1FSD08110 Data Sheet

Abstract

The 1FSD08110 is a high-performance digital gate driver with optical fiber interface developed for high-voltage and high-power IGBT, which is suitable for 2-level and multi-level converters. The digital can optimize the switching performance of IGBTs, which provides optimal protection for IGBTs. Its good EMC characteristics is suitable for harsh electromagnetic field environment.Now it has been widely used in various fields such as new energy, rail, industrial transmission and smart grid.

The 1FSD08110 is a plug-and-play gate driver developed for modules in 140×190mm and 140×130mm IGBT packages, such as Infineon IHM and ABB HiPak. It is suitable for IGBTs in the same package from different manufacturers.

Fig.1 1FSD08110

Highlight：

√ 8W/110A, optical interface

√ Support 1700V/3300V module

√ Short Circuit (Soft Shut Down)

√ Support multi-level Application

Application：

√ special equipment

√ Variable-Frequency Power

√ Grid

√ Marine Propulsion

Contents

System block diagram

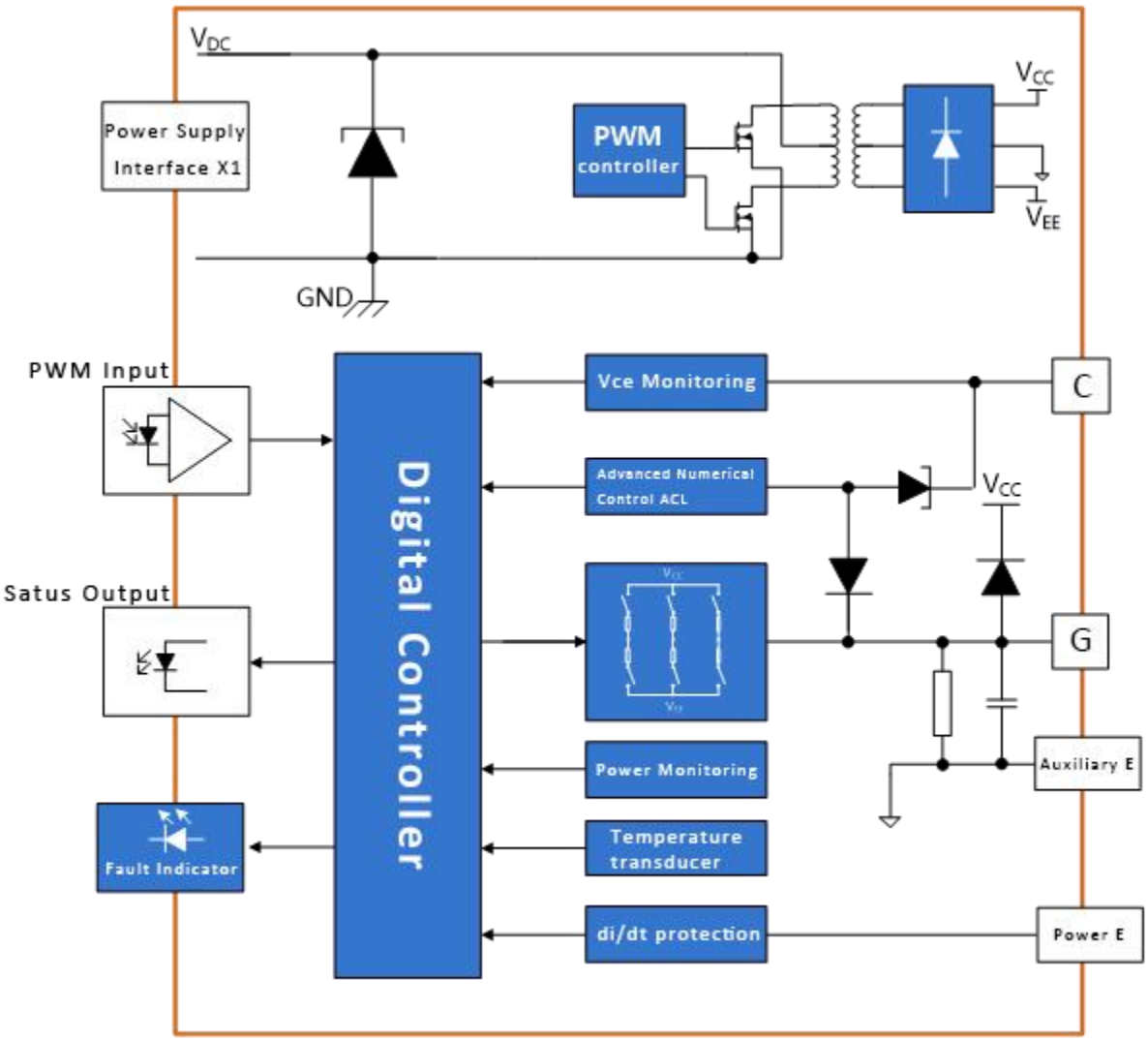


Fig.2 System block diagram (di/dt protection reserved)

The primary side power supply inputs a DC voltage of 15V, and the power supply voltage required by the system is obtained through the relevant circuit, which ensures the energy source of the system; the PWM signal is transmitted directly to the secondary side through the optical fiber, and the driving signal of the semiconductor device IGBT is obtained through the processing of the relevant unit circuit.

