

SK08110 Data Sheet

Abstract

SK08110 is a high performance gate driver developed for crimp modules in high reliability fields such as HVDC and offshore wind power. Through Firststack's unique "Digitally controlled advanced active clamping", the module can be safely shut down with any large current under the commutation loop of 200+nH stray inductance.

The intelligent fault management system provides all-round protection measures such as V_{CE} short-circuit protection, di/dt short-circuit protection; the digital driver cooperates with the controller by opening the protection authority, and adopts different protection strategies according to the degree of fault damage to ensure the system operates safely and continuously and smoothly.

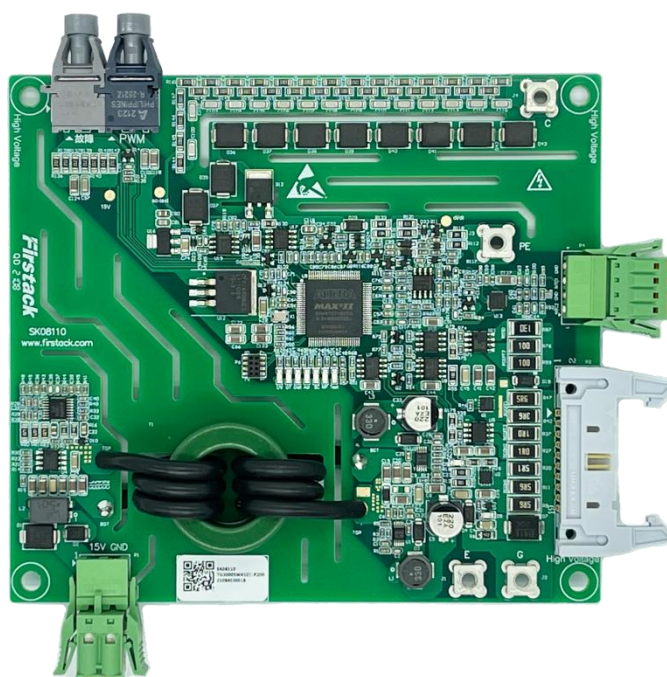


Fig.1 Product photo (SK08110V)

Core advantages:

- ✓ Driving power 8W, maximum gate output current 80A
- ✓ Suitable for 4500V and 6500V crimping IGBT/IEGT modules.
- ✓ Universal or ST fiber interface
- ✓ Digitally controlled advanced active clamping

Typical application:

- ✓ Rail Transit
- ✓ HVDC
- ✓ STATCOM
- ✓ Medium voltage inverter

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System block diagram

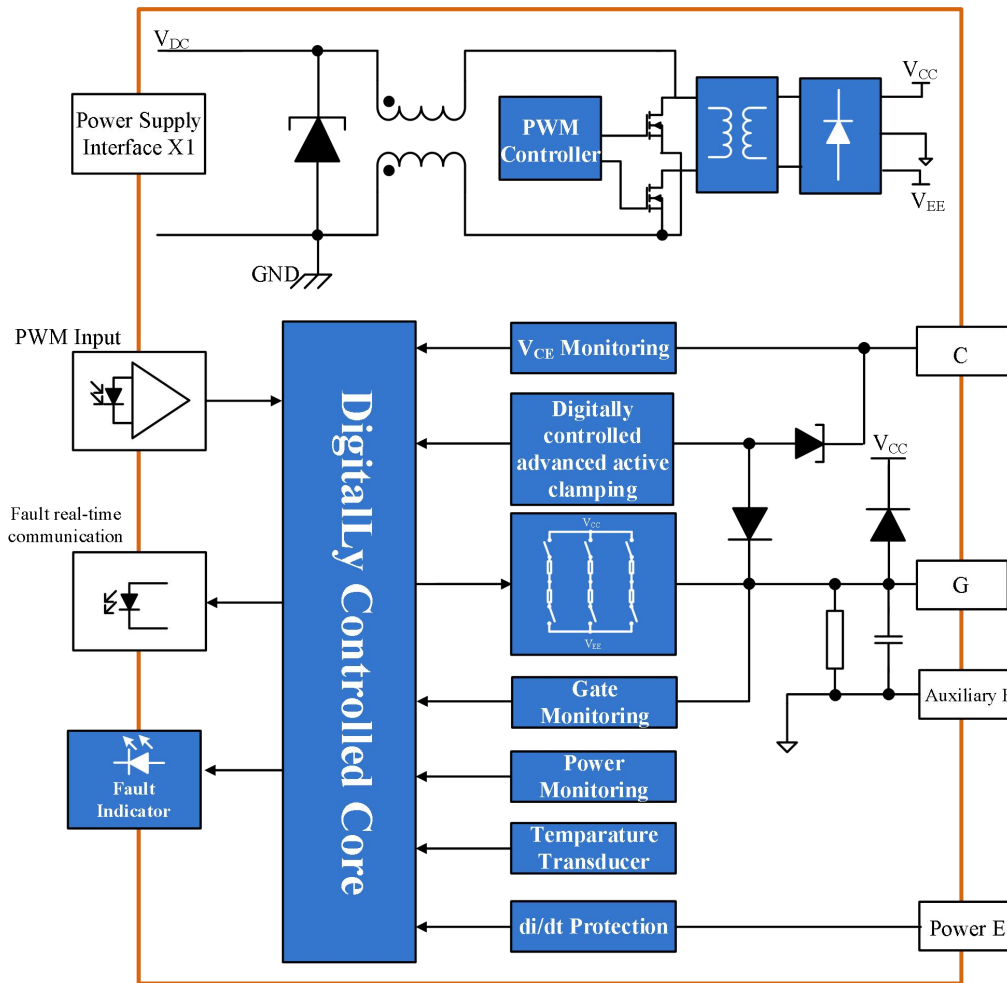


Fig.2 System block diagram

The primary side provides 15V DC voltage, and the power supply voltage required by the system is obtained by isolating the power supply; The PWM signal is transmitted to the secondary side through optical fiber and processed by CPLD to get the driving signal of IGBT.

