Description and Application Manual for PHD1032-65 HV high power IGBT driver

WEPOWER series high power IGBT intelligent driving modules are specially designed for high power IGBT module with high reliability and security. The products series have been patented in China.

The high power IGBT intelligent module driver released by WEPOWER is easy to use with smart design, high driving power (10W/±32A) and complete function. With high voltage isolation, it also can drive high voltage IGBTs module and in series IGBTs. Through fiber optic cable transmit signals with very short time, PHD1032-65 can be used for high voltage frequency inverters and high frequency power supply and RF converter and resonance converter. PHD1032-65 HV high power IGBT intelligent drive module can drive high power IGBTs of 6500V, 3300V, 2500V and 1700V.

The WEPOWER IGBT driver is a winning project of the competition organized by "China National Invention Association" in 2009.

The IGBT driver by distinguishing it as the "Bronze Medal" in the "National Exhibition of Inventions" in 2009.

Applications

- ※ Traction
- ※ Motor Drives
- ※ Switch Mode Power Supplies
- ※ Radiology and Laser Technology
- ※ High Frequency Applications
- ※ Radar and Laser Technology
- ※ High Voltage Converters
- ※ RF Generators and Converters

1. Main Features & Technical Specifications

1.1 Main Features

(1) Suitable for driving high voltage IGBT module
(2) Short circuit and over current and under-voltage protection.
(3) Reliable and durable
(4) High electrical isolation
(5) Switching frequency: 0~100KHz
(6) Duty ratio: 0~100%
(7) Disturbance rejection property: dv/dt >100,000V/us
(8) Integrated internal DC/DC power supply

1.2 Technical Specifications

Drive channel number	1 channels
Suitable DC Bus bar Voltage	≤6500V
Rated Input Voltage	15V（±0.5V）
Max. Drive Current	±32A
Internal DC/DC Rated Power	10W
Rated Drive Voltage	+15V/-15V

Maximum Ratings			
Symbol	Definition	Value	Unit
VDC	voltage supply primary input side	15.6	V
V_{iH}	Input signal voltage (high)	5+0.5	V
V_{iL}	Input signal voltage (low)	GND-0.3	V
$Iout_{PEAK}$	Output gate peak current	32	A
$Iout_{AVmax}$	Output average current	650	mA
f_{max}	Max switch frequency	500	kHz
V_{CE}	Collector emitter voltage sense across the IGBT	6500	V
dv/dt	Rate of rise and fall of voltage secondary to signal primary side	50	kV/us
V_{isolIO}	Isolation test voltage input-output (AC,RMS,10S)	12	kV
R_{Gonmin}	Minimum rating for R_{Gon}	0.5	Ω
$R_{Goffmin}$	Minimum rating for R_{Goff}	0.5	Ω

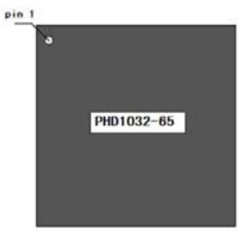
$Q_{out/pulse}$	Max. rating for output charge per pulse		65	uC
T_{op}	Operation Temperature	PHD1032-65I	-40℃～+85℃	℃
		PHD1032-65J	-40℃～+105℃	
		PHD1032-65M	-55℃～+125℃	
T_{stg}	Storage Temperature	PHD1032-65I	-55℃～+105℃	℃
		PHD1032-65J	-55℃～+125℃	
		PHD1032-65M	-60℃～+130℃	