When the gate is turned on, if no short-circuit fault occurs, the main power device is saturated and turned on, the voltage across the IGBT-CE is close to zero, the IGBT-CE detection is reset, and the corresponding soft shut down circuit does not start; if a short-circuit fault occurs, during the gate opening process, the main power device exits saturation, the voltage across

IGBT-CE is close to the bus voltage, the IGBT-CE detection is set, and the corresponding soft shut down circuit is activated to protect the main power device from damage. At the same time, the fault signal is transmitted to the master computer through the optical fiber; when there is no PWM signal input, the gate is always in the negative pressure turn-off state.

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 European standard EN 100015 (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 (optical fiber) 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 driver, the gate driver status indicator TEST (green) remains on after the gate driver has been provided with a suitable supply voltage.

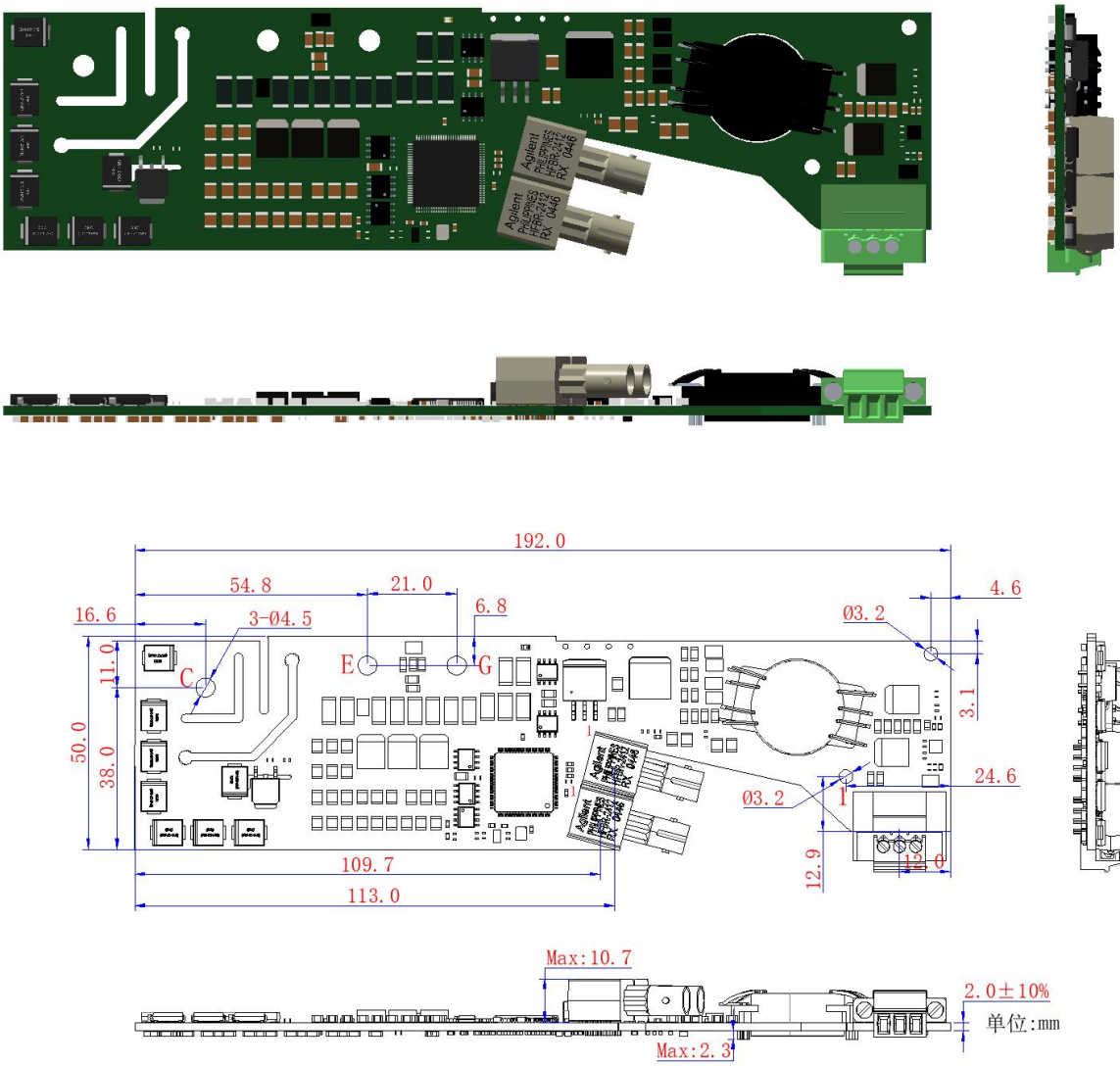
These tests should be performed before installation, because the gate terminal may not be accessible after installation.