When the gate is turned on, if there is no short circuit fault, the IGBT is saturated and turned on, the voltage across IGBT-CE is close to zero, the IGBT-CE detection is reset, and the soft turn-off circuit is not started. If a short circuit fault occurs, the main power device exits the saturation region during the gate opening process, the voltage across IGBT-CE is close to the bus voltage, the IGBT-CE detection is set, the soft shutdown circuit is driven to protect the main power device, and the fault signal is transmitted to the controller through the optical fiber; When there is no PWM signal input, the gate is always in the negative pressure off state.

Use steps and safety notice

Simple use steps of the gate driver are as follows:

1. Choose the right drive

When using the driver, you should pay attention to the IGBT module model that the driver adapts to. It is invalid for non-designated IGBT modules, and improper use may lead to driver and module failure.

2. Install the driver on the IGBT module

Any treatment of IGBT module or driver should follow the general specification of electrostatic sensitive device protection required by chapter VII of international standard IEC 60747-1 or IEC60340-5-2 (that is, workplaces, tools, etc. must meet these standards).

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



3. Connect the driver to the control unit

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

4. Check the drive function

Check the gate voltage: for the off state, the rated gate voltage is given in the corresponding data sheet, and for the on state.

State, the voltage is 15V. Also, please check the input current of the driver with and without control signals respectively.

For the digital driver of Firstack, after the driver provides an appropriate power supply voltage, the driving status indicator light TEST (green) is always on.

These tests should be carried out before installation, because the door terminal may not be accessible after installation.

5. Set up and test the power unit

Before the system starts, it is suggested to check each IGBT module separately by single pulse or double pulse test method. Firstack specifically advises users to ensure that the IGBT module will not exceed the working range specified by SOA even under the worst conditions, because it strongly depends on the specific converter structure.

Mechanical dimensions

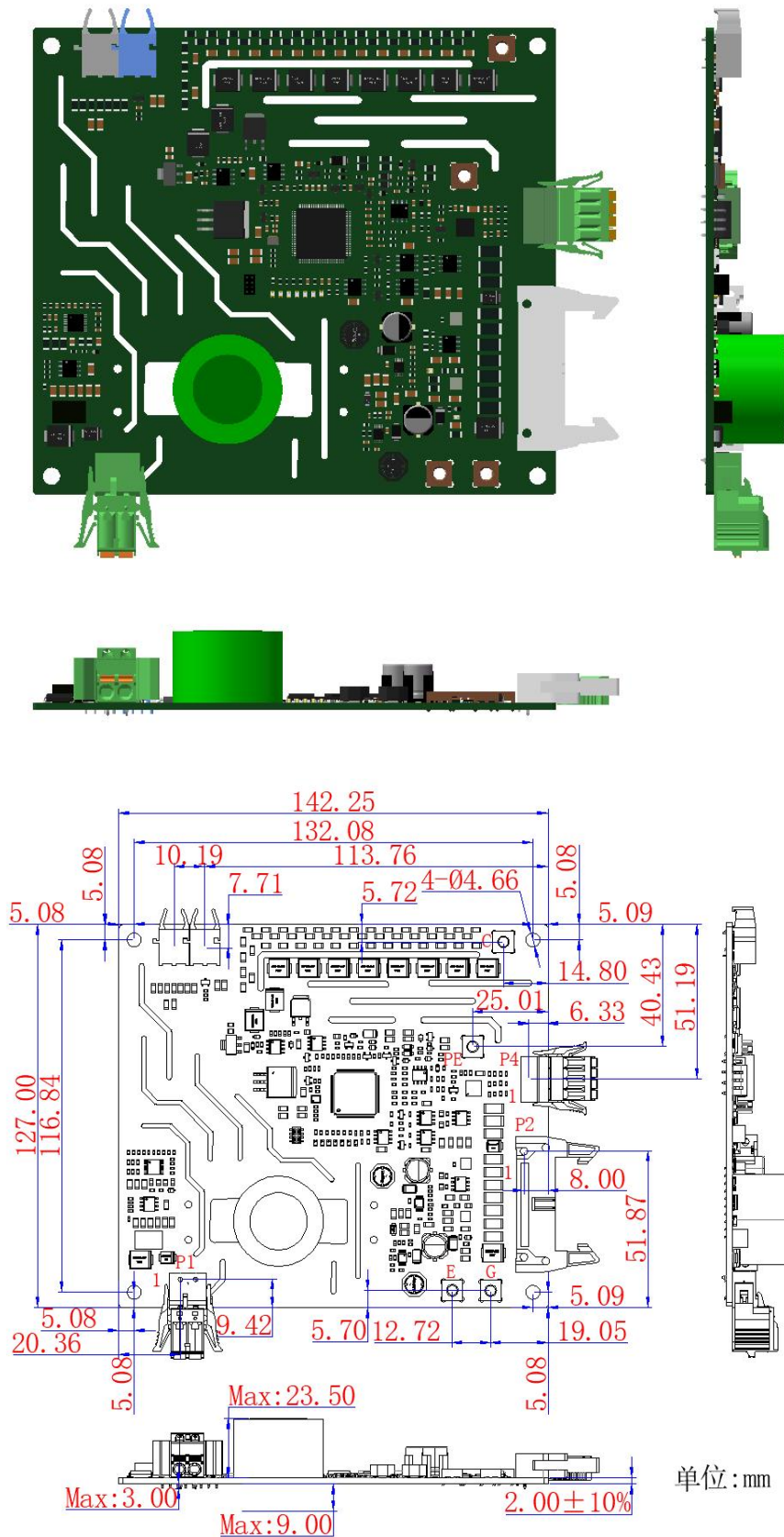
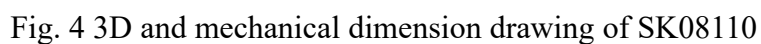


Fig.3 3D and mechanical dimension drawing of SK08110V



1. Thickness tolerance of 10%;
2. The overall dimension of PCB is $\leq 400\text{mm}$, and the tolerance is $\pm 0.5\text{mm}$; the overall dimension of PCB is > 400 , and the tolerance is $\pm 0.8\text{mm}$; refer to GB/T1804-m for other dimensional tolerances.
3. The fixing holes at the four corners are fixed with M4 plastic insulating screws and need to be fixed on the insulating plate, otherwise there will be safety problems.

