PM124-E5 datasheet

Abstract

PM124-E5 is the Plug-and-play driver solution for 1500V PV Converter is specialized in FF1800R12IE5 module. Which can support NPC1 topology. It has integrated "Intelligent Faults Management System "(IFMS) to ensure right switching sequence under all faults conditions and Multi-Level Turn off (MLTO) to suppress voltage spike caused by long loop commutation path, which can greatly improve the reliability of the system. Making NPC1 topology as reliable and easy to use as 2-level one.

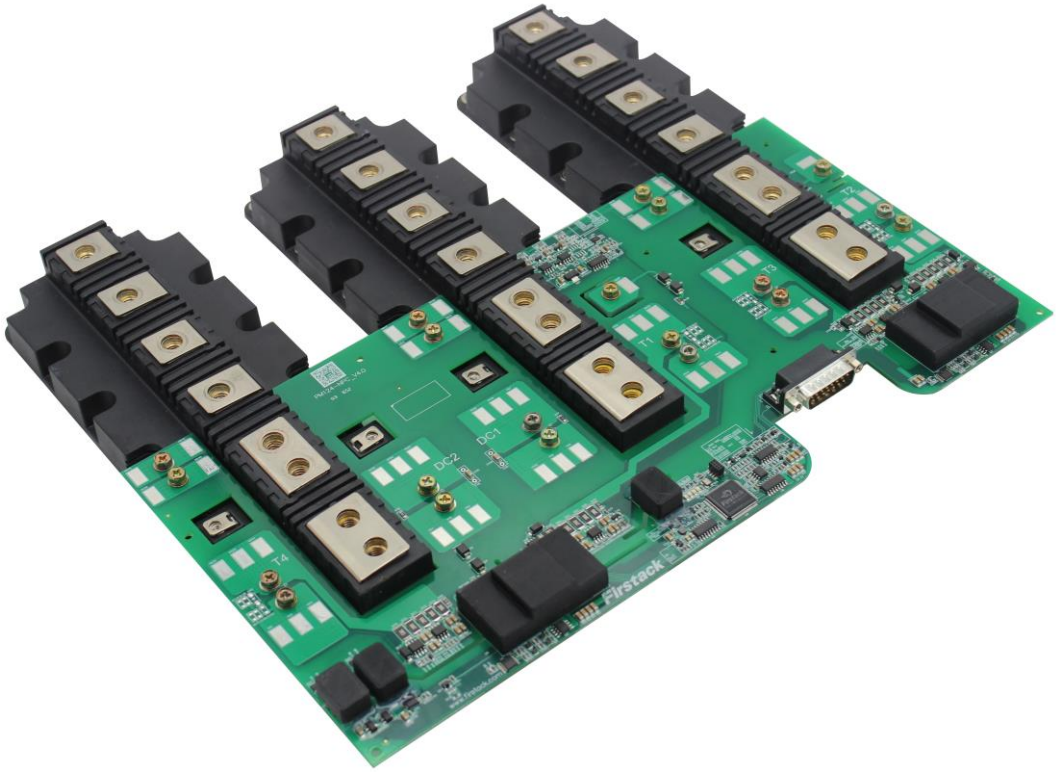

Fig. 1 PM124-E5

Contents

System Block

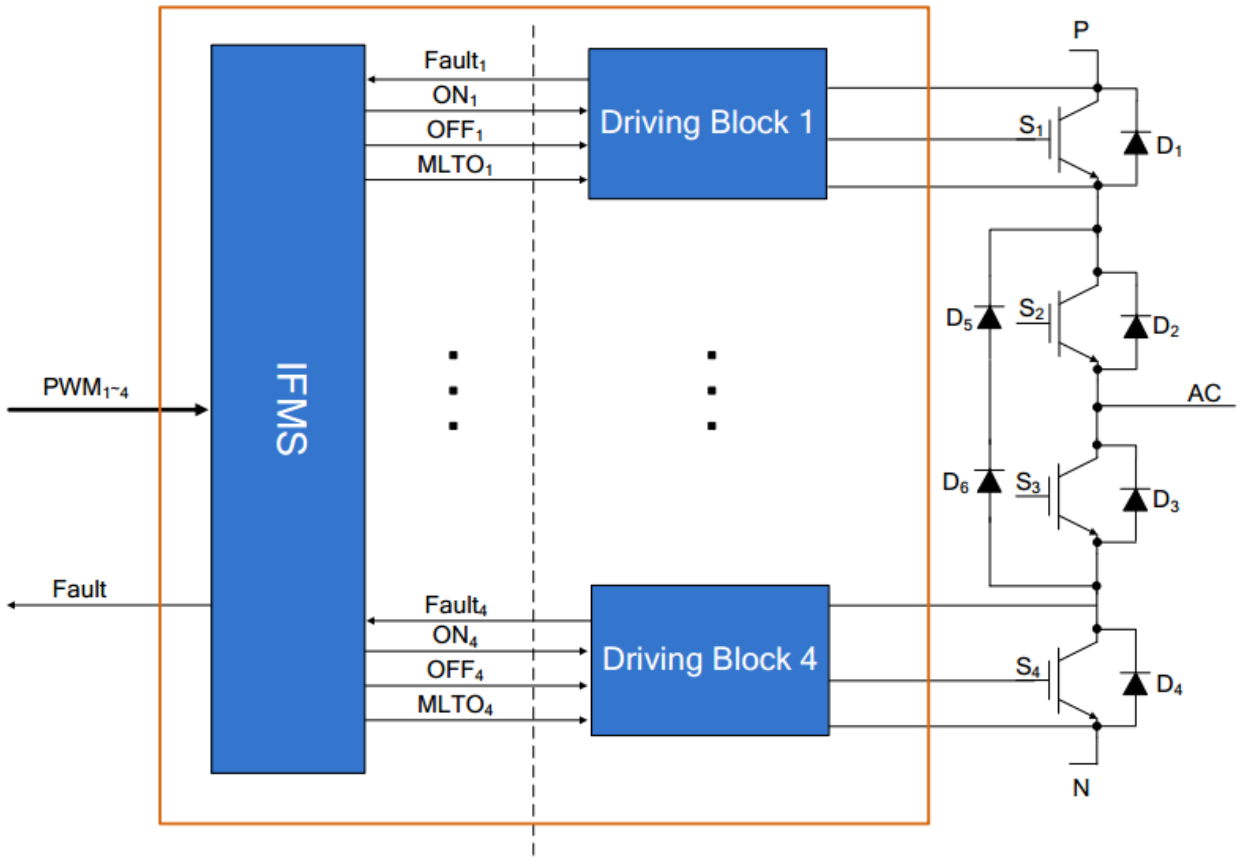

Fig. 2 System Block

Using steps and precautions

The following steps pointed out the easy way to use PM124-E5 drivers:

1. Choose a suitable driver

When applying PM124-E5drivers, you should note that they are specifically adapted to a particular type of IGBT module. These drivers are not valid for IGBT modules other than those specified. Incorrect use may result in failure.

2. Attach the drivers to the IGBT modules (one driver per IGBT module)

Any handing of IGBT modules or drivers is subject to the general specifications for protecting electrostatic-sensitive devices according to international standard IEC 60747-1, Chapter IX or European standard EN 100015(i.e. the workplace, tools, etc. must comply with these standards).

If these specifications are ignored, both IGBTs and drivers may be damaged.

3. Connect the driver to use the control electronics

Connect the driver connector (fiber) to the control unit and provide the appropriate supply voltage for the driver.

4. Check the driver function

Check the gate voltage of all drivers: For the off-state, the nominal gate voltage is specified in the relevant data sheet. For the on-state, it is +15V. Also check the input current consumption of the driver without clock signal and at the desired switching frequency. After the Firstack digital drivers are provided the appropriate supply voltage, the status indicator TEST displays a green light

These tests should be performed before installation, as the gate terminals may

otherwise not be accessible.

5. Set up and test the power stack

Before starting up the system, it is recommended to check each IGBT module with a single pulse or double pulse test method. Firstack recommends that the user need to ensure that the IGBT module does not exceed the operating range specified by the SOA even under the worst conditions, because it relies on the specific converter structure.

