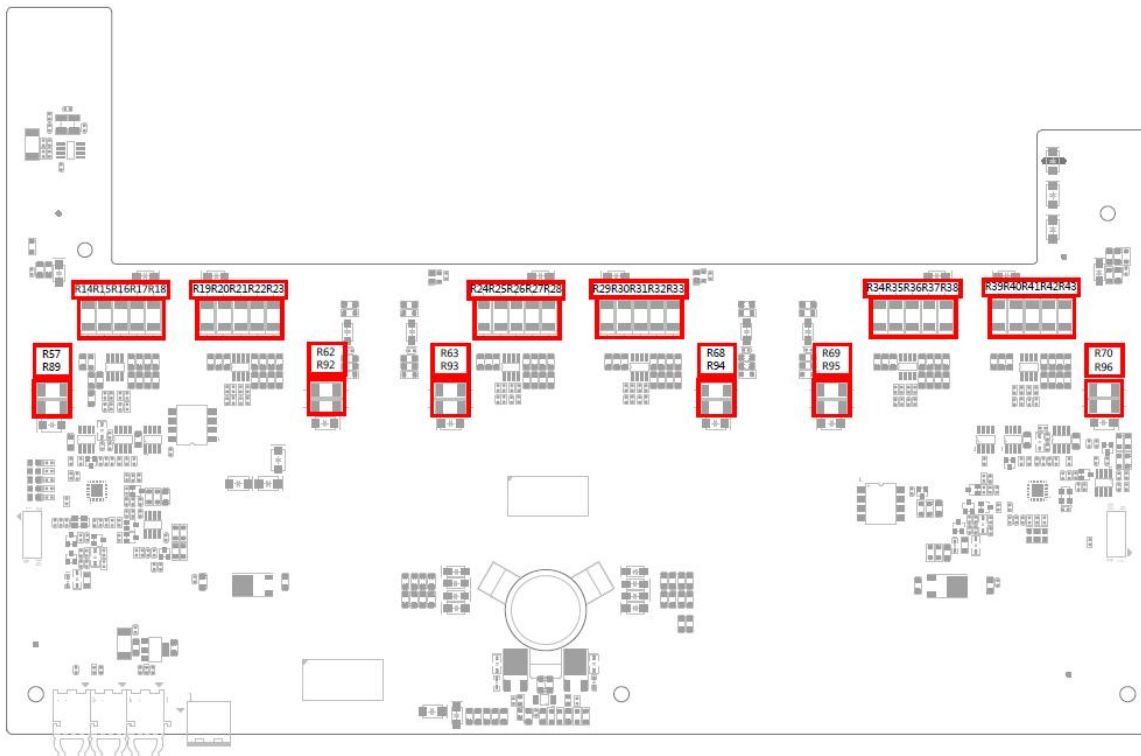


Fig. 9 Gate resistor indication

Calculation formula of gate resistor

	R_{GON}	R_{GOFF}	R_E
Top IGBT 1	$R22//R23+R62//R92$	$R20//R21+R62//R92$	$R62//R92$
Bottom IGBT1	$R16//R17+R57//R89$	$R14//R15+R57//R89$	$R57//R89$
Top IGBT2	$R32//R33+R68//R94$	$R30//R31+R68//R94$	$R68//R94$
Bottom 2	$R26//R27+R63//R93$	$R24//R25+R63//R93$	$R63//R93$
Top IGBT3	$R42//R43+R76//R96$	$R40//R41+R76//R96$	$R76//R96$
Bottom 3	$R36//R37+R69//R95$	$R34//R35+R69//R95$	$R69//R95$

Common IGBT module gate parameter table

IGBT part number	R_{GON}	R_{GOFF}	R_E
FF650R17IE4	2.14 Ω	3.74 Ω	0.34 Ω
FF1000R17IE4	1.54 Ω	3.74 Ω	0.34 Ω
FF1400R17IP4	0.985 Ω	2.035 Ω	0.235 Ω

Product Selection

Product part number	Cooling method	PWM input level	Fault output
PM110TRP-A-FF1000R17IE4	Air cooling	Fibre-optic input	Fibre-optic output
PM110TRP-W-FF1000R17IE4	Water cooling	Fibre-optic input	Fibre-optic output

Ordering information

PM110TRP can support different part numbers of PrimePACK™ modules from multiple manufacturers. If you have a purchase request, please contact us and we will provide the gate driver that best meets your needs.

Technical support

Firststack'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.

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

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