Pin definition

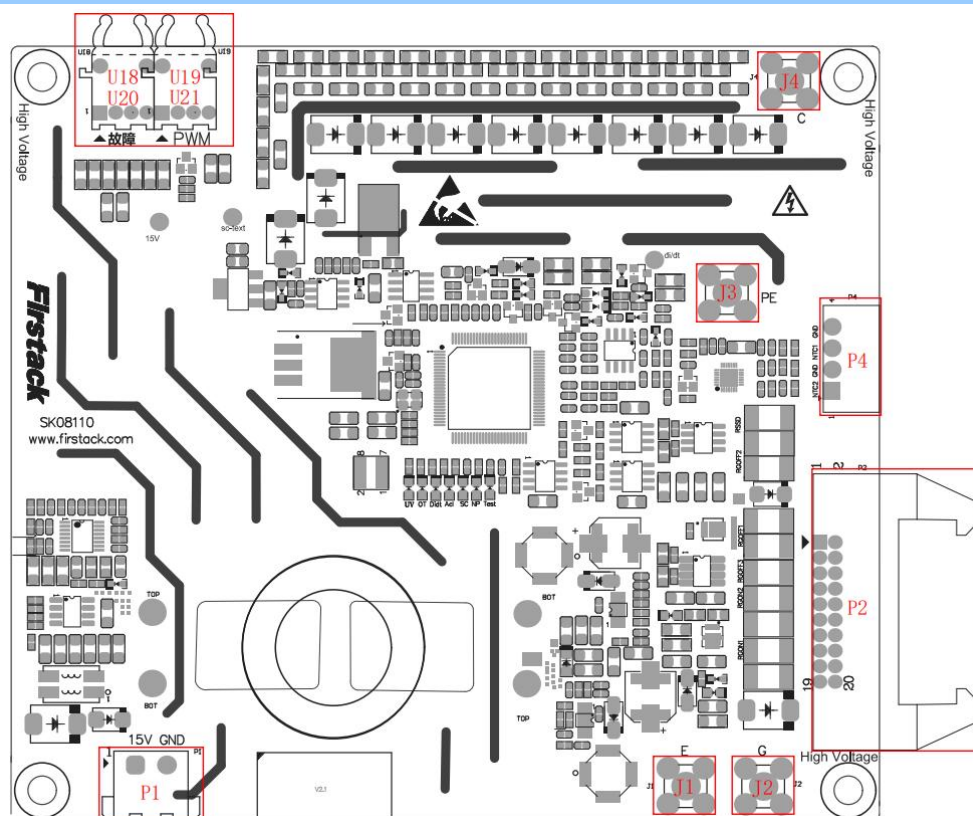


Fig.5 SK08110 Drive Interface Diagram

P1 pin definition:

Pin	Pin Name	Description	Pin	Pin Name	Description
1	VDC	Drive 15V power supply	2	GND	Gate driver reference ground

P2 pin definition:

Pin	Pin Name	Description	Pin	Pin Name	Description
1	E	Gate signal E	2	G	Gate signal G
3	E	Gate signal E	4	G	Gate signal G
5	E	Gate signal E	6	G	Gate signal G
7	E	Gate signal E	8	G	Gate signal G
9	E	Gate signal E	10	G	Gate signal G
11	E	Gate signal E	12	G	Gate signal G
13	E	Gate signal E	14	G	Gate signal G
15	E	Gate signal E	16	G	Gate signal G
17	E	Gate signal E	18	G	Gate signal G
19	E	Gate signal E	20	G	Gate signal G

P4 pin definition:

Pin	Pin Name	Description	Pin	Pin Name	Description
1	NTC1	NTC input terminal	2	GND	Driving secondary reference ground VEE
3	NTC2	NTC input terminal	4	GND	Driving secondary reference ground VEE

J1, J2, J3 and J4 pin definitions:

Pin	Pin Name	Description	Pin	Pin Name	Description
J1	E	Driver gate emitter terminal	J2	G	Driver Gate G Terminal
J3	PE	Power E terminal of the IGBT module	J4	C	IGBT Module Power C Terminal

Note:

1. P2 terminal is designed for the golden finger gate of ABB press-pack modules.
2. Two NTC sampling channels are supported, with a single output of the highest temperature value.
3. For single-switch applications, either of the two NTC channels can be connected.
4. The recommended NTC thermistor model is MF53-502F-3470-100LM4. NTC requirements: B25/50 = 3740 K $\pm$ 1%; R25 = 5 k Ω $\pm$ 1%.

Connector manufacturer and model

Number	Pin	Factory	Model	Recommended mating terminals or remarks
1	P1	PHOENIX	MSTBA 2,5/2-G-5,08-RN-1926015	FKC 2,5/2-ST-5,08-RF- 1925692
2	P2	Nextron	20-pin 2.54 mm pitch shrouded header	20-pin, 2.54 mm pitch female box header
3	P4	PHOENIX	MC-1.5-4-G-3.5-RN (1731691)	FMC-1.5-4-ST-3.5-RF (1952047)
2	J1、J2、J3、J4	WE	M4 screw boss	M4 screws, 304 stainless steel, Recommended torque: 1.2 N·m
3	U18	AVAGO	HFBR-1521Z	Universal optical module, fault signal transmission
4	U20	AVAGO	HFBR-1414TZ	ST optical module, fault signal transmission
5	U19	AVAGO	HFBR-2521Z	Universal optical module, PWM signal reception
6	U21	AVAGO	HFBR-2412TZ	ST optical module, PWM signal reception

Note:

1. Use U20/U21 (ST optical modules) as a pair, or U18/U19 (universal optical modules) as a pair.
2. It is recommended to mount the driver on an insulating plate and use insulating screws for fixation to ensure safety compliance.

3. Please ensure that the driver power supply and the output gate control signal cables are properly insulated from surrounding components.