Mechanical Size

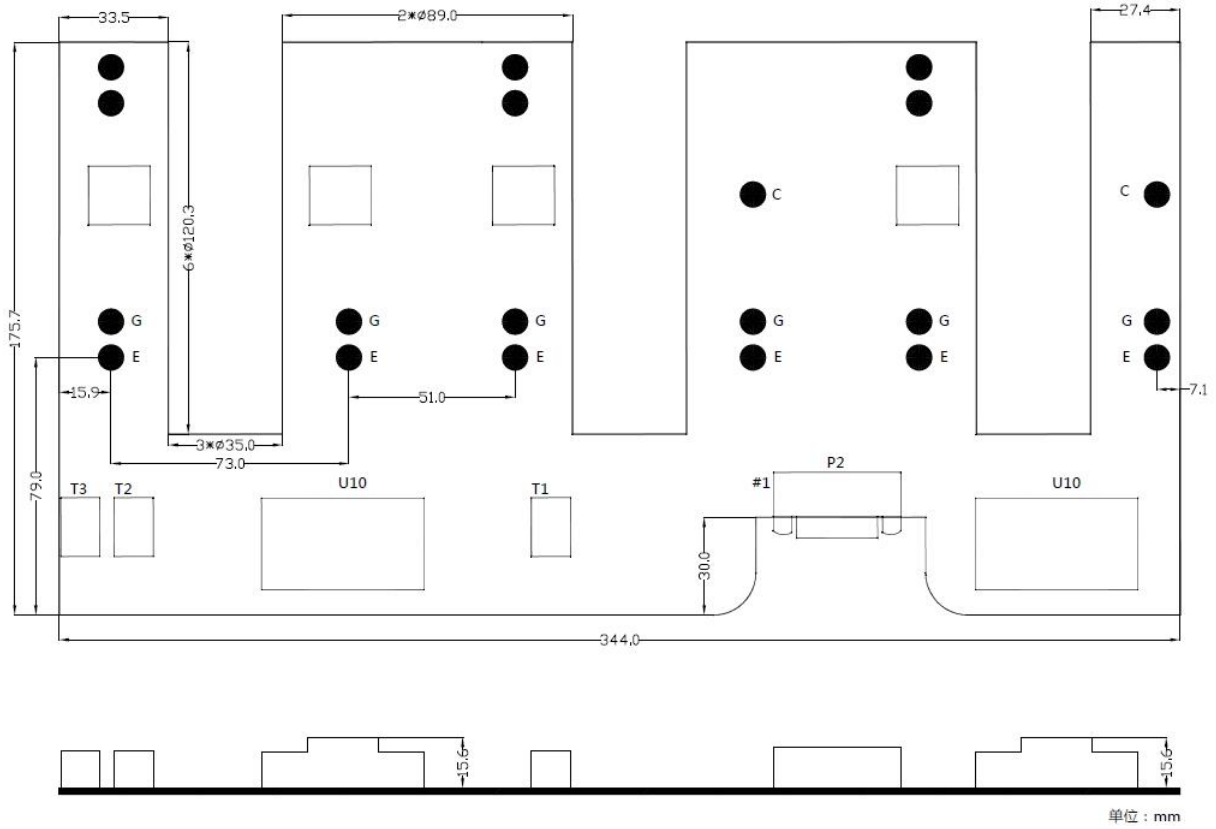

Fig. 3 mechanical size

Connector manufacturers and models

No.	Lable	Manufacturer	Model	Recommended terminal
1	P2	WE	618015231221	618015227221

Pin Destination

P2 destination：

Pin	Lable	Remarks	Pin	Lable	Remarks
1	V_{IN}	+15V for Primary	2	V_{IN}	+15V for Primary
3	IN1	T1 PWM	4	IN2	T2 PWM
5	SO	Status output	6	IN3	T3 PWM
7	IN4	T4 PWM	8	F_{OUT}	Frequency output
9	GND	Ground	10	GND	Ground
11	GND	Ground	12	GND	Ground
13	GND	Ground	14	GND	Ground
15	GND	Ground			

LED Indicator

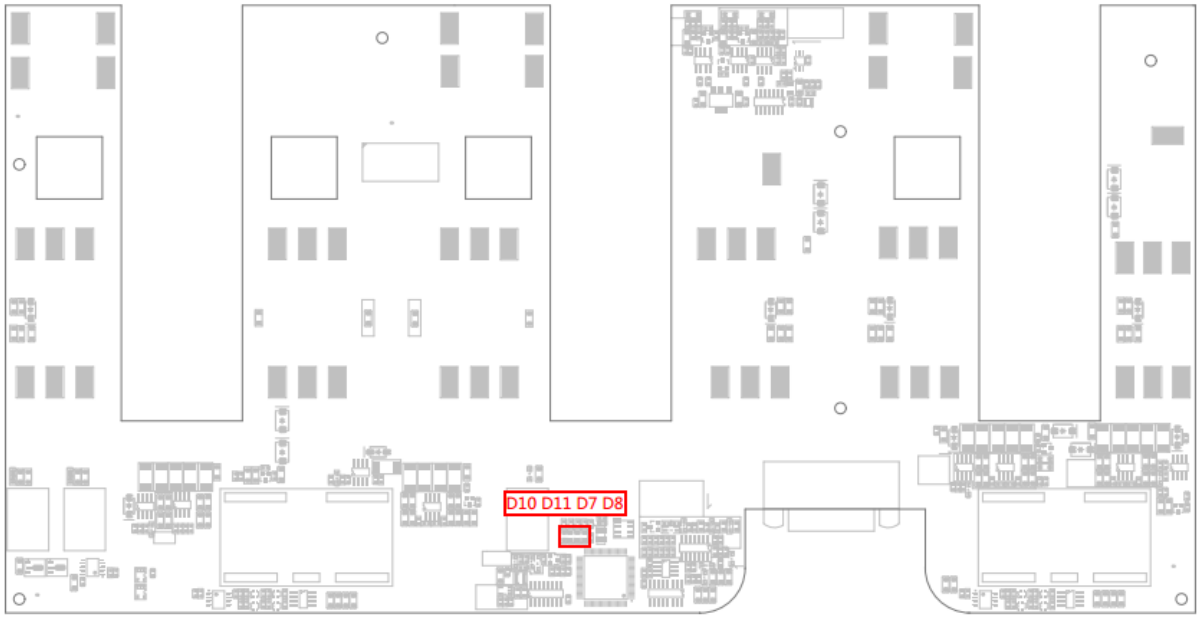

Fig. 4 LED Indicator

LED indicators has been added in Firstack driver board for monitoring the working status of the driver and the converter.

