2FHD0115x

Application Manual

Optical interface gate driver solution for EconoDUAL modules, support multi-level

The 2FHD0115x are the dual-channel gate drivers with optical interface and ASIC digital control, which can safely and reliably drive the IGBT. The 2FHD0115x are suitable for Infineon EconoDUAL as well as other brands of IGBTs in the same package. The plug-and-play gate driver can be assembled directly without further development.

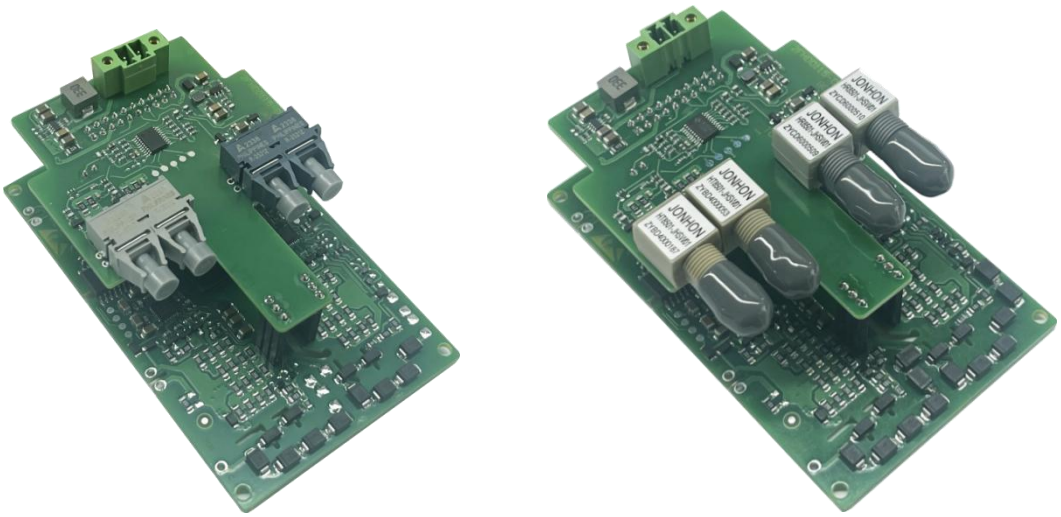


Fig. 1 2FHD0115V(left) and 2FHD0115S(right)

Contents

Abstract

The 2FHD0115x are plug-and-play gate drivers developed by Firstack based on digital control. The basic block diagram is shown in **Fig.2**, and the values of the gate resistors and other key components can be found in the data sheet of the corresponding gate driver.