4. PWM logic: “Light ON” = IGBT ON; “Light OFF” = IGBT OFF.

4. Fault logic: “Light ON” = driver normal; “Light OFF” = driver fault.

LED status indication

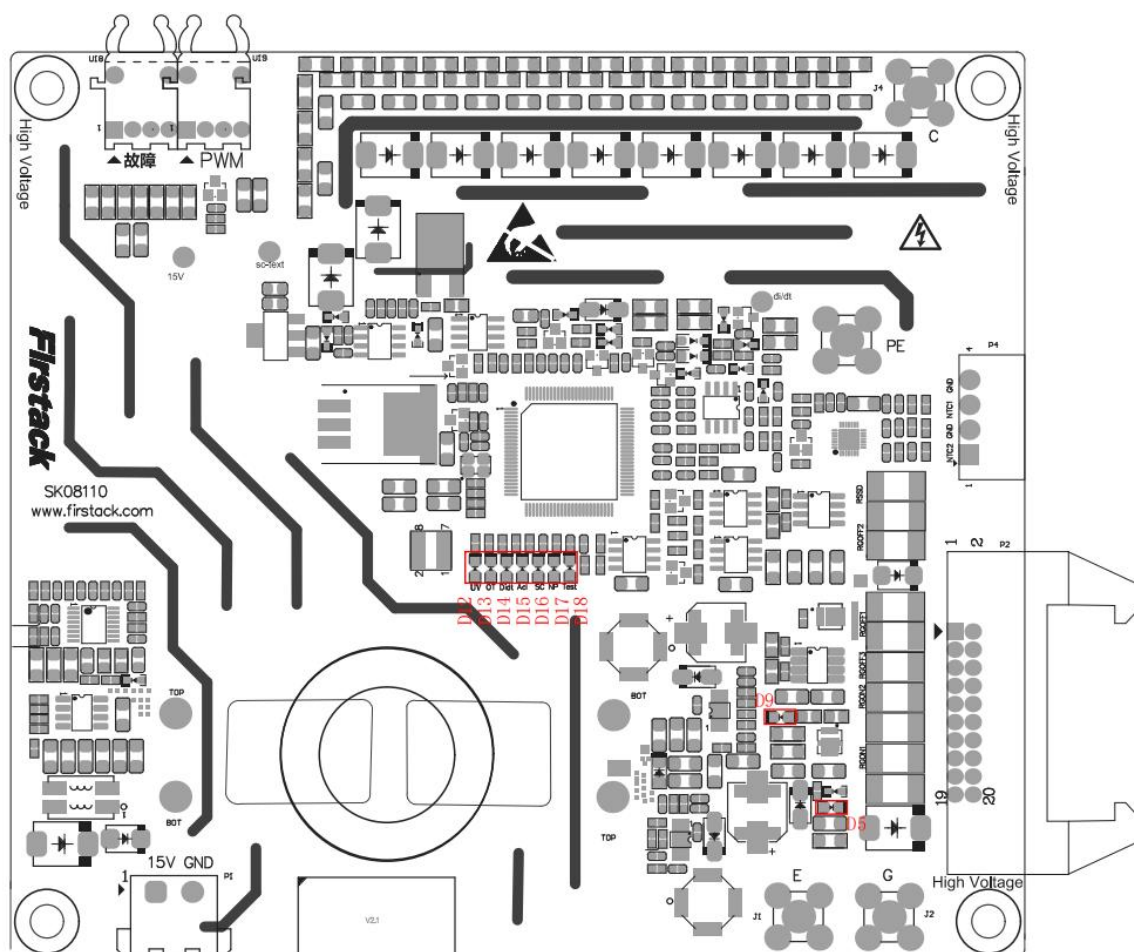


Fig. 6 Status indicator

For the convenience of customers, a number of status indicator LEDs are added to the Firstack driver, which is convenient for customers to know the working status of the driver and converter. The specific explanation is as follows:

Status indicator

Number	Label	Function	Color	Note
1	D5		Green	Gate ON indicator LED: lit during normal gate turn-on; off during gate turn-off
2	D9		Green	Power signal indicator, always on when power is on.
3	D12	UV	Red	An undervoltage trigger is always on, unless it is restarted.

4	D13	OT	Red	An overtemperature trigger is always on unless it is restarted.
5	D14	Di/dt	Red	Once triggered, the di/dt short-circuit protection is always on, unless it is restarted.
6	D15	Acl	Red	Once the ACL is triggered, it will always be on unless it is restarted.
7	D16	SC	Red	Once VCE short-circuit protection is triggered, it is always on, unless it is restarted.
8	D17	NP	Red	Once triggered by a narrow gate pulse, it is always on unless it is restarted.
9	D18	TEST	Green	On when there is no fault, and off when there is no fault.

Driving parameters

Absolute maximum rating

Parameter	Note	Min.	Max.	Unit
V _{DC}	Ground-referenced	0	18	V
Maximum output current			80	A
Single output power	T _A ≤25°C		8	W
	T _A ≤85°C		3	W
Test voltage (50Hz/1min)	Primary to secondary	10.5		kV _{RMS}
Working temperature		-40	+85	°C
Storage temperature		-40	+85	°C

The following data were measured at ambient temperature ≤25°C and V_{DC}=15V:

Recommended work conditions

Parameter	Note	Min.	Typ.	Max.	Unit
V _{DC}		14.5	15	15.5	V

Electrical Characteristics

Parameter	Note	Min.	Typ.	Max.	Unit
Power Supply Current	No load		0.25		A
Coupling Capacitor	Primary and secondary side			5	pF

Output characteristics

Parameter	Note	Min.	Typ.	Max.	Unit
Gate Turn-on Voltage			15		V
Gate Turn-off Voltage			-10		V

Timing characteristics

Parameter	Note	Min.	Typ.	Max.	Unit
Turn-on Delay	Note 1		600		ns
Turn-off Delay	Note 2		600		ns
Rise Time	Note 3		10		ns
Fall Time	Note 4		40		ns
Edge Feedback		500	700	900	ns

Protection function characteristic

Parameter	Note	Min.	Typ.	Max.	Unit
Input undervoltage threshold	Primary		13.3		V
Positive undervoltage threshold	Secondary		12.6		V
Negative undervoltage threshold	Secondary		-6.1		V
VCE monitoring threshold	Comparator threshold		10.2		V
VCE protection response time	Note 5		9.1		us
di/dt Protection Response Time			4		us
Fault Holding Time	Note 6		11		us
Fault Blocking Time	Note 7		96		ms