LED Indicator

No.	Location	lable	Remarks
1	D10	OT	OT on, unless driver restarted
2	D11	TEST	Test on, unless fault occurred
3	D7	SC	SC on, unless driver restarted
4	D8	UV	UV on, unless driver restarted

Parameters

Absolute Maximum Ratings

Parameters	Remarks	Min	Max	Unit
V_{IN}	GND		15.5	V
Logic input voltages	GND		15.5	V
SO current	Failure condition		500	mA
Gate peak current	I_{peak}		27	A
Output power	Ambient temperature 85℃		5	W
Test voltage(50HzVAC/1min)	Primary to secondary		4	kV_{RMS}
	Secondary to secondary		4	kV_{RMS}
|dv/dt|			50	kV/us
Operating temperature		-40	85	℃
Storage temperature		-40	85	℃

Recommended Operating Condition

Parameter	Remarks	Min	Typ	Max	Unit
V_{IN}			15		V
PWM			15		V

Electrical characteristics

Power supply	remarks	Min	Typ	Max	unit
Supply current	unload，note 1		0.36		A
Coupling capacitor	Primary and secondary ,note 2		10		pF
Power monitoring					
Threshold			12		V
Logical input and output					
Input impedance			5.1		kΩ
Turn-on threshold	note 3	6.3	9.4		V
Turn-off threshold	note 4	4.8			V
SOx			15		V
Short circuit protection					
V_{CE} monitoring Threshold			8		V
Response time	T1、T4 note 5		6.5		us
	T2、T3 note 5		8.5		us
Blocking time			96		ms
Timing Characteristics					
Turn-on delay	T1，note 6		1150		ns
	T2，note 6		1150		ns
	T3，note 6		1150		ns
	T4，note 6		1150		ns
Turn-off delay	T1，note 7		1150		ns
	T2，note 7		1150		ns
	T3，note 7		1150		ns
	T4，note 7		1150		ns
Rise time	T1，note 8		30		ns
	T2，note 8		30		ns
	T3，note 8		30		ns
	T4，note 8		30		ns

Fall time	T1，note 9	240	ns
	T2，note 9	530	ns
	T3，note 9	530	ns
	T4，note 9	240	ns
Fault hold time		40	ms
Electrical Isolation			
Creepage distance	Primary to secondary，note 10	15	mm
Clearance	Primary to secondary	9	mm

All data are tested based on +25 ℃ and V_{IN} = 15V

NOTES：

1. **Supply current： connected the IGBT module without any PWM signal input；**
2. **Coupling capacitor：The coupling capacitance value is within the range given in the table；**
3. **Turn-on threshold：The input voltage value at the time of turn-on；**
4. **Turn-off threshold：The input voltage value at the time of turn-off；**
5. **Response time：Short-circuit protection response time refers to the implementation of SSD from failure to start；**
6. **Turn-on delay： The required time that the rising edge of PMW signal input from the primary edge transferred to the rising edge of the secondary gate driver；**
7. **Turn-off delay：The required time that the falling edge of PMW signal input from the primary edge transferred to the falling edge of the secondary gate driver；**
8. **Rise time：The required time from 10% of the gate turn-off voltage(-10V) to 90% of the gate turn-on voltage(+15V);**
9. **Fall time：The required time from 90% of the gate turn-on voltage(+15V) to 10% of the gate turn-off voltage(-10V)；**
10. **Creepage：IEC61800-5-1-2007**

Main function

◆ Short circuit protection

V_{CE} is checked after the response time at turn on to detect a short circuit

If V_{CE} is higher than the programmed threshold V_{TH}, the driver detects a short circuit at the IGBT, and feedback the fault to the host. The driver will not turn off the IGBT but keep it in turn on status until turn off by the host.