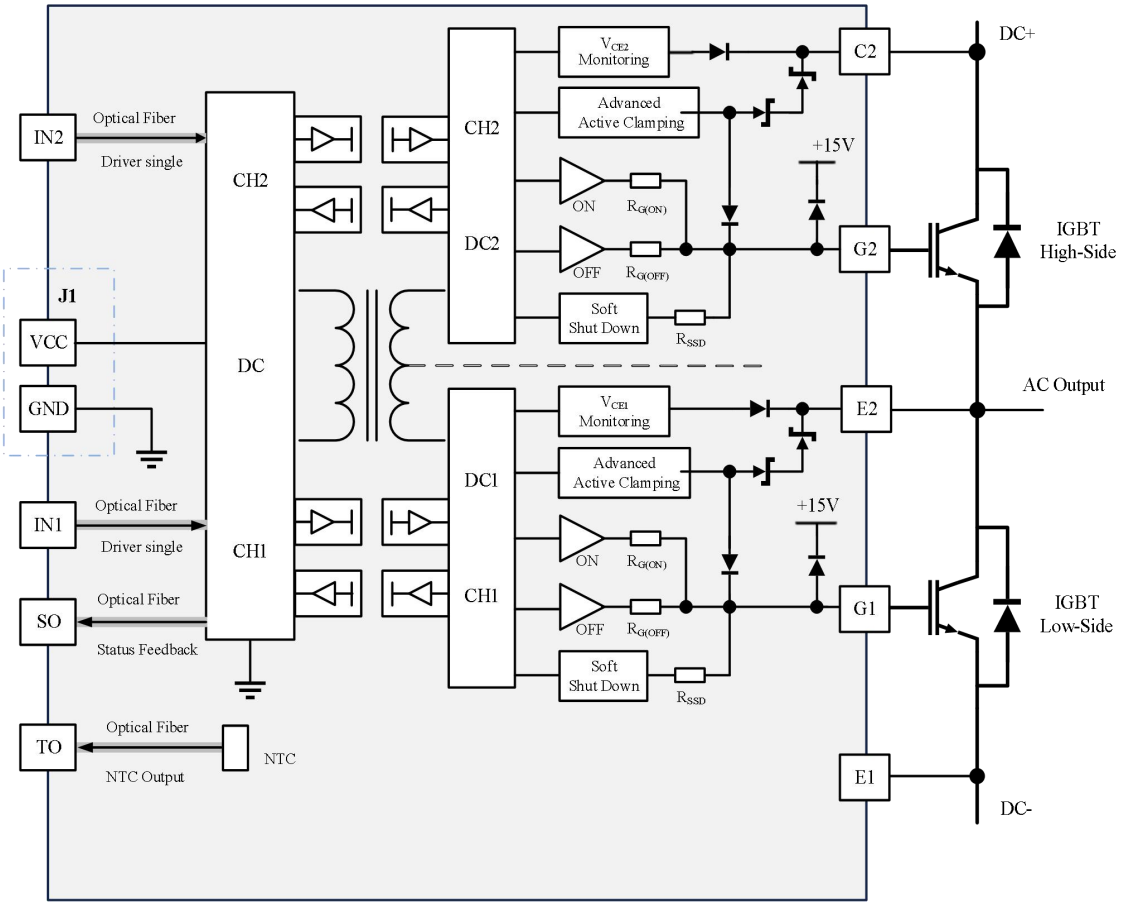


Fig.2 2FHD0115x block diagram

The gate drivers have built-in input connector J1, isolated DCDC power supply, driving circuit with Vce sense (short-circuit protection), UVLO, active clamping, soft shut down, etc., which can safely and reliably drive IGBT modules.

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 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.

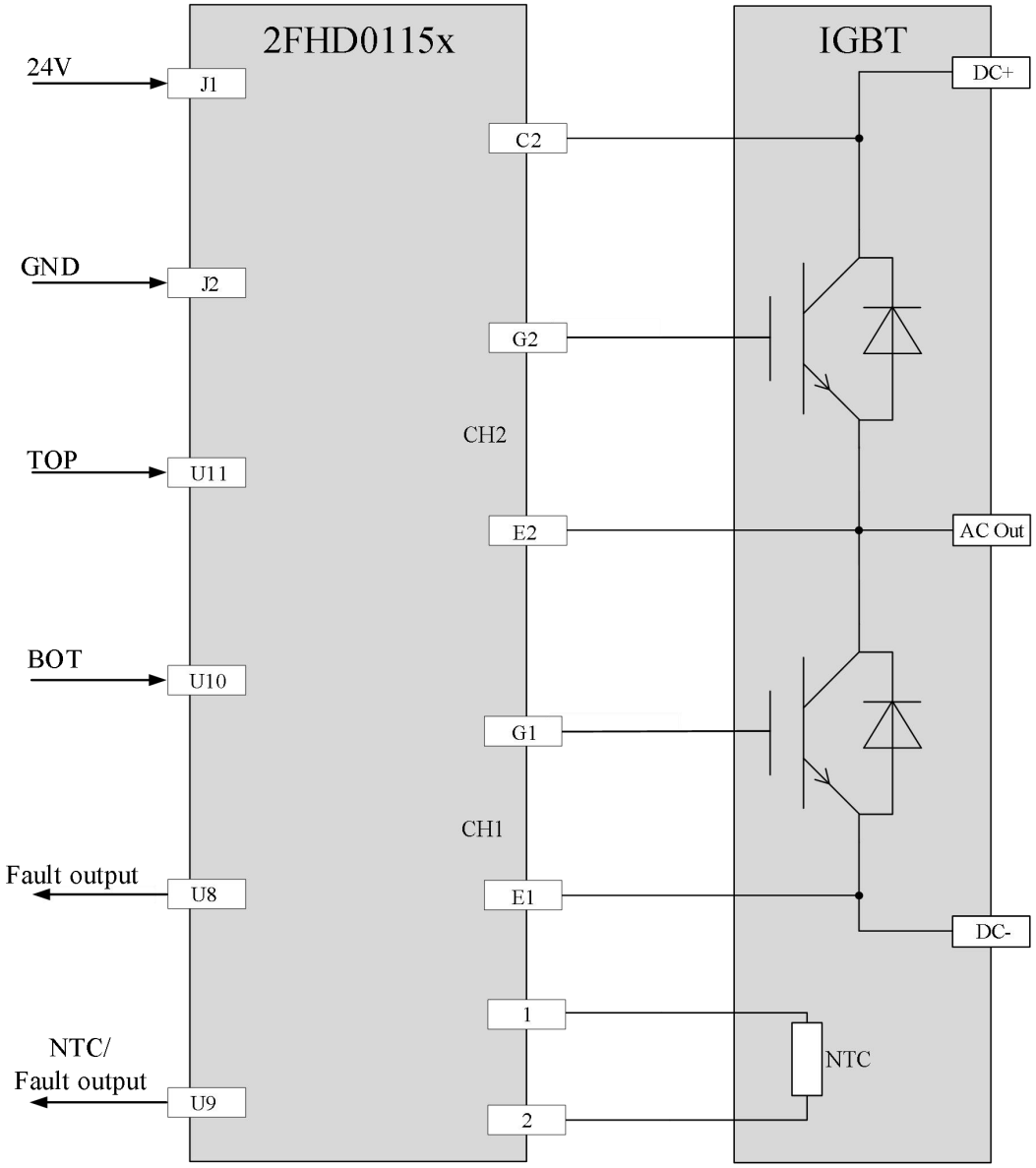
These tests should be performed before installation, because the gate terminal may not be accessible after installation.