Electrical Isolation

Parameter	Note	Min.	Typ.	Max.	Unit
Creepage Distance	Primary to secondary	66			mm
	Secondary to secondary	36			mm
Clearance Distance	Primary to secondary	31			mm
	Secondary to secondary	20			mm

Note:

1. Turn-on delay: With no IGBT connected, the time required for the rising edge of the PWM input signal to propagate to the rising edge of the secondary-side gate drive signal.
2. Turn-off delay: With no IGBT connected, the time required for the falling edge of the PWM input signal to propagate to the falling edge of the secondary-side gate drive signal.
3. Rise time: With no IGBT connected, the time interval from 10% of the gate turn-off voltage (−10 V) to 90% of the gate turn-on voltage (+15 V).
4. Fall time: With no IGBT connected, the time interval from 90% of the gate turn-on voltage (+15 V) to 10% of the gate turn-off voltage (−10 V).
5. VCE protection response time: After a bridge-arm IGBT short-circuit occurs, the time from normal IGBT gate turn-on to the initiation of soft shutdown.
6. Fault holding time: The time for which the fault signal is held after a fault occurs.
7. Fault blocking time: The time for which the gate signal is blocked after a fault occurs.

Function description

◆ Short circuit protection-di/dt

The driving circuit has the function of di/dt protection. Di/dt protection is based on voltage measurement of Power Emitter (PE) and Auxiliary Emitter (AE). The voltage V_{PA} between the auxiliary emitter and the power emitter is proportional to the change di/dt of the collector current I_c .

In normal operation, the di/dt is generally in the tens of amperes per microsecond, but when the IGBT is short-circuited, the di/dt will reach thousands of amperes per microsecond, with a difference of hundreds of times. Because the di/dt protection directly monitors the change rate of current, it does not need a Blank time like VCE monitoring, so the di/dt response is faster.

Compared with VCE-based short-circuit protection, di/dt protection has faster response and higher signal-to-noise ratio, and it has more obvious competitiveness in multi-level applications.

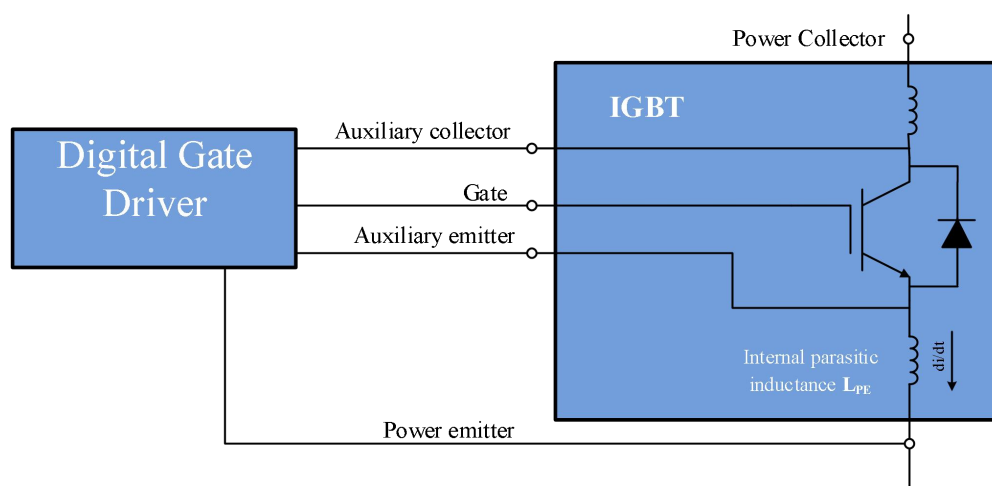
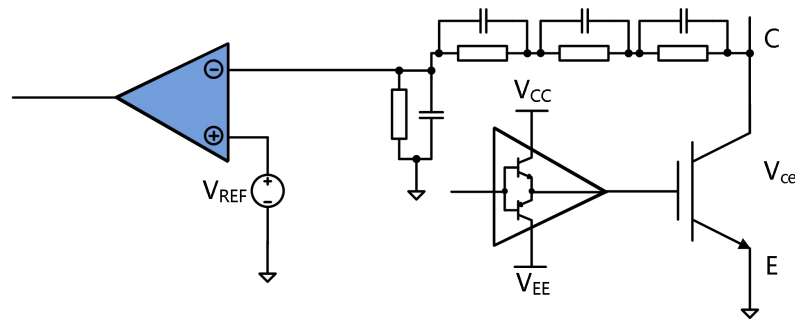


Fig. 7 di/dt detection circuit

◆ Short circuit protection- V_{CE}

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.

V_{CE} voltage is detected by resistor voltage division. When the V_{CE} voltage exceeds the set threshold, the driver determines that the IGBT is in a short-circuit state, and the driver will start soft shunt down, turn off the IGBT slowly, and return the fault to the controller.

Fig. 8 V_{CE} desaturation detection circuit

◆ UVLO

The driving board monitors the positive and negative power supply of the secondary side at the same time. When the absolute value of the positive or negative voltage of the secondary side is lower than the threshold voltage, the driving circuit determines that an undervoltage fault has occurred and will feed back a fault signal to the master computer.

Firstack intelligent gate driver strongly suggests that any IGBT in IGBT bridge arm 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 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 spike at both terminals of IGBT, which will cause IGBT overvoltage breakdown.

In order to suppress the turn-off spike in short-circuit, the Firstack intelligent driving circuit introduces soft shut down technology. In case of direct short-circuit of IGBT, on the

premise of ensuring that the short-circuit time does not exceed 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 and ensuring the safety of IGBT.