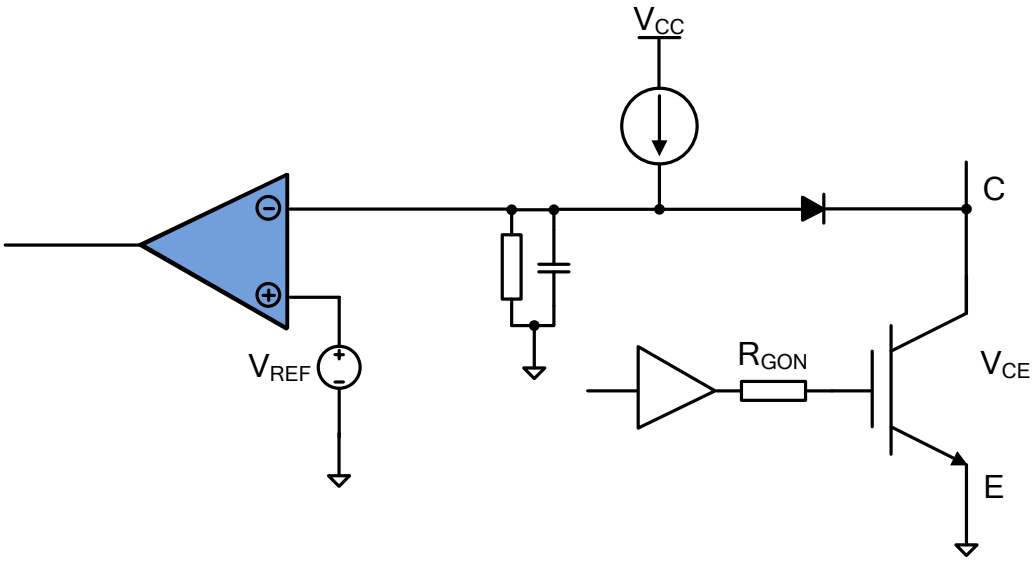

Fig. 5 V_{CE} salutation detection circuit

◆ under voltage protection

The driver monitoring the positive and negative power supply on the secondary side. If V_{CE} is higher than the programmed threshold V_{TH}, the driver detects a short circuit at the IGBT, and feedback the fault to the host. The driver will not turn off the IGBT but keep it in turn on status until turn off by the host.

Intelligent Driver recommended that any IGBTs in the bridge arm should not work under under-voltage condition. Due to the presence of CCG, when a certain IGBT in the bridge arm is turned on, its high dv / dt can be coupled to another IGBT via CGC, resulting in another IGBT micro-conductivity. The lower

V_{GE} will increase the IGBT switching losses.

◆ MLTO

Multi-level turn off is used to suppress the voltage spike of the long communication loop, which typically has an inductance of about 100-150 nH. By doing so, V_{CEMAX} of T_2 and T_3 are greatly reduced.