5. Set up and test the power unit

Before starting the system, it is recommended to check each IGBT module with a single pulse

or double pulse test method. 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 configuration.

Mechanical dimensions



unit: mm

Fig.3 3D and mechanical dimensions of the 1FSD08110-S

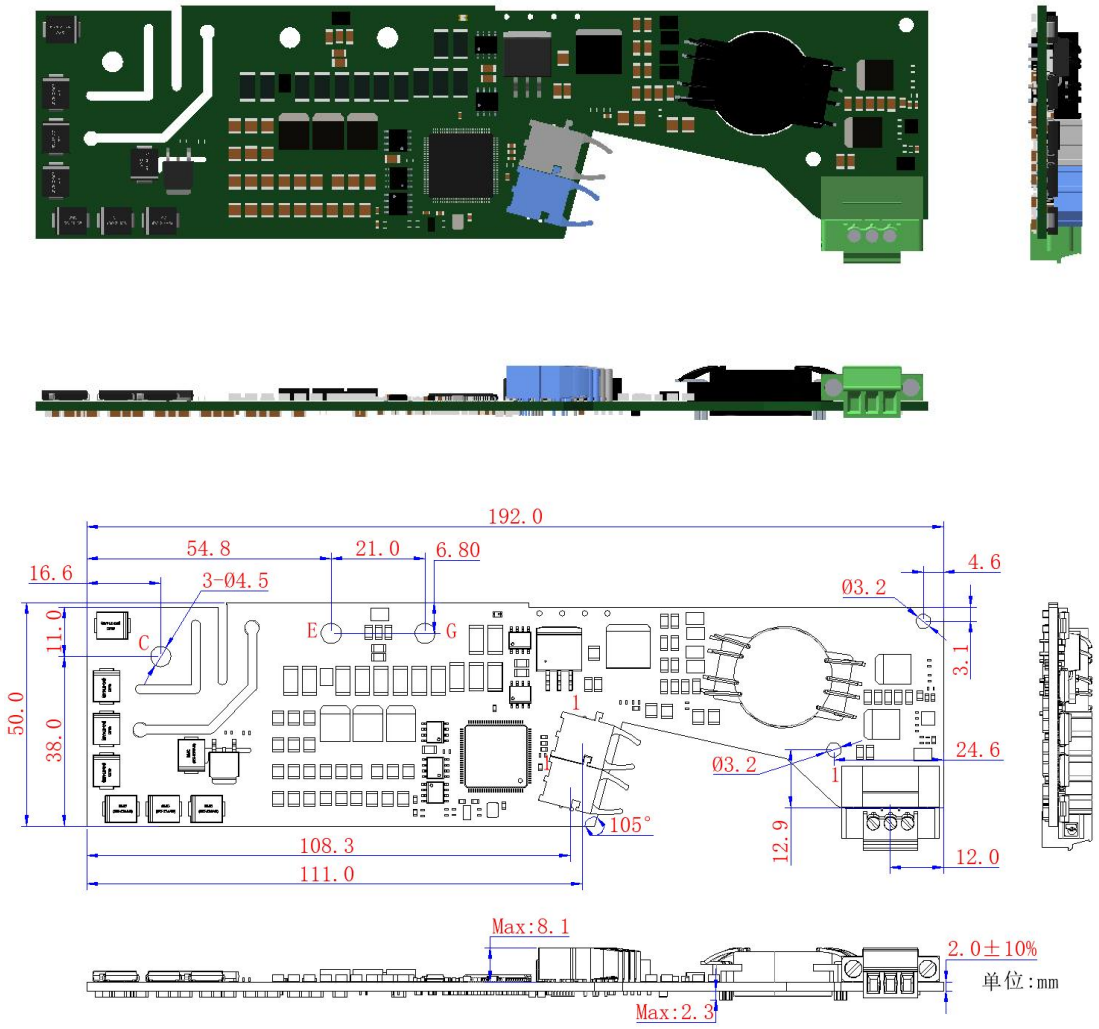


Fig.4 3D and mechanical dimensions of the 1FSD08110

Note:

1. The thickness tolerance of the board is ±10%;

2. Other dimensional tolerances refer to GB/T1804-m. For PCB dimensions ≤400 mm, the tolerance is ±0.5 mm; for PCB dimensions>400 mm, the tolerance is ±0.8 mm; other dimensional tolerances refer to GB/T 1804-m.