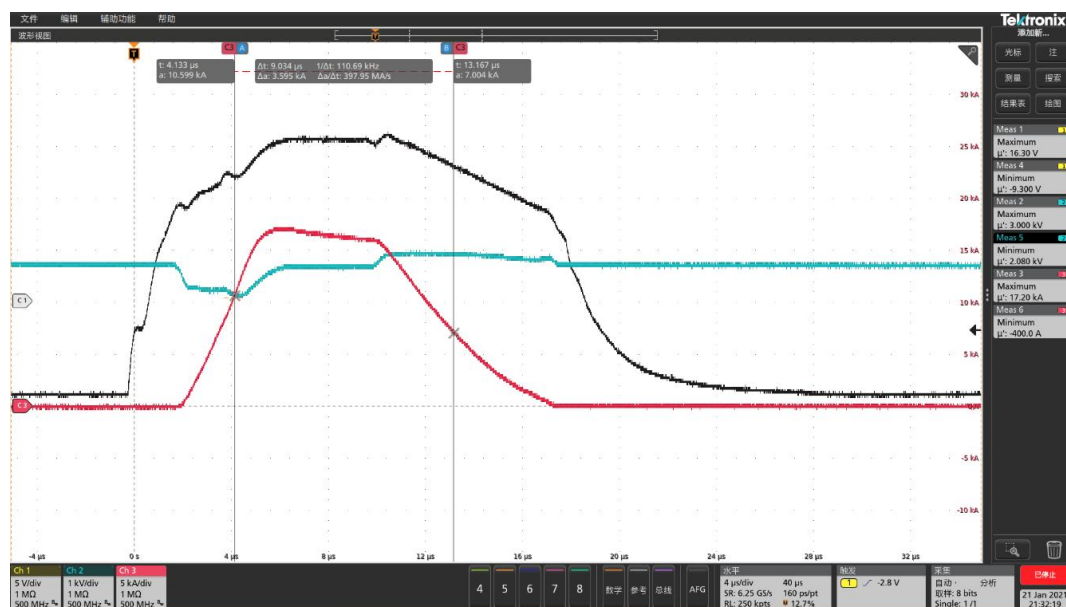


Fig. 9 Short-circuit waveform of TG3000SW45ZC-P200 at 2800V

In the above picture, CH1: V_{GE} ; CH2: V_{CE} ; CH3: I_C .

Fig.9 shows the short-circuit waveform of the 4500V/3000A IGBT (TG3000SW45ZC-P200) controlled by the Firstack IGBT driving circuit when the DC bus is 2800V. The peak value of short-circuit current is 17200A(5.7 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.

◆ Digitally controlled advanced active clamping

When the system is overloaded or short-circuited on the load side, the turn-off current of the IGBT will increase significantly. Under these conditions, active clamping can protect the IGBT and avoid failures caused by turn-off overvoltage.

When the V_{CE} voltage exceeds the TVS threshold, the TVS is broken down and the current sinks into the gate, which makes the V_{GE} rise and the IGBT enters the linear region, thereby limiting the turn-off voltage within a safe range.

In order to improve the clamping effect, Firstack introduced a digitally controlled active clamping and added a "digitally controlled current source" to the gate. When the current I_z

flowing through the TVS is greater than a certain threshold, the N transistor is turned off and the "digitally controlled current source" is started at the same time. At this time, $I_Z = I_G + I_D$, through the digitally controlled current source, keeping I_Z at a low value, the TVS has been in a weak breakdown state until the end of the turn-off.

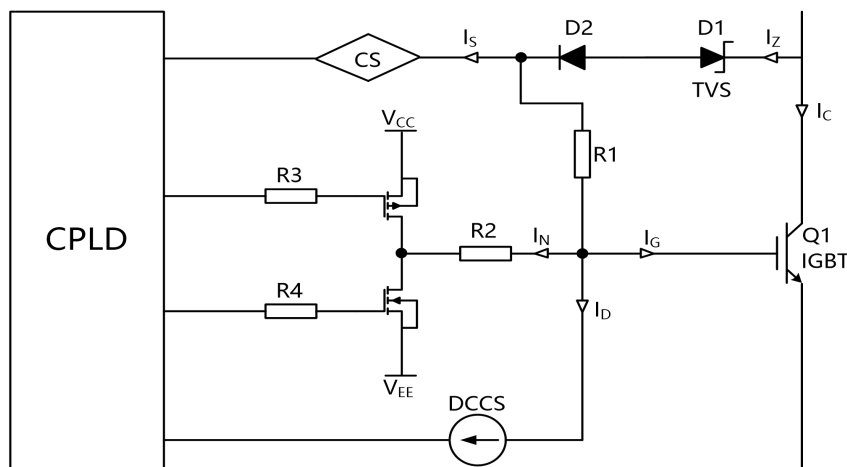


Fig. 10 Schematic diagram of digitally controlled advanced active clamping principle

◆ **High robustness DC/DC**

Since the built-in DC/DC of the gate driver needs to reduce the coupling capacitance C_{PS} of the primary and secondary side as much as possible. It generally adopts an open-loop form, so it is difficult to integrate functions such as overcurrent protection, which also leads to the anti-overload of the built-in DC/DC ability very poor.

In order to improve the reliability of the driver, Firstack puts forward the concept of "highly robust DC/DC". Under the premise of keeping the open-loop, the gate driver can withstand a GE short-circuit.

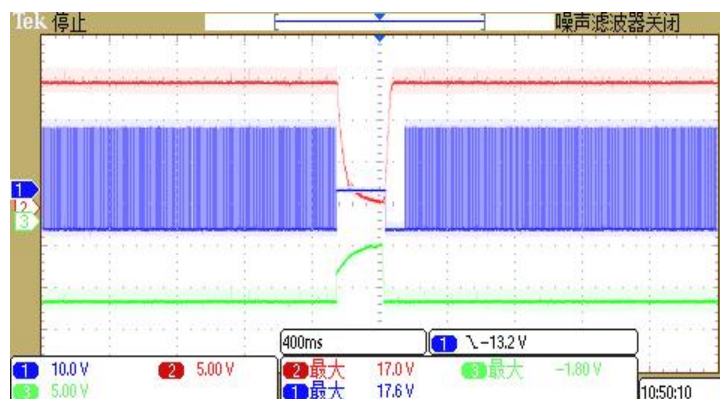


Fig.11 GE short circuit

In the picture above, CH1: V_{GE} (blue); CH2: I_C (red)=+15V(secondary side); CH3: V_{CE} (green)

= -10V(secondary side)

When an overload occurs, the gate driver will block the PWM signal and report a fault signal to the master computer at the same time. When the overload is removed, the gate driver will return to its normal state.