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.

Even when testing a single IGBT, power must be supplied to the remaining gate drivers in the system to ensure that the gates of all other IGBTs operate in negative voltage off state. This is particularly important when testing the switching behaviour of an IGBT.

2FHD0115x Recommended Application Circuitry



Description of Connector J1 Interface

J1 is the core board power supply interface, which requires 24V power supply. A plug for this interface is included with the product.

Driver Characteristics

Power Supply

The gate drivers have two V_{CC} power terminals on the P2 connector for primary side circuitry and isolated DC-DC power.

The total power of the gate drivers are 2*1.5W+2.4W=5.4W, with 80% efficiency, 24V requires an input current of about 281mA, which can limit the start-up impulse current.

Driving Mode

Direct Mode:

The top and bottom IGBTs are independent of each other, and receive the input signal of the corresponding channels. The top and bottom channels can be turned on at the same time. For half-bridge applications, it is necessary to ensure that there is sufficient dead time between the two channels of module.

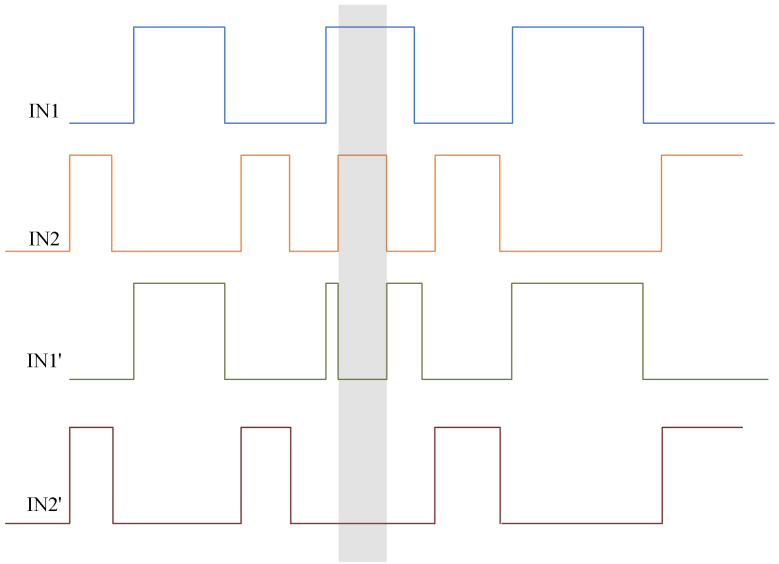
Interlock Mode:

During the operation if the master computer operates abnormally or the transmission line is interfered, it is possible that the control commands of the top and bottom channels, which are originally complementary, appear to be of the same high level. In the bridge arm architecture, the same high command will turn on the two channels at the same time, leading to the module desaturation, generating a large amount of heat, or even causing damage to the module in serious cases.

