2FSS0338 Data Sheet

Abstract

The 2FSS0338(the original version was named 2FHS0338) is developed for 3300V/1700V modules. It features powerful functions, small volume and high reliability. Its applications cover various fields such as renewable energy, rail, industrial drives and smart grid. The 2FSS0338 is the digital intelligent IGBT gate driver of Firstack, which integrates functions such as short-circuit protection, undervoltage protection to effectively protect the IGBT. The 2FSS0338 is a 2-channel gate driver core and requires adaptor boards for different IGBTs.

Highlights:

- √ Driving power 3W, 38A
- $\sqrt{\text{Suitable for 1700V/3300V modules}}$
- $\sqrt{}$ Short-circuit protection (soft shut down)
- √ Undervoltage protection

Applications: √ Industrial drives √ Rail



Fig.1 2FSS0338

Contents

Abstract
Functional block diagram
Use steps and safety notice
Mechanical dimensions
Connector part number
Gate driver board interface definition
LED status indication
Driving parameters
Function description
Short-circuit protection
• Undervoltage protection
• Soft shut down
• Short pulse suppression
Adaptor board solution - A-HM0338-33-20025017
Ordering information
Technical support
Legal disclaimer
Contact information

Functional block diagram



Fig. 2 Functional block diagram

The 2FSS0338 integrates short-circuit protection, short pulse suppression and undervoltage protection, which can effectively protect the IGBT. Meanwhile, the gate driver supports multiple parallel connections, which can effectively help customers increase system output power.

The supply voltage of the gate driver is 15V, and two secondary side power supplies are obtained via the switching power supply. The PWM signal is transmitted to the secondary side via the optical fiber, and the IGBT drive signal is obtained after CPLD processing.

When the gate is turned on, the IGBT is saturated and turned on, the voltage of the IGBT-CE is close to zero, and the IGBT-CE detection is reset; if a short-circuit fault occurs, the IGBT is

< Firstack

desaturated during the gate turn-on process, and IGBT-CE voltage is close to the bus voltage, the IGBT-CE detection is set, the corresponding soft shut down circuit is activated to protect the IGBT from damage, while 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 voltage turn-off state.

 Firstack

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 part number 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 (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 off state, the rated gate voltage is given in the corresponding data sheet; for the on state, the voltage is 15V. Please also check the input current of the gate driver with and without a control signal separately. For Firstack's digital gate driver, the gate driver status indicator TEST (green) is always on after the gate driver is provided 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 single pulse

< Firstack

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 of the driver board(unit: mm)

Note:

- 1. The thickness of the board tolerance is $\pm 10\%$;
- 2. Other dimensional tolerances refer to GB/T1804-m.

Connector part number

Number	Ref	Manufacturer	Part number	Recommended matching terminals	
1	D6 D12	DUOENIV	MC	FMC	
1	P0, P12	PHOENIA	1,5/4-G-3,5-RN-1731691	1,5/4-ST-3,5-RF-1952047	
2	D1	MSTBA 2,5/2-G-5,08-RN-		MSTB 2,5/2-ST-5,08-	
Z	ΡI	PHOENIA	1926015	1757019	
2	UC 1111	A	LIEDD 15017	Plastic optical fiber	
3	06, 011	Avago	HFBK-1521Z	(optional)	
4			110 1110	LIEDD 25217	Plastic optical fiber
4	U8, U13	Avago	НГВК-23212	(optional)	

Connector manufacturer and part number

Note:

PWM logic: "light" = IGBT is turned on; "no light" = IGBT is turned off.

Fault logic: "light" = the gate driver is normal; "no light" = the gate driver has a fault.

Gate driver board interface definition



Fig. 4 Gate driver board interface diagram

P1 pin definition:

Pin	Name	Note
1	V _{DC}	15V supply voltage
2	GND	Power supply ground

P6 pin definition:

Pin	Name	Note
1	G_TOP	Gate signal
2	E_TOP	Emitter E
3	DIDT_TOP	didt sampling signal
4	TC_TOP	Collector TC/C detection

P12 pin definition:

Pin	Name	Note
1	G_BOT	Gate signal
2	E_BOT	Emitter E
3	DIDT_BOT	didt sampling signal
4	TC_BOT	Collector TC/C detection

LED status indication



Fig. 5 LED status indication

For the convenience of customers, a number of LED status indicators have been added to the Firstack gate driver board to facilitate customers to understand the operating status of the gate driver board and converter. The specific explanations are as follows:

Number	Bit Number	Screen Printing	Description
1	D22, D24	ERROR	Always on when triggered by the fault, off after restarting, red
2	D21, D23	TEST	Always on when there is no fault, otherwise off, green
3	D5		The power indicator light, always on when power on, otherwise off, green

LED Status	Indicator	of the	Gate Driver
-------------------	-----------	--------	--------------------

Driving parameters

Absolute Maximum Ratings					
Parameter	Note	Min	Max	Unit	
V _{DC}	V _{DC} to GND	0	30	V	
Gate peak current	Single interface		38	А	
Output power per channel	T _A =85°C		3	W	
Test voltage(50Hz/1min)	Primary to secondary side	6000		V _{RMS}	
Operating temperature -40			85	°C	
Ambient temperature	≤25°C				