Electrical characteristics

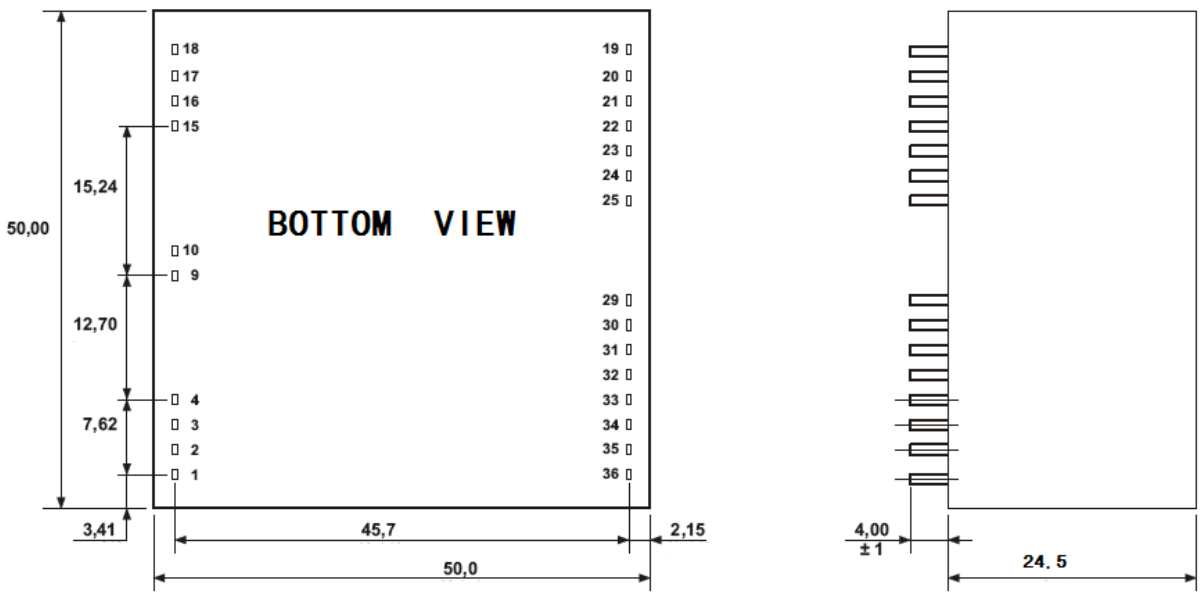
Symbol	Definition	Value			Unit
		Min.	Typ.	Max.	
VDC	voltage supply DC/DC converter	14.5	15	15.6	
I_{SO}	Supply current primary side (no load)		80		mA
	Supply current primary side (max)			750	mA
$V_{G(on)}$	Turn on gate voltage output		+15		V
$V_{G(off)}$	Turn off gate voltage output		-15		V
I_{OMAX}	Max drive current		32		A
$t_{d(on)}$	Turn-on propagation time		110		ns
$t_{d(off)}$	Turn-off propagation time		100		ns
$t_{r(out)}$	Output rise time		40		ns
$t_{f(out)}$	Output fall time		40		ns
$t_{d(err)}$	Error propagation time			300	ns
C_{PS}	Coupling capacitance primary secondary		10		pF
W	Weight		60		g
MTBF	Mean time between failure (Ta=40℃,max load)		2.0		10^6h

Notes:
When work under +85℃ ~ +105℃,reduce 30% power of the driver;
When work under +105℃ ~ +125℃,reduce 50% power of the driver.