To solve this problem, the gate drivers integrate PWM interlock function. When the electric level of both channels are high, the gate driver will automatically ignore the high command, but not

return fault signal.

This function is only available on the 2FHD0115V17A1C-Y0005.



Fault Output

The 2FHD0115x adopt the optical fiber fault output mode with two configurable optical fibers. Customers can select either fault summary output + NTC sampling (U8: fault summary; U9: NTC sampling) or top fault + bottom fault (U8: top IGBT fault; U9: bottom IGBT fault).

Fault Signal (SOx) Output Logic

When an undervoltage is detected on the primary side of the gate driver, GDU will turn off the module with negative voltage and maintains blocking signal, both SOx report the fault and the optical fiber light off. When the primary side power supply returns to normal, after another 40ms, the SOx will automatically reset and the optical fiber light on. If the undervoltage disappears before the end of the above process, the SOx stays high and the optical fiber light on; if the undervoltage still exists at the end of the above process, the optical fiber light off until the fault disappears after one blocking time (80ms) and then light on again.

When the undervoltage is detected on the secondary side of the gate driver, the gate will perform soft shut down first, keep the negative voltage for a certain period of time, and then keep 0V shut down and maintain blocking signal, the corresponding SOx signal will report the fault, the optical

fiber light off. At the moment that the fault disappears, after another 20ms, the corresponding SOx will be restored to a high level automatically, and the optical fiber light will on. If the undervoltage fault disappears before the end of the above process, the optical fibre light on; if the undervoltage fault still exists at the end of the above process, the optical fibre goes out until the fault disappears and then lights up again within one blocking time (80ms).

When a short-circuit occurs on the secondary side of the gate driver, the gate will perform the soft shut down function first, then put in negative voltage to keep the turn-off state, and maintain blocking signal, the corresponding SOx signal will report the fault. Optical fiber light off, and on automatically after 10ms.

The 2FHD0115x series are equipped with intelligent fault management function, please refer to the following for details.

Optical Fiber Input

The optical fiber is signal input terminal, currently only 2FHD0115V17A1C-Y0005 in 2FHD0115x series has interlock mode, the rest of them are direct mode.

Technical Principle

Function Description

The 2FHD0115x series plug-and-play drivers are used in EconoDUAL equivalently packaged IGBT modules.

Basic functions: signal isolation, DC-DC power isolation

Protection functions: SC protection, UVLO, soft shut down, active clamping, fault blocking signal, status feedback

Digital functions: intelligent fault management

Temperature sampling: NTC sampling

Power Supply and Electrical Isolation

The gate drivers implement isolated power and signal. Power isolation is realized by the transformer, signal isolation is realized by capacitive coupling. The transformer complies with the safety isolation standard EN50178 and the primary and secondary sides fulfil protection class 2.

Please note that a stable supply voltage and current are required to the gate driver.

Power Supply Monitoring

The primary side of the gate driver, as well as the two secondary side power supplies, have local power sense circuits and corresponding UVLO.

When an undervoltage occurs in the primary power supply, both channels remain turn-off under the negative gate voltage (both channels are blocked), and the optical fiber light off.

When the positive or negative voltage of the secondary side is lower than the threshold voltage,

the driving circuit will detect that an undervoltage has occurred, and the driving circuit will automatically block the IGBT, while the optical fiber light off.

When the primary and secondary side undervoltage disappears, after the corresponding fault return time (refer to Intelligent Fault Management) the optical fiber will automatically light on.

Firstack recommends that any IGBT in the bridge arm should not operate in an undervoltage state.

1. Due to the presence of C_{CG}, when one IGBT in the bridge arm turns on, the high dv/dt from it can be coupled to the other IGBT through the C_{CG}, resulting in partial conduction of the other IGBT.

2. Undervoltage on the primary and secondary side results in a lower gate voltage, which causes an increase in IGBT switching losses.

Short-circuit Protection

The driving circuit judges whether the IGBT is in a short-circuit state by detecting the collector-emitter 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.