Recommended Operating Conditions						
Parameter	Note	Min	Тур	Max	Unit	
V _{DC}		14	15	30	V	
	Electrical Cha	racteristics				
Power supply	Note	Min	Тур	Max	Unit	
Supply current	Without load, Note 1		0.19		А	
Power Supply Monit	toring					
Secondary side positive voltage threshold			13.4		V	
Secondary side negative voltage threshold -4.4		V				
Short-circuit Protect	tion					
V _{CE} monitoring threshold			20		V	
D. (Channel 1, Note 2		8		μs	
kesponse time	Channel 2, Note 2		8		μs	
Blocking time			90		ms	



Timing Characteristics					
	Channel 1, Note 3	2	μs		
lurn-on delay	Channel 2, Note 3	2	μs		
	Channel 1, Note 4	2	μs		
lurn-off delay	Channel 2, Note 4	2	μs		
D' /'	Channel 1, Note 5	9	ns		
Rise time	Channel 2, Note 5	8	ns		
	Channel 1, Note 6	22	ns		
Fall time	Channel 2, Note 6	24	ns		
Fault hold time13					
Output Characterist	ics				
Gate resistor		-			
Gate turn-on voltage		15	V		
Gate turn-off voltage		-8	V		
Gate static impedance		/	kΩ		
Electrical Isolation					
Creepage distance	Primary to secondary side, Note 7	22	mm		
	Secondary to secondary side	22	mm		
Claamaa distance	Primary to secondary side	18	mm		
Clearance distance	Secondary to secondary side	14	mm		

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; channel 1 and channel 2 are

\land Firstack

the left and right drive signals respectively; (the program doesn't include the short pulse suppression test, and the delay characteristics are parameters all measured without load)

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; (the program doesn't include the short pulse suppression test)

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);

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 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 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 soft shut down to slowly turn the IGBT off, and returns the fault to the master computer at the same time.



Fig. 6 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 drive circuit will determine that an undervoltage fault has occurred, and the drive circuit will automatically block the IGBT and feed back a fault signal to the master computer. When the fault disappears, the fault terminal on the primary side will automatically reset after one 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 partly conducting of IGBT. At the same time, low gate voltage will increase the switching loss of IGBT.

• Soft shut down

When a short-circuit shoot-through occurs, IGBT will quickly desaturate, and the V_{CE} of the IGBT will reach the DC bus voltage; the short-circuit current I_{SC} 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 peak to the IGBT, which will cause the IGBT overvoltage breakdown.

In order to suppress the turn-off voltage peak generated during short-circuit, Firstack intelligent drive circuit introduces soft shut down technology. In case of an IGBT short-circuit shoot-through, while ensuring that the short-circuit time does not exceed 10 μ s, by gradually reducing the gate voltage V_{GE}, it not only ensures that the IGBT chip will not be burned down due to overheating but also effectively reduces di/dt, avoiding the voltage peak when the IGBT is turned off, thus ensuring the safety of the IGBT.



Fig. 7 Short-circuit waveform of FF1400R17IP4 at 1100V In the picture above, CH1: V_{GE} (blue); CH2: V_{CE} (red); CH3: I_C (green)

Fig.7 shows the short-circuit waveform of a 1700V/1000A IGBT (FF1000R17IP4) controlled

by the Firstack IGBT drive circuit when the DC bus is at 1100V. The short-circuit current peak value is 6400A (4.5 times of the rated current). Under the action of soft shut down, I_C drops gradually, and V_{CE} has almost no overshoot, which safely turns off the IGBT.

• Short pulse suppression

Optical fiber communication has the advantages of high interference immunity and high insulation grade. At the same time, when using optical fiber, there are some problems, such as the fiber buckle is not firm, the turning radius of optical fiber line is not enough, which easily leads to light leakage, light attenuation, etc., a large number of stray and high frequency short pulses are generated at the receiving end of the optical fiber head. These short pulses will cause IGBT to turn on/off quickly, generating a great deal of heat, which is extremely harmful to high voltage and high power IGBT.

The Firstack intelligent gate driver monitors the PWM pulse width in real time, and filters out short pulses when the PWM pulse width is less than a preset value, but does not report faults.

Adaptor board solution - A-HM0338-33-200250

A-HM0338-33-200250 can be adapted to TIM250PHM33-PSA011, DIM250PHM33-TS000 and other IGBT modules in the same package, and the gate parameter bit numbers of the adaptor board are as follows:

ТОР				ВОТ	
C _{GE}	R _{gon}	R _{goff}	CGE	R _{gon}	R _{goff}
C1	R3//R4//R5	R4//R5	C2	R6//R7//R8	R7//R8



Fig. 10 A-HM0338-33-200250 adaptor board

Adaptor board part number	C _{ge} (nF)	$\mathrm{R}_{\mathrm{gon}}\left(\Omega ight)$	$\mathrm{R}_{\mathrm{goff}}\left(\Omega ight)$
A-HM0338-33-200250	47	10//10//10	10//10



Fig. 11 Mechanical dimensions of the A-HM0338-33-200250(unit: mm)

Ordering information

The 2FSS0338 can support 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.

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 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: <u>fsales@firstack.com</u>



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