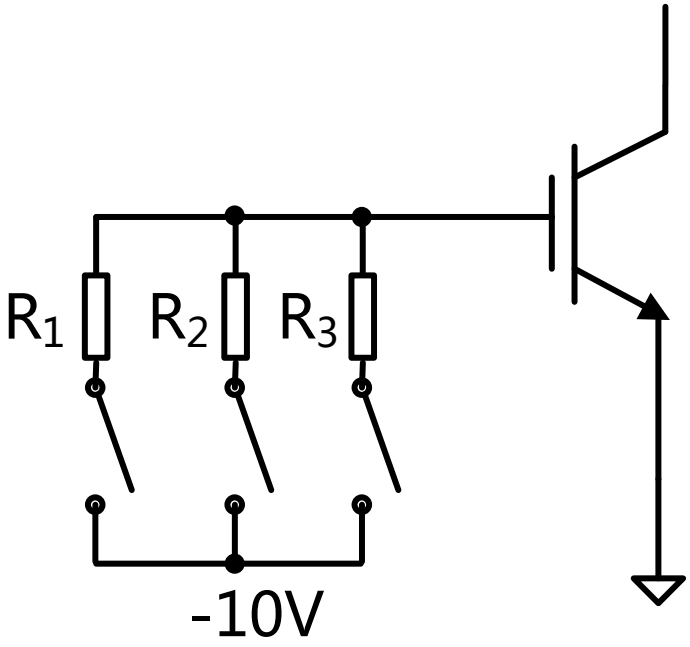

Fig. 6 Multi-level turn off

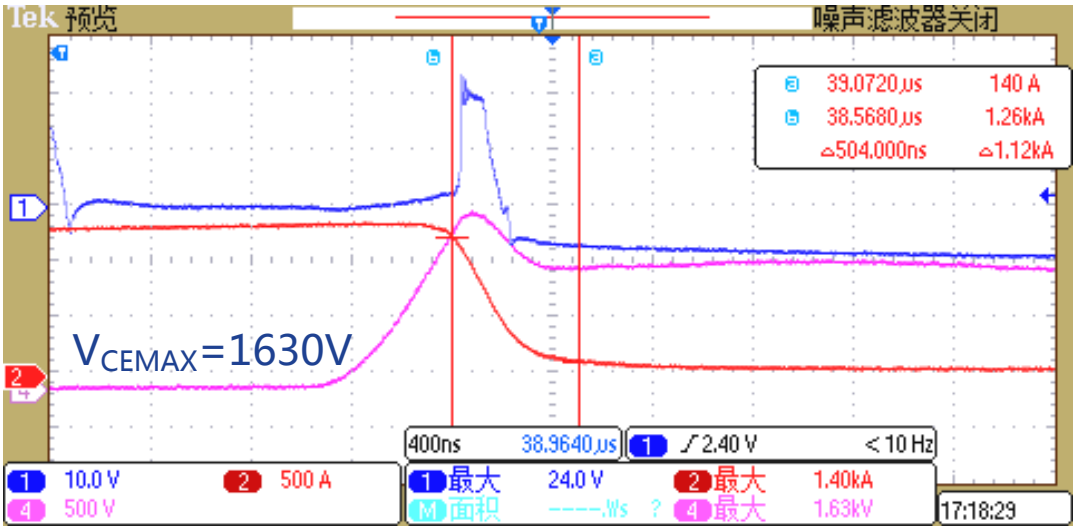

Fig. 7a turn on/off without multi-level

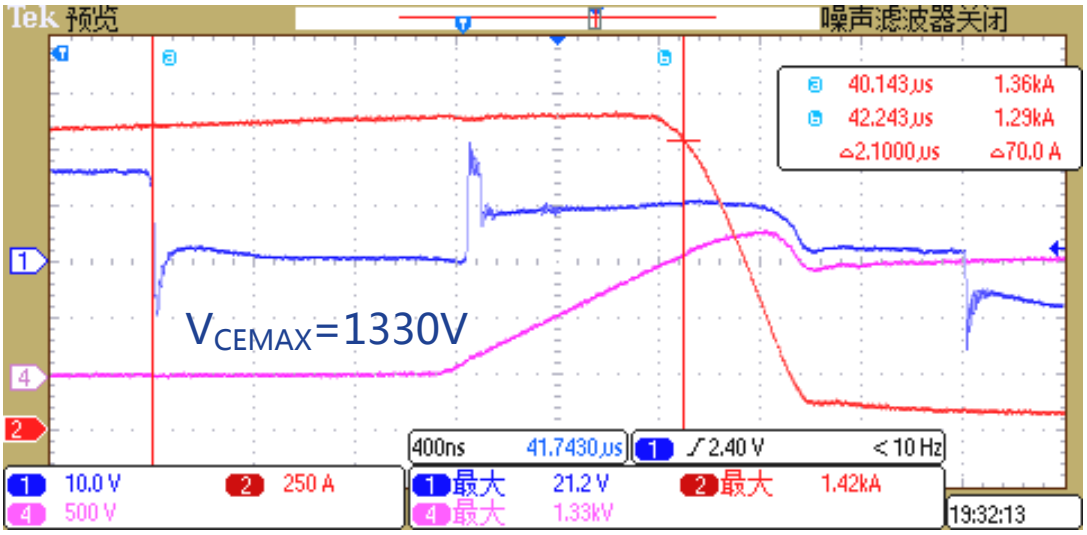

Fig. 7b turn on/off with multi-level

◆ Abnormal Pulse

During the converter works, when the host occurs abnormal or the transmission line is disturbed. And the control commands from upper and lower tube appear as high as the case. In the bridge arm structure, the same high control command will be opened on the upper and lower tube at the same time while causing the module back to saturation, and resulting in a lot of heat, finally damage the module seriously.