Note: When the gate resistance is small, or the gate resistance is too large ($>10\Omega$), this function may not be applicable

◆ Optical fiber port notification signal

In the process of using optical fiber, there are some phenomena, such as the buckle of optical fiber mouth is not firm/falling off, and the turning radius of optical fiber line is not enough. In order to ensure the normal optical fiber communication, the Firststack intelligent gate driver is configured with the fiber port response function, as follows:

1. When the driving board works normally, every time a PWM command is received, the lamp returning to the optical fiber head will turn off for a short time of 700ns at the rising edge and falling edge of the PWM command as a response to receiving the command.

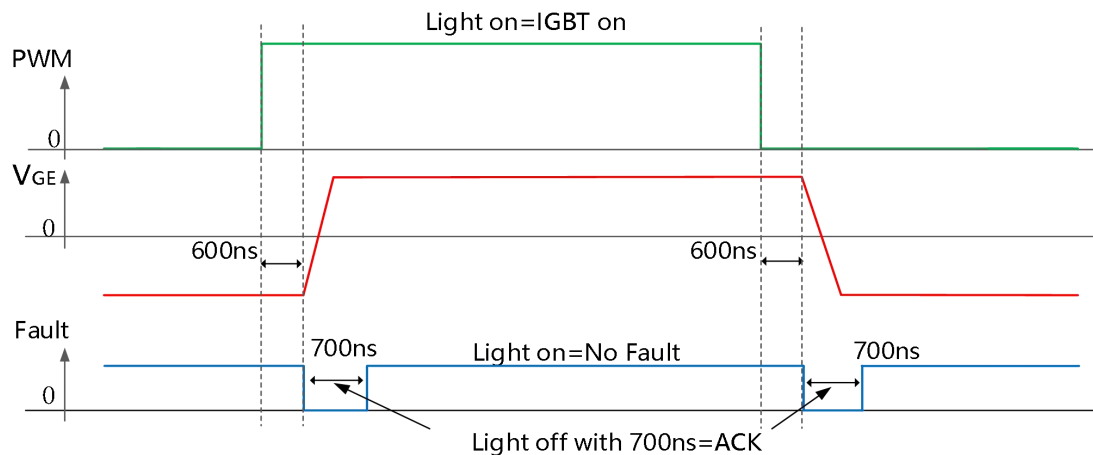


Fig.12a Under normal conditions

2. When the fault is detected by the driving board, the lamp returning to the optical fiber head will be extinguished for more than 30us, which will be used as a fault signal to inform the controller.

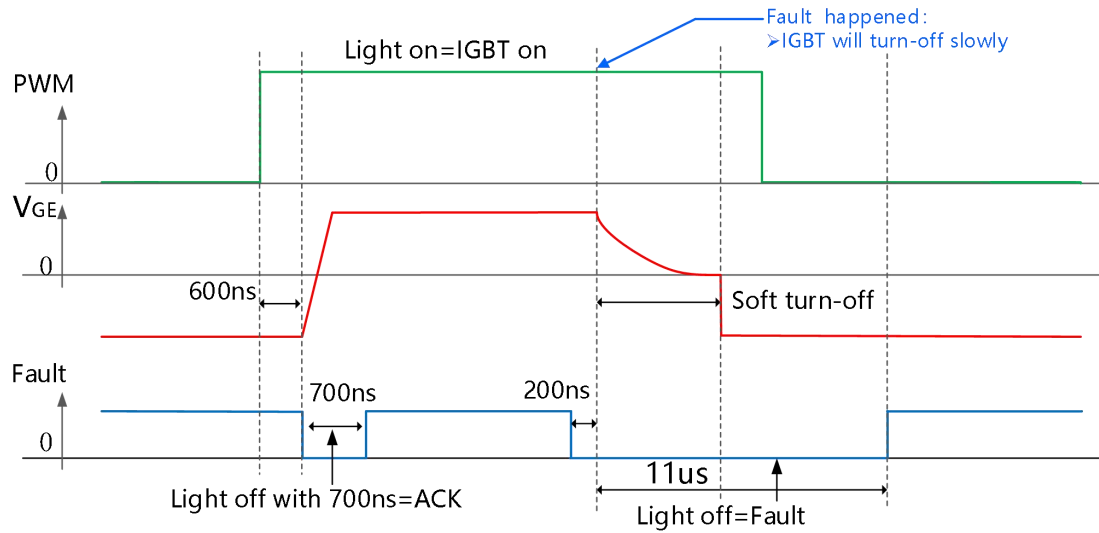


Fig. 13b In case of fault

By returning the length of the light-off time of the optical fiber head, the controller can accurately distinguish the response information from the fault information.