Pin functional description

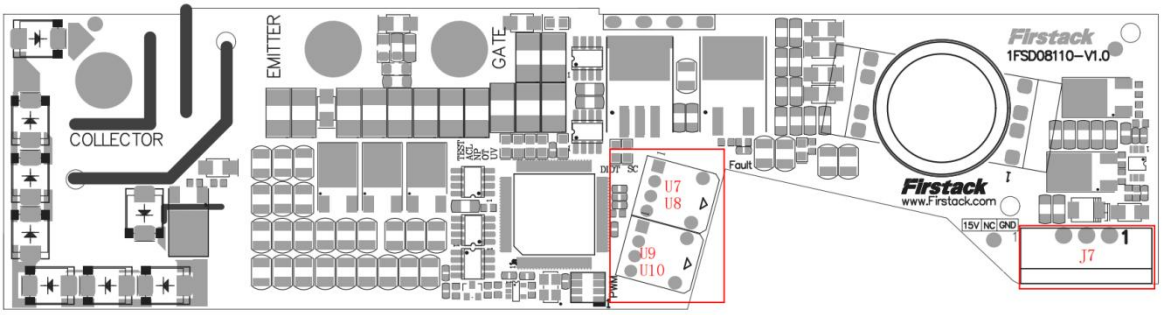


Fig. 5: Interface diagram of J7 on the 1FSD08110 driver board

J7 Pin Definitions

Pin	Ref	Note	Pin	Ref	Note
1	GND	Ground of Input	2	NC	Not Connect
3	V_{DC}	Input Voltage			

Connector Manufacturer and Part Number

Number	Ref	Manufacturer	Part Number	Recommended Matching Terminals
1	J7	WÜRTH	691325310003	691364300003
2	U7	AVAGO	HFBR-1521Z	HFBR-2521Z
3	U9	AVAGO	HFBR-2521Z	HFBR-1521Z
4	U8	AVAGO	HFBR-1414TZ	HFBR-2412TZ
5	U10	AVAGO	HFBR-2412TZ	HFBR-1414TZ

Note:

1. Torque requirements: For fixed holes C, G, and E, use M4 screws with a recommended installation torque of 1.8–2.1 Nm; for the matching terminal "691364300003" for J7, the recommended installation torque is 0.34 Nm.

2. The J7 component and its matching terminals are secured with screws. To prevent damage to the J7 terminal housing during removal, ensure all locking screws are fully loosened before disassembly.

3. PWM logic: "Light present" = IGBT turned on; "No light" = IGBT turned off;

4. Fault logic: "Light present" = normal drive operation; "No light" = drive failure;

LED status indicator

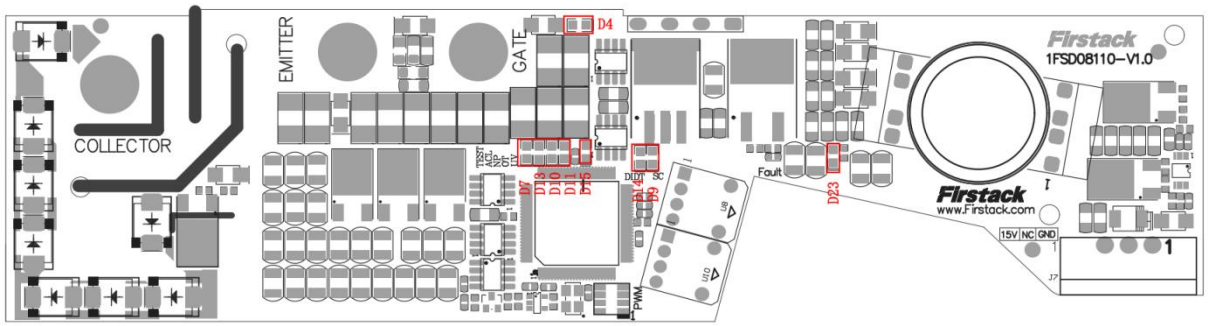


Fig.6 LED status indicator

For the convenience of customers, several LED status indicators 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	Ref	silk-screen	Light	Note
1	D23	\	Green	Power indicator
2	D4	\	Green	GE indicator. Light up when it is turned on, otherwise off
3	D7	TEST	Green	Light up when the power supply is normal and there is no fault, otherwise off
4	D9	SC	Red	Once triggered by a short-circuit, it is always on, unless restarted
5	D10	NP	Red	This indicator is not enabled
6	D11	OT	Red	Once triggered by overheating, it is always on, unless restarted
7	D13	ACL	Red	Once the ACL is triggered, it is always on, unless restarted
8	D14	DIDT	Red	Once triggered by a short-circuit, it is always on, unless restarted
9	D15	UV	Red	Once triggered by undervoltage, it is always on, unless restarted