To solve this problem, Firstack driver integrated PWM interlock function. When it is found that the PWM instructions are very high in both upper and lower tubes, and the driver will ignore the high command automatically, but it will not return the fault information.

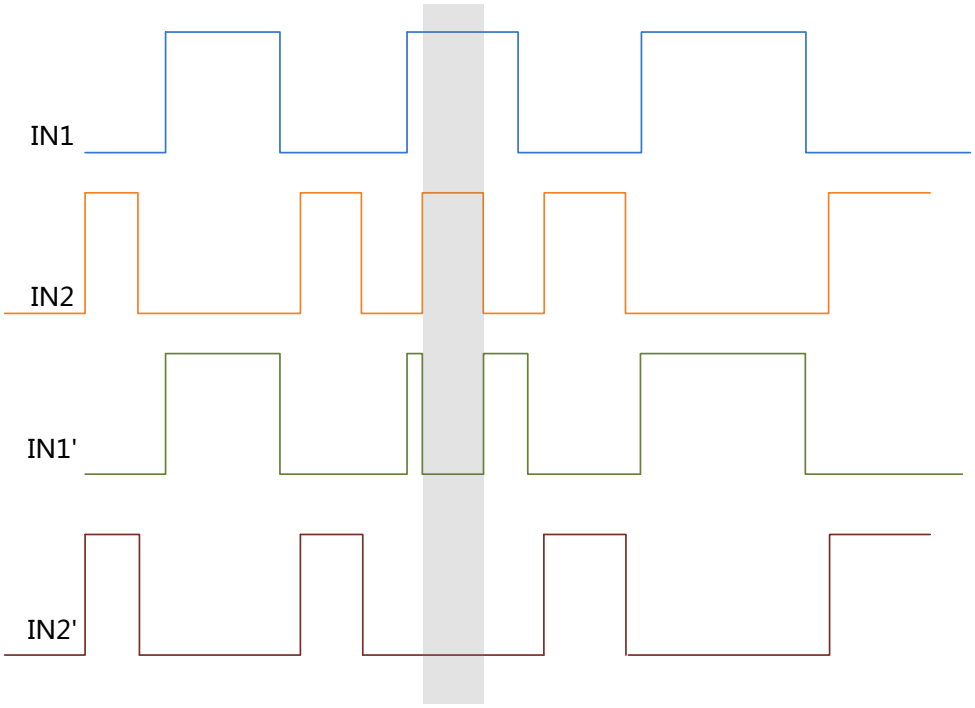

Fig. 8 PWM interlock sequence diagram

◆ Immortal Driver

Since it is necessary to reduce the coupling capacitance C_{PS} of the primary and secondary sides as much as possible, the DC/DC of the driver works at open loop mode, so it is difficult to integrate overcurrent protection and other functions, which leads weak overload capacity. Almost all drivers' failure is associated with DC / DC failure.