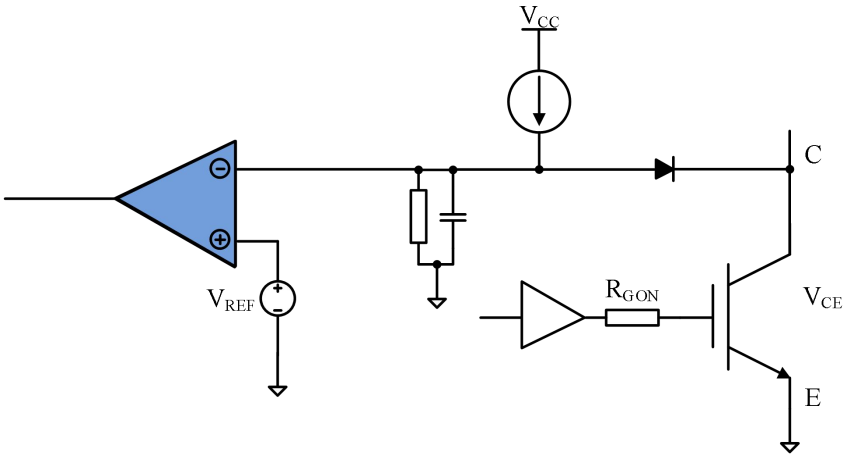
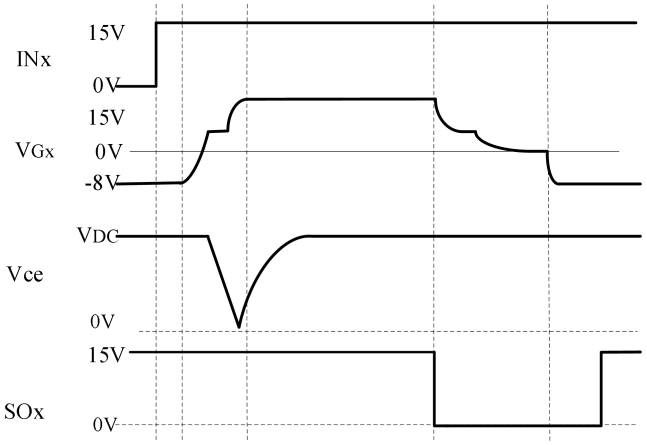


Fig.3 V_{CE} desaturation sense circuit

The V_{CE} is detected after a response time in the on-state (refer to **Fig.3**) to determine the short-circuit condition. If this voltage is higher than the preset threshold V_{th}, the gate driver determines that the IGBT has a short-circuit and sends a fault signal to the corresponding SOx output. At the same time, soft shut down is initiated to turn off the IGBT slowly. The IGBT keeps in the off-state (cut off), the SOx output fault state lasts for 10ms and then returns to high level, and the fault blocking time lasts for 80ms.

Note: the desaturation function is only used for short-circuit protection and cannot provide overcurrent protection.



Soft Shut Down

When the IGBT desaturation occurs, V_{CE} reaches the bus voltage. At the same time, the I_C will reach 4 times of the rated current or even more and the di/dt at the turn-off time will form a very high voltage peak on the parasitic inductance, which will easily damage the IGBT.

When the IGBT desaturation is triggered, the digital core will detect and trigger soft shut down to turn off the IGBT. Within 10μs, the IGBT is gradually turned off by slowly lowering the gate voltage Vge, which effectively reduces the di/dt, and then reduces the voltage peak at the turn-off moment. Thus, the short-circuit protection of IGBT is achieved.

Active Clamping

The active clamping function triggers the active clamping action when the collector-emitter

voltage exceeds the preset threshold, which partially turns on the IGBT, thus suppressing the collector-emitter voltage of it, and the IGBT operates in the linear region.

The 2FHD0115x adopt six TVS to form an advanced active clamping, which can effectively suppress the turn-off overvoltage peak.

Intelligent Fault Management

The gate driver detects the operation status of the module in real time, and when there is a fault, the module uploads the fault status to the master computer through the SOx output. The 2FHD0115x realizes the fault differentiation by the difference of optical fiber light off time (fault return time).

For more information, please see the table below.

Fault type	SC fault	UVLO(sec.)	UVLO(pri.)	Other faults
Fault return time	10ms	20ms	40ms	80ms

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.

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Company Information

Tel: +86-571 8817 2737

Fax: +86-571 8817 3973

Web: www.firstack.com

Email: fsales@firstack.com

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