Driving parameters

Absolute Maximum Ratings

Parameter	Note	Min.	Max.	Unit
V_{DC}	To GND		16	V
Gate Peak Current			110	A
Output Power	25℃		8	W
Output Power	T_A≤85℃		4	W
Test Voltage(50Hz/1min)		6		kV_{RMS}
Operating Temperature		-40	85	℃
Storage Temperature		-40	85	℃

The following data were obtained under ambient temperatures ≤25°C and VDC = 15 V:

Recommended Operating Conditions

Parameter	Note	Min.	Typ.	Max.	Unit
V_{IN}		14.5	15	15.5	V

Electrical Characteristics

Parameter	Note	Min.	Typ.	Max.	Unit
Power Supply Current	Without Load, Note 1		0.15		A
Coupling Capacitance	Primary to Secondary Side		9.5		pF

Output Characteristics

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

Timing Characteristics

Parameter	Note	Min.	Typ.	Max.	Unit
Turn-on Delay	Note 2		500		ns
Turn-off Delay	Note 3		500		ns
Rise Time	Note 4		15		ns
Fall Time	Note 5		12		ns
Edge Feedback		500	700	900	ns

Protection Function Features

Parameter	Note	Min.	Typ.	Max.	Unit
Input power under			12.7		V
V_{CE} Threshold			10.2		V
V_{CE} Response time	Note 6		8		us
Didt Response Time			3		us
Fault duration time			30		us
Fault blocking time			90		ms

Electrical Isolation Characteristics

Parameter	Note	Min.	Typ.	Max.	Unit
Creepage	Primary to secondary Side	22			mm
	Secondary to secondary Side	26			mm
Clearance	Primary to secondary Side	20.9			mm
	Secondary to secondary Side	13.5			mm

Note:

1. Power Supply Current: gate driver core connected to IGBT, no PWM input;
2. 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;
3. 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;
4. Rise Time: the amount of time from 10% of the gate turn-off voltage(-10V) to 90% of the gate turn-on voltage(+15V) without connecting the IGBT;
5. Fall Time: the amount of time from 90% of the gate turn-on voltage(+15V) to the gate turn-off voltage(-10V).
6. Response Time: the time from the occurrence of the fault to the start of soft shut down;

Functional description

◆ Short-circuit protection—V_{CE} monitoring

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 resistance division. When the V_{CE} voltage exceeds the set threshold, the gate driver determines that the IGBT is in a short-circuit state and returns the fault to the master computer.

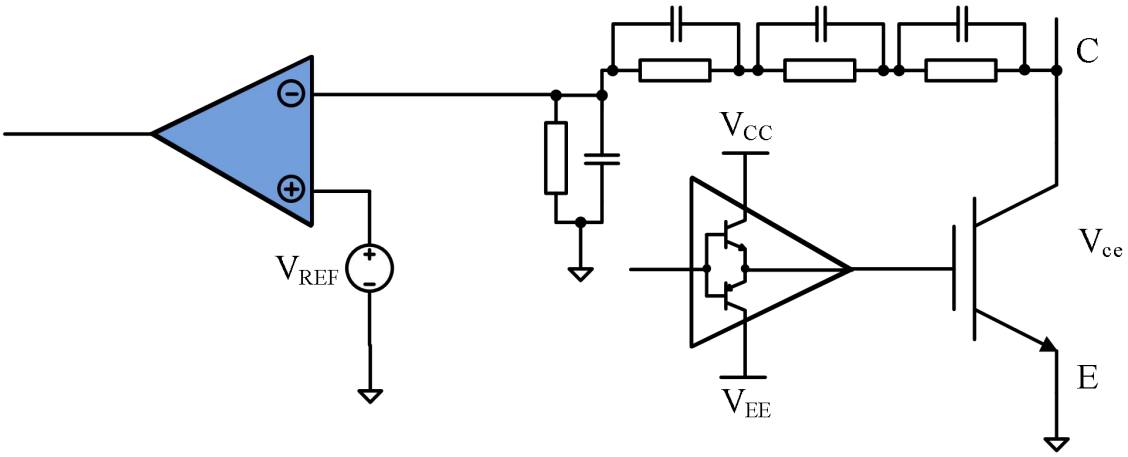


Fig.7 V_{CE} monitoring circuit

◆ Undervoltage protection

The driver 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.