Gate resistance position indication

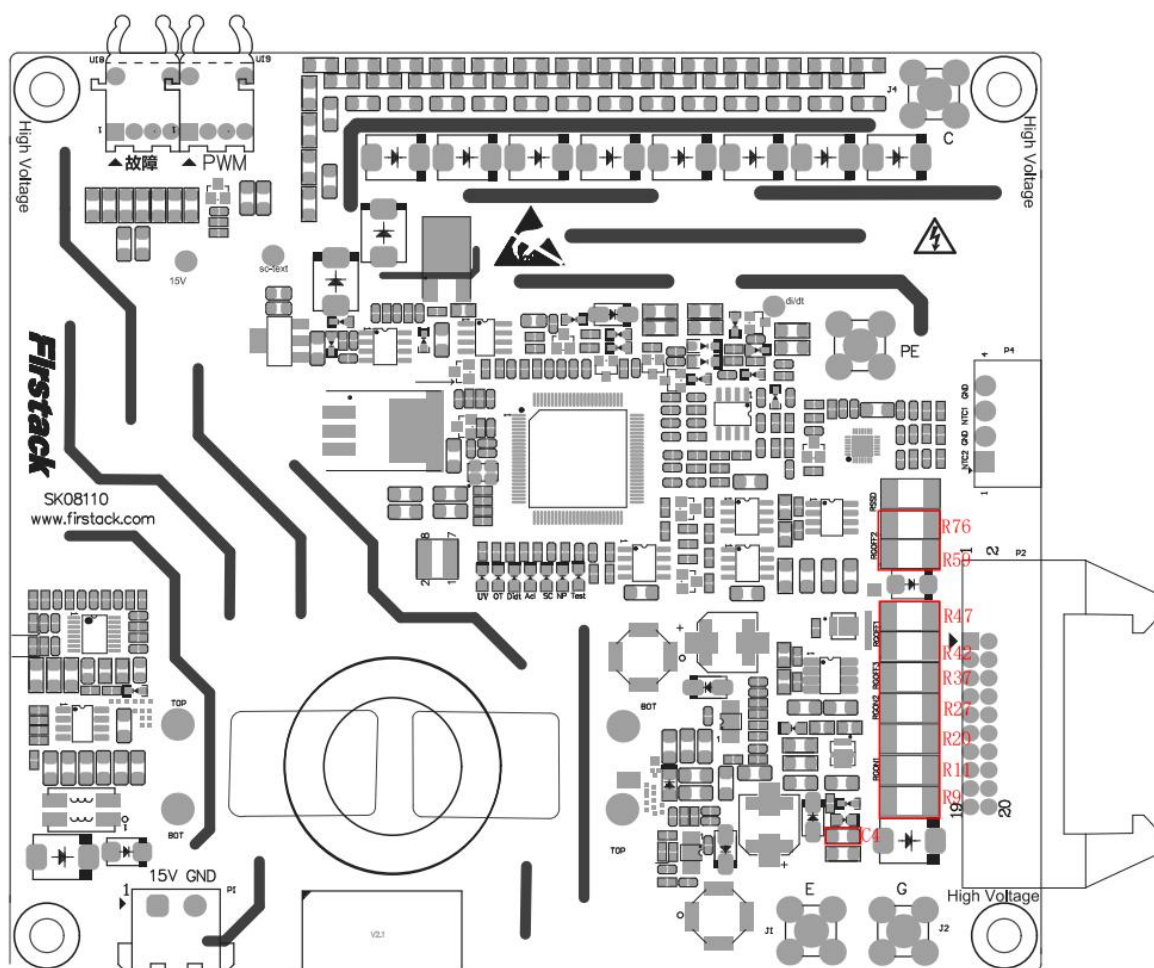


Fig. 19 Indicating diagram of gate resistance position

Gate parameter

Position	Silkscreen	Package
R _{GON1}	R9//R11//20	2512
R _{GON2}	R27	2512
R _{GOFF1}	R42//R47	2512
R _{GOFF2}	R59//R76	2512
R _{GOFF3}	R37	2512
C _{GE}	C4	1206

Gate resistance table of common modules

IGBT module	Brand	$C_{GE}(nF)$	$R_{GON}(\Omega)$	$R_{GOFF}(\Omega)$
ST1500GXH24	Toshiba	220	6.7	16.5
TG3000SW45ZC-P200	CRRC	330	1.6	10
5SNA2000K452300	ABB	330	1.9	13.5
5SNA3000K452300	ABB	330	1.9	10

Notes:

1. For other IGBT modules, please refer to the device datasheet for adaptation.
2. The unpopulated version has no stepped turn-on or stepped turn-off function. For turn-on, solder the resistor to R_{GON1} ; for turn-off, solder the resistor to R_{GOFF1} .
3. For soldering of the gate resistors and capacitors, please refer to Firstack's "General Soldering Guide for SMD Gate Resistors of IGBT Drivers".

Coating

Conformal coating model: Yiligao, UVCL-FCH.

Apart from the necessary external interfaces, Firstack will apply conformal coating to all circuitry of the driver to ensure its long-term reliable and stable operation.

Ordering information

SK08110 can support different types of crimping modules of CRRC, ABB and Toshiba. When purchasing, please provide IGBT module model and system electrical topology, so that we can provide the driver that best meets your needs.

Drive selection table

Product Model	Voltage	Optical Module	C _{GE} (nF)	R _{GON} (Ω)	R _{G OFF} (Ω)
SK08110-A1	4500V	ST optical module	NC	NC	NC
SK08110V-A1	4500V	Universal optical module	NC	NC	NC
SK08110V-65-A1	6500V	Universal optical module	NC	NC	NC

Note:

1. The "-S" in the driving model indicates ST optical module, that is, HFBR-1414TZ and HFBR-2412TZ; are adopted; "Vacancy" means that general optical modules are adopted, that is, HFBR-1521Z and HFBR-2521Z are adopted.
2. The above-mentioned drive models will not be sprayed with three-proof paint because the gate electrode is empty and the customer needs to weld the device.
3. The above-mentioned drive models have no step-by-step turn-on and step-by-step turn-off functions, and Firstack will only enable this function under extreme working conditions, and technicians need to assist in configuration.
4. For driver installation, please refer to Firstack's "IGBT Driver Installation Guide"

Change Log

2026-10-23 Preliminary version

Technical support

The professional team of Firstack will provide you with relevant information such as business consultation, technical support, product selection, price and delivery cycle, and guarantee to answer your questions within 48 hours.

Legal disclaimer

1.All parameters listed in this Specification Sheet were measured under specific laboratory conditions and are provided for reference only. Due to variations in installation conditions and operating environments, the actual performance of the Product may deviate from the nominal values. Users are advised to conduct independent verification under their own operating conditions.

2.This Specification Sheet reflects the product characteristics as of the date of issuance, based on the then-existing condition and to the best of our knowledge. No representation or warranty is made that all performance characteristics under all operating conditions have been exhaustively tested or verified.

3.We reserve the right to modify this Specification Sheet and technical parameters for product improvement without prior notice. Products already sold shall be governed by the Sales Contract between the parties and the Specification Sheet effective at the time of delivery.

4.This Specification Sheet is a technical descriptive document. Its binding effect is limited to the Sales Contract, and it shall not create any independent warranty obligation outside the Contract.

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