2. PHD1032-65 Block Diagram



TOP VIEW

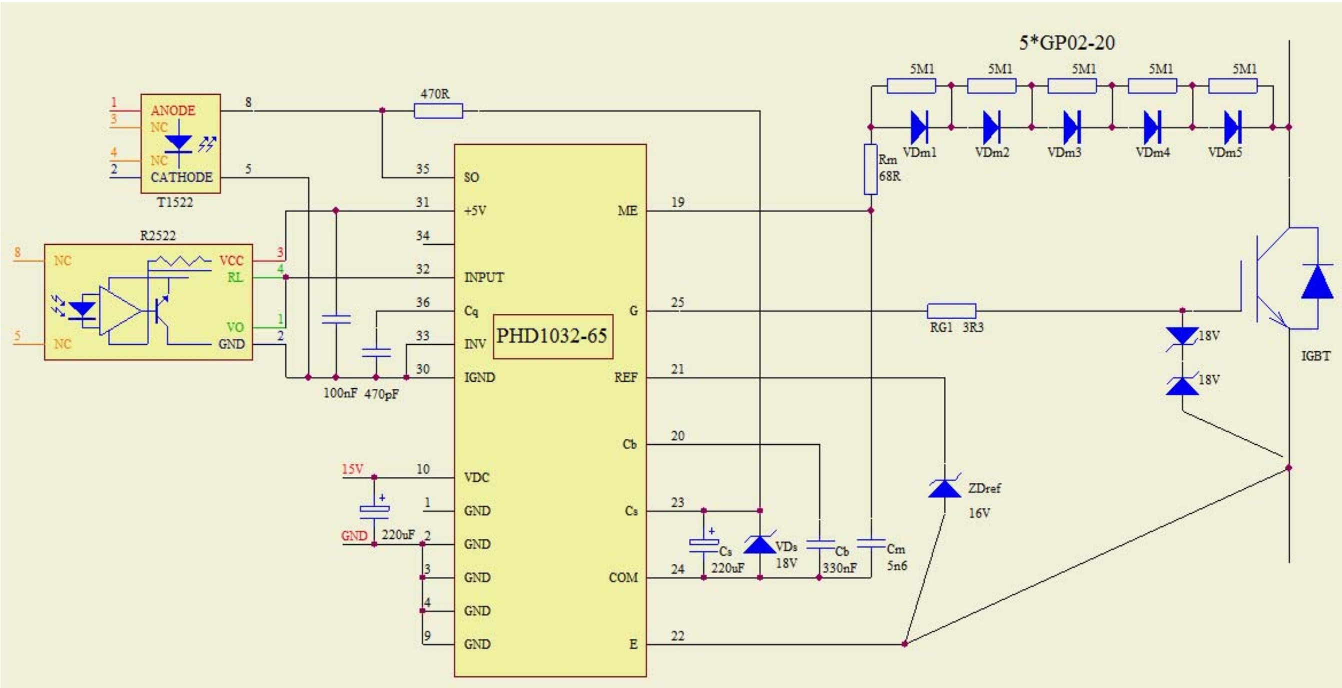


PHD1032-65 Dimensional Diagram

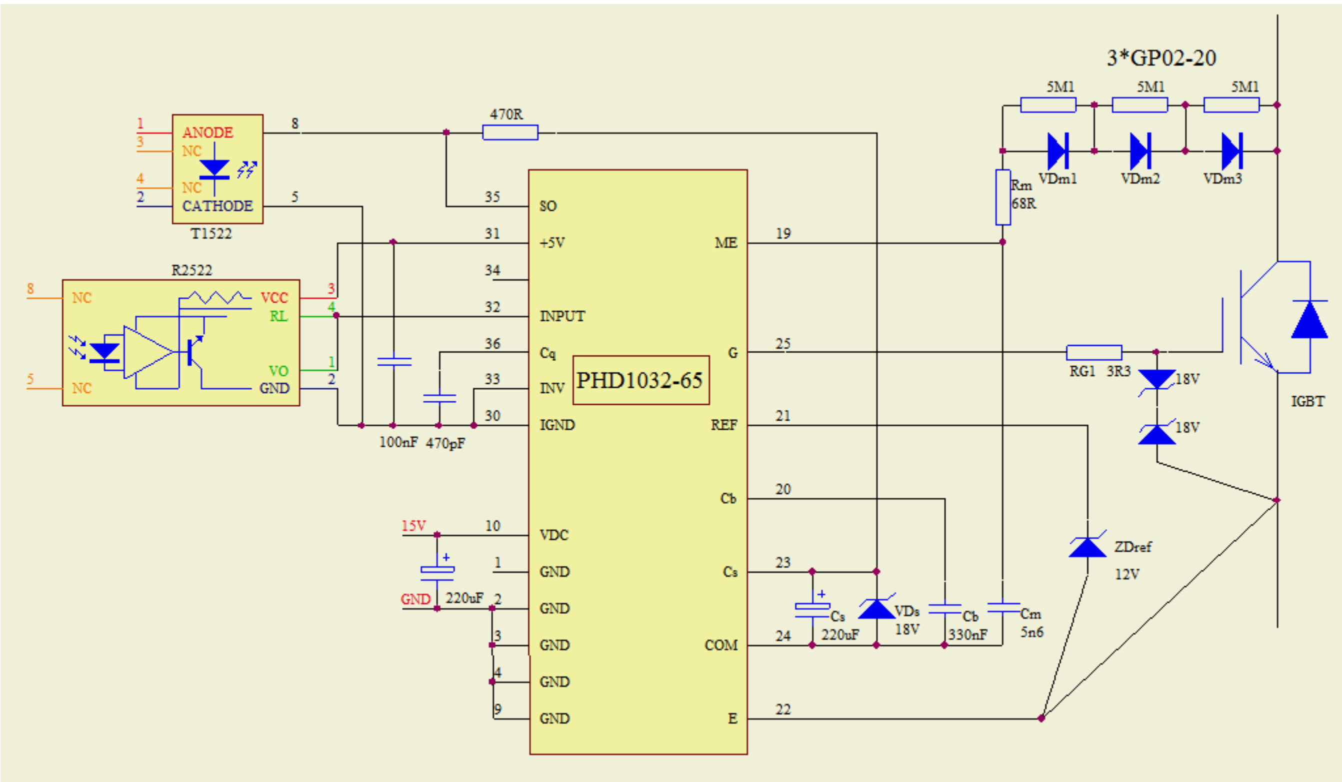
Pin	Function	Pin	Function
1 GND	Power Supply GND	19ME	V_{CE} Measurement
2 GND	Power Supply GND	20 Cb	Blocking time capacitor
3 GND	Power Supply GND	21 REF	External Reference
4 GND	Power Supply GND	22 E	Emitter / Source
5 NC		23 CS	Blocking Capacitor 15V
6 NC		24 COM	Virtual Common
7 NC		25 G	Gate Drive Output
8 NC		26 NC	
9 GND	Power Supply GND	27 NC	
10 VDC	Power Supply15V	28 NC	
11 NC		29 NC	
12 NC		30 IGND	GND for FOL
13 NC		31 +5V	5V Power Supply for FOL
14 NC		32 INPUT	Input Signal from FOL
15 NC		33 INV	Inverse Input
16 NC		34 SDOSA	Series Connected IGBT Mode
17 NC		35 SO	Status Output Signal
18 NC		36 Cq	Acknowledgement Pulse Capacitor

3. Application example

Below are two Typical Application Circuit for PHD1032-65. Typical Application Circuit 1 is used to drive 6500V IGBTs and typical application circuit 2 is used to drive 3300V IGBTs.



PHD1032-65 Typical Application Circuit 1



PHD1032-65 Typical Application Circuit 2

4. Overview of WEPOWER High Power IGBT Intelligent Driving Module

(1) More reliable operation (Gate bipolar power supply with +15V/-15V is suitable for IGBT of any manufacturer. The gate is driven by negative voltage which increases capacity of anti-interference and more Parallel IGBTs can be driven.)

(2) True electrical isolation. (Adapting high voltage isolation transformer technology for better insulation performance)