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 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 under 10us, 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.

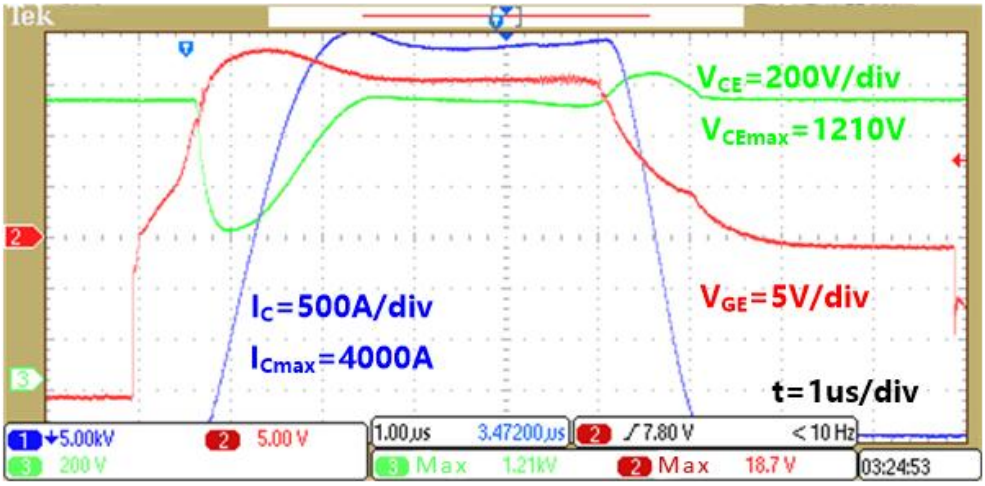


Fig.8 Short-circuit waveform of FF1400R17IP4 at 1100V

Fig.8 shows the short-circuit waveform of the 1700V/1400A IGBT(FF1400R17IP4) controlled by the Firstack IGBT driving circuit when the DC bus is 1100V. The peak value of short-circuit current is 6400A(4.5 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 dynamic advanced active clamping D^2A^2C technology

When the system is in an overload or short-circuit state 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 introduces 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 larger 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, $I_Z=I_G+I_D$, keeping I_Z at a low value by the digitally controlled current source, and the TVS will be in a weak breakdown state until the end of the turn-off.

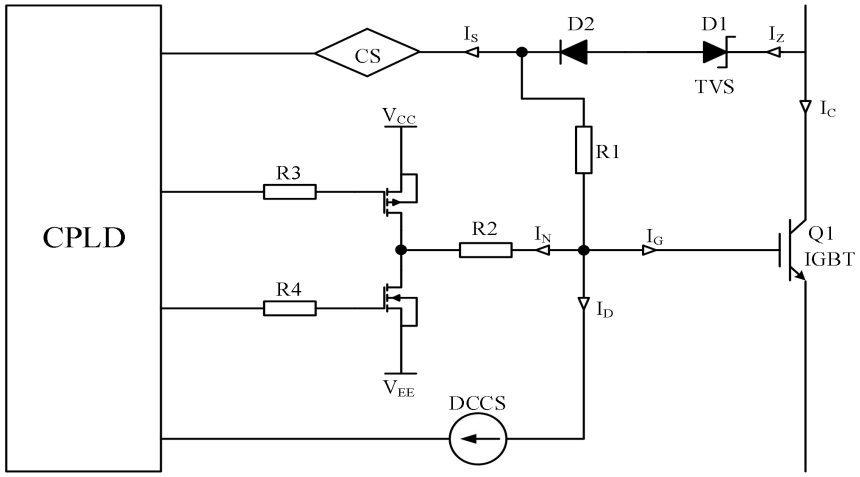


Fig.9 Schematic diagram of active clamping principle

The following Fig.9 is the short-circuit test waveform of intelligent gate driver products based on Infineon FF1000R17IP4 module. The turn-off moment Vce voltage is basically clamped at 1380V, and the turn-off process is very smooth with no violent oscillation.