In order to improve the reliability of the driver, Firstack intelligent driver proposed an "Immortal Driver" concept. The driver can withstand GE short circuits in the open loop under the premise.

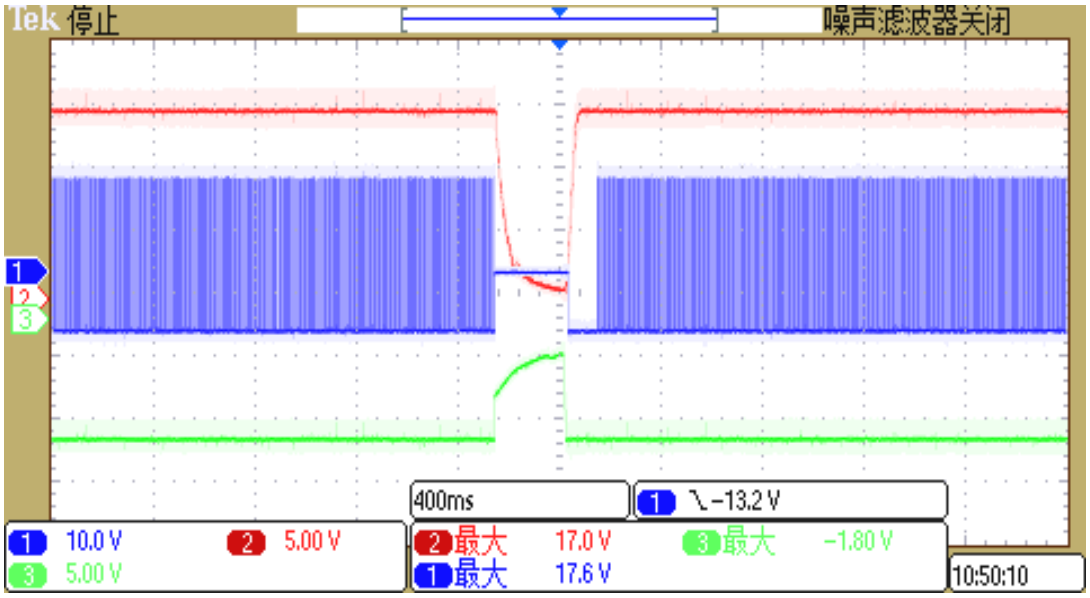

Fig. 9 GE short circuit

As shown in the Fig. 9，CH1（blue）=VGE, CH2（red）=+15V(secondary)，CH3（green）=-10V(secondary). When overload occurs, the driver will block the PWM signal, and feedback the fault signal to the host. After overload removal, the driver return to the normal state.

◆ Environment OT Protection

When the converter running for a long time, the fan may fail and cause the ambient temperature in the cabinet to rise significantly. It will cause great damage to the temperature sensitive device in the cabinet, including the driver board.

To solve the environmental temperature problems, Firstack integrated temperature switches on the driver board. When the temperature of the PCB board is higher than the default value, the driver will feedback this over temperature signal to the host. But it will not blocks IGBT.

◆ Temperature protection and sampling

With the progress of module packaging technology, more and more modules are internally integrated with temperature sensors like NTC, and other modules as PrimePACK™, EconoDUAL™. NTC is on DCB, only a few millimeters away from the chip. However, the arc produced by chip fails may encounter NTC, so for security reasons, when dealing with NTC, it should meet the EN50178 specification.

Firstack intelligent driver integrated temperature monitoring circuit, which can transform the temperature signal into a frequency signal through the frequency conversion circuit, while the isolation device through the frequency signal to inform the host computer.