5. Operation Principle

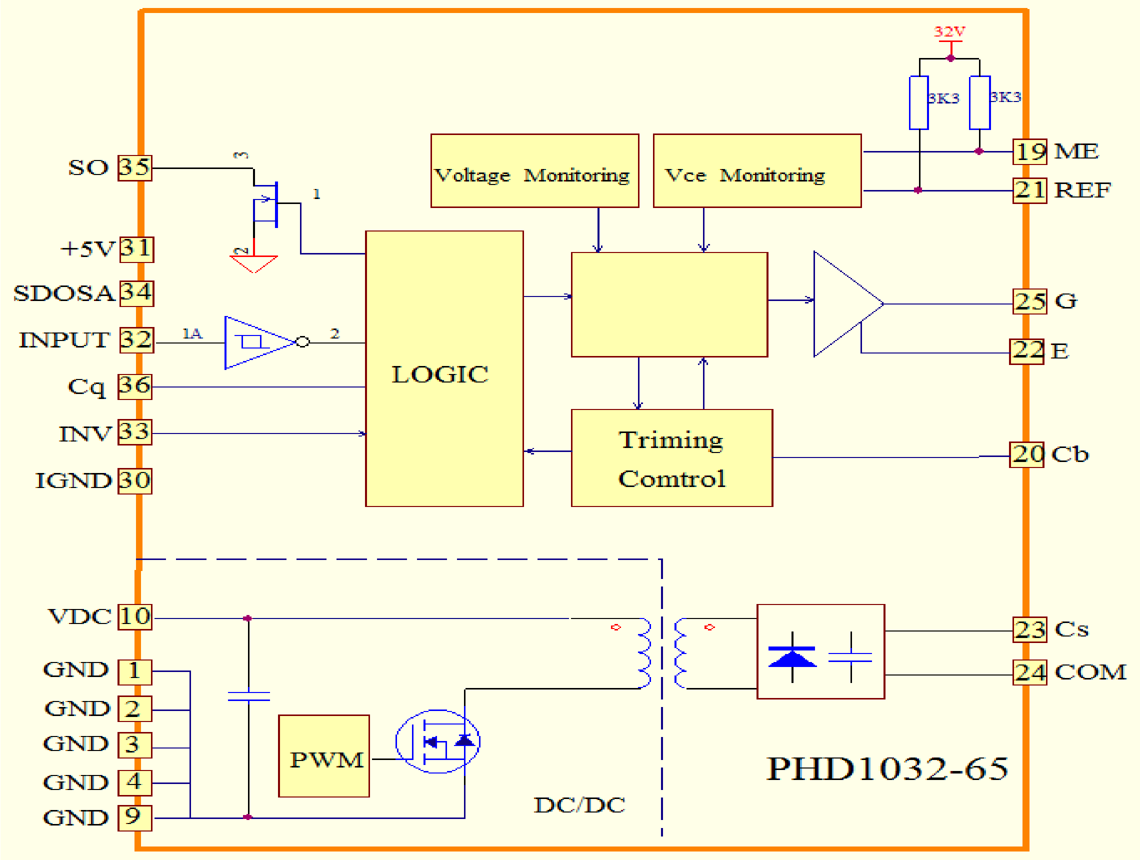
5.1 Block diagram

PHD1032-65 high-power IGBT intelligent driving module mainly consists of internal DC / DC converting circuit and IGBT Intelligent driving circuit which is formed by a logic processing circuit, a power drive and detection circuits.

Integrated DC / DC power supply

All of the standard series of WEPOWER high-power IGBT intelligent drive module includes a DC / DC converter for each channel to provide drive voltage. Therefore, drivers need only a stable 15V DC power supply. As for different application, especially the different switching frequency and power valve gate charge, WEPOWER offers different driving power. Internal DC/DC drive power of PHD1032-65 is 10W.

The block diagram is shown below.



PHD1032-65 Block diagram

5.2 Protection Features

The IGBT V_{CE} detection circuit is set in PHD1032-65 HV high power intelligent driver. Once the V_{CE} value exceeds setting voltage of gate or fault of under-voltage is detected, shutdown signal will generated by the module immediately. The drive board begins to turn off the power tube and no longer receive any driving signal. SO output is low level. The driver will not accept any driving signal until the "blocking" time has elapsed and then to restart. Error blocking time can be set by Cb.

5.3 Operation Mode

PHD1032-65 HV high power driver provides selection for series connection working mode. Pin SDOSA is the selection terminal for series connection and in normal condition it is vacant. When over-current happens for IGBTs, the driver will turn off immediately and transmits the status to SO. When +5V is connected to SDOSA, IGBTs are in series mode. When over-current happens for IGBTs, IGBTs are not turned off, it only transmits status to SO and pass to control part of the system by optical fiber, then the system will shut off all the IGBTs.

5.4 The Pin Designation

5.4.1 The Input Side

Pin GND

Pin GND is connected to the ground of the electronic power supply.