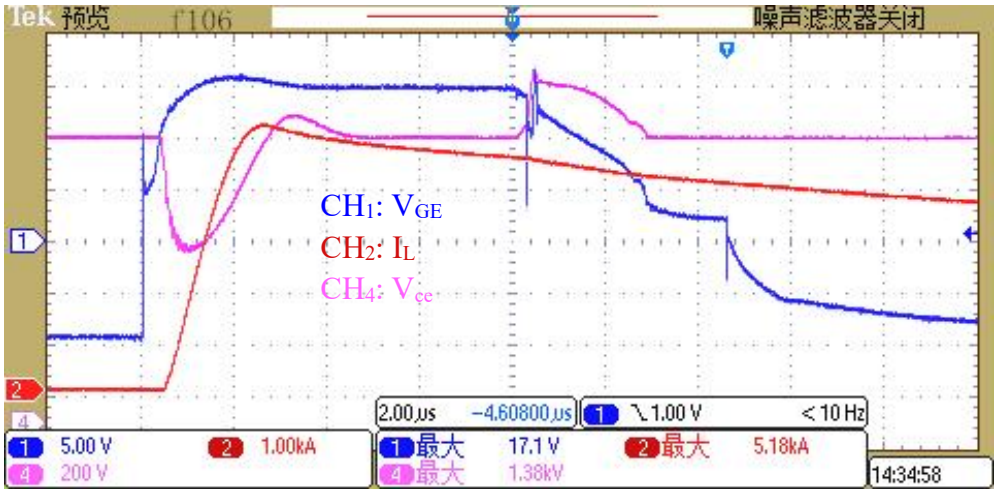


Fig.10 Digitally controlled active clamping waveform

In the picture above, CH1: V_{GE}(blue); CH2:I_C(red); CH4: V_{CE}(pink)

◆ Pulse anomaly protection

Fiber optic communication offers significant advantages such as strong interference resistance and high insulation ratings. However, during operation, issues like loose fiber clamps and insufficient bending radii can occur, leading to light leakage and optical attenuation. At the receiving end of the fiber optic connector, substantial stray, high-frequency narrow pulses are generated. These pulses can cause rapid switching of the components, generating substantial heat—a major hazard for high-voltage, high-power devices that requires strict prevention measures.

The Firstask intelligent driver continuously monitors PWM pulse width in real time. If the pulse width falls below a preset threshold, it filters out narrow pulses without triggering a fault alarm.

◆ Optical fiber port notification signal

In the process of using optical fiber, there are phenomena such as the buckle of optical fiber port 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 Firstack intelligent gate driver is configured with the fiber port response function, as follows:

1. When the driver board operates normally, every time a PWM command is received, the light of the returning fibre optic head will go out for a short time of 700ns at the rising edge

and falling edge of the PWM command as a response to receiving the command.

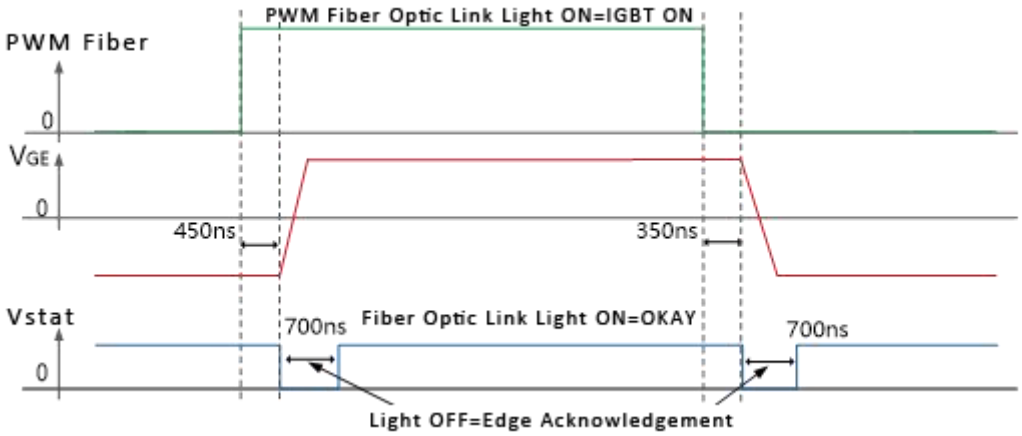


Fig.11a Normal condition

2. When the fault is detected by the driver board, the light of the return fibre optic head will go out for more than 30us, which will be used as a fault signal to inform the master computer.