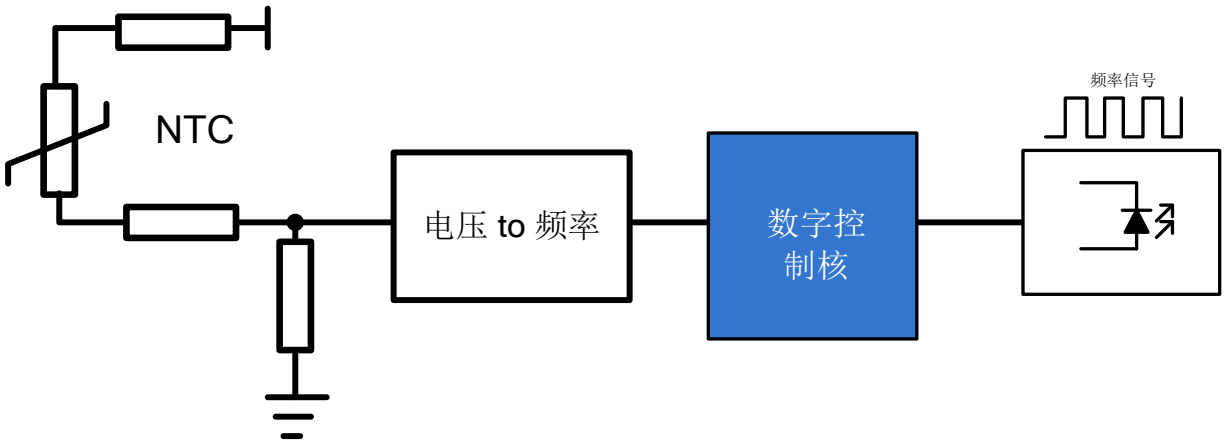

Fig. 10 principle diagram of temperature monitoring

F_{out} NTC

➢ Frequency output

PM124-E5 Choose the maximum temperature of NTC in three-way IGBT, through the frequency output to the master, the frequency signal correspondence is as follows：

$F_{OUT}=0.1*f_{CLKIN}+0.8*(V_{IN}/V_{REF})* f_{CLKIN}$

$*f_{CLKIN}=32.768$ kHz

$*V_{IN}=V_{CC}*R_2// (R_2+1.5K\Omega)$

$*R_2=R_{NTC}//10K\Omega$；Vcc=5V；$V_{REF}=5V$

Gate Resistance Position Indicator

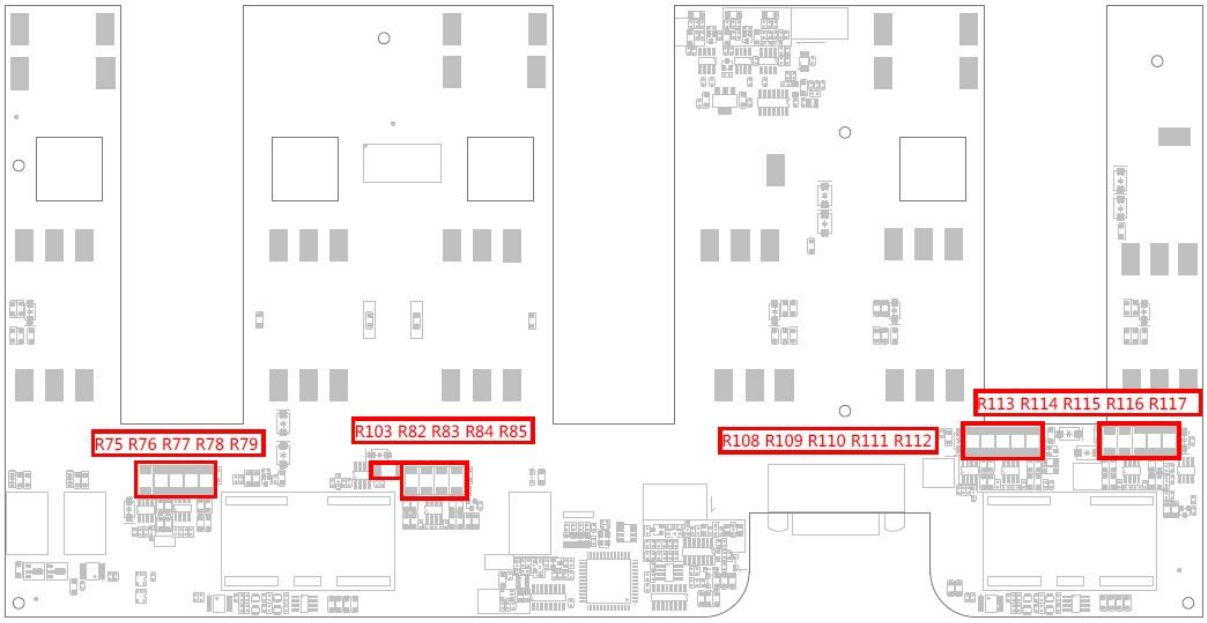

Fig. 11 Gate Resistance Position Indication

Gate resistance calculation formula

	R_{GON}	R_{GOFF}	R_S
T1	R84//R85	R82//R83	R103
T2	R115//R116	R113//R114	R117
T3	R111//R112	R109//110	R108
T4	R78//R79	R76//R77	R75

Gate resistance table for commonly used modules

IGBT model		R_{GON}	R_{GOFF}	R_S
FF1800R12IE5	T1	1.8Ω	1.0Ω	7.5Ω
	T2	1.8Ω	1.0Ω	5.6Ω
	T3	1.8Ω	1.0Ω	5.6Ω
	T4	1.8Ω	1.0Ω	7.5Ω

Ordering Information

PM124-E5 during purchasing, please provide a specific driver model, the format is as follows: PM124-E5-xxx, xxx represents a specific module model, such as PM124-E5- FF450R33TE3

Technical Support

Any questions about business advice, technical support, product selection and other related information are guaranteed to be answered within 48 hours by Firstack professional team.

24h Technical & Services hot line：4001-577-522

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