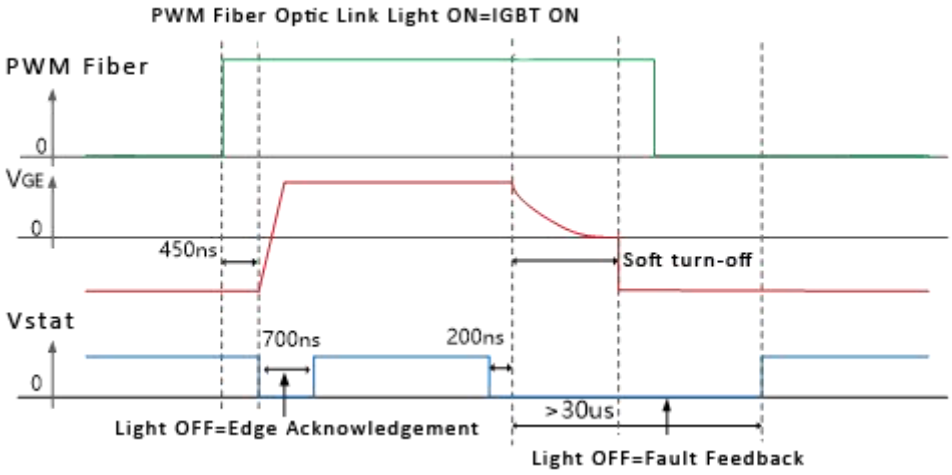


Fig.11b Fault condition

The host computer can accurately distinguish the response information from the fault information by the length of time for the light of the returning optical fiber head going out.

Gate resistor indication

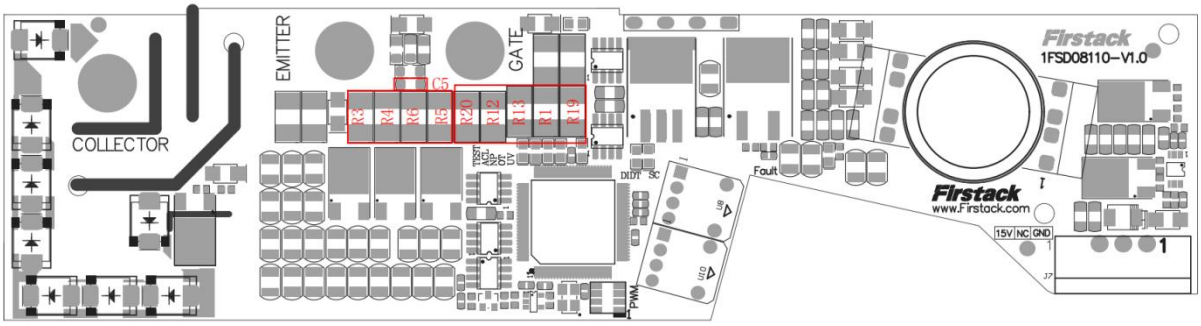


Fig.12 Gate resistor indication

Calculation formula of gate resistor

Location	Silk-screen	Package
R_{GON}	R3 // R4 // R5 // R6	2512
R_{GOFF}	R1 // R12 // R13 // R19 // R20	2512
C_{GE}	C5	1206

Note:

1. Refer to the device specification document for gate parameters of IGBT modules to ensure proper matching.

2. For gate resistor and capacitor soldering, refer to Firstack's "Soldering Guideline".

Coating

Coating Part Number: UVCL-FCH

In addition to essential external interfaces, Firstack will apply three-proof coating to all circuit lines of the drive unit to ensure its long-term, reliable, and stable operation.

Ordering information

The 1FSD8110 can support IHM™ modules of different models from multiple manufacturers. If you have a purchase request, please contact us, and we can provide the gate driver that best meets your needs.

Driver Selection Table

Part Number	Voltage	Optical Module	C_{GE}(nF)	R_{GON}(Ω)	R_{GOFF}(Ω)
1FSD08110-17-A1	1700V	General Optical Module	NC	NC	NC
1FSD08110-33-A2	3300V	General Optical Module	NC	NC	NC
1FSD08110-S-17-A1	1700V	ST Optical Module	NC	NC	NC
1FSD08110-S-33-A1	3300V	ST Optical Module	NC	NC	NC

Note:

1. The "-S" in the drive model indicates ST optical modules (e.g., HFBR-1414TZ and HFBR-2412TZ), while a blank indicates standard optical modules (e.g., HFBR-1521Z and HFBR-2521Z).
2. Due to the gate surface being exposed, these drive models require customer-led component soldering and therefore do not undergo anti-corrosion coating application.
3. The aforementioned drive models lack a multi-level shutdown function; Firstack only activates this feature under extreme operating conditions and requires technical assistance for configuration.
4. The aforementioned drive model does not have di/dt short-circuit protection functionality.
5. For driver installation, please refer to Firstack's "Soldering Guide."

Change details

2026-06-10 Update the Electrical Isolation Parameters and contents

Technical support

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

Legal disclaimer

This manual gives a detailed introduction to the product, but cannot promise to provide specific parameters for the delivery, performance or applicability of the product. This article does not provide any express or implied warranties or guarantees.

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

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