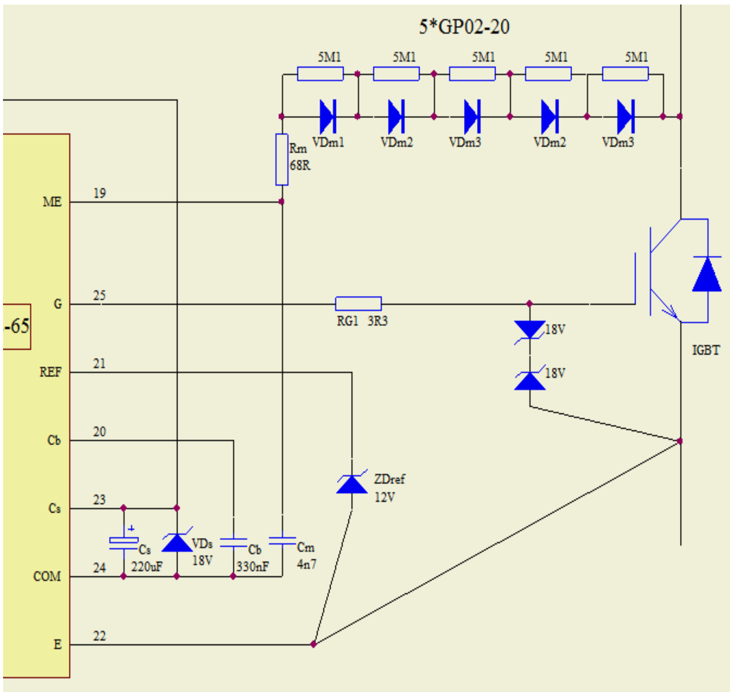
Pin VDC (+15V voltage supply of input side)

Filtering capacitor 220uF/25V is suggested to be connected between VDC and ground.

5.4.2 The Power Side

Pin ME

This Pin is used to measure the voltage drop at the turned-on power transistor in order to ensure protection against short circuit and overload. It should be noted that it must never be connected directly to the drain or collector of the power transistor. To protect the measurement terminal from the high drain or collector voltage of the turned-off power element, a circuit with high-blocking diodes (Dme) or several diodes connect in series should be included. It is absolutely recommended to over dimension these diodes in terms of voltage.



A pull-up resistor integrated in the driver module ensures that a current flows through the measurement diode (Dme), the resistor (Rme) and the power transistor when the latter is turned on. A potential is then present at the measurement input ME that corresponds to the forward voltage of the turned-on transistor plus the diode forward voltage and the voltage drop at Rme. Rme attenuates the reverse-current peaks of the measurement diode Dme and should have a value of about 68Ω.

It should be noted that the power transistor do not turn on immediately. It can take several microseconds for them to switch through fully, especially with IGBTs. Together with the integrated pull-up resistor and the external capacitor (Cme), this produces a delay in the measurement after the power transistor has switched on. This delay shall henceforth be known as the response time. This response time (and thus Cme) must be selected to be greater in inverse proportion to the speed at which the power transistor turn on.

The calculation formula for this responsible as below:

$$C_{me} = \frac{t_a}{3,3\,k\Omega \;\ln\left(\frac{V_{cc}}{V_{cc} - V_{ref}}\right)}$$

Pin Cb

After the current monitoring circuit responds, an error message is reported via the status output SO during a defined time –known henceforth as the blocking time. In normal mode the power transistor is also turned off by the intelligent driver's protection function and remains in this state during the blocking time. This function is used to protect the component from thermal overload at a continuous or repeated short circuit. The blocking time can be determined by connecting Pin 20 (Cb) to Pin 24 (COM) via a capacitor. The calculation formula for Cb as below:

$$C_b = \frac{t_b}{100k\Omega \;\ln\left(\frac{2 \cdot V_{cc}}{V_{ref}}\right)}$$

Pin REF

An external zener diode is connected to this pin as a reference. This defines the maximum voltage drop at the turned-on power transistor at which the protective function of the driver circuit is activated.

The protection function of the intelligent drivers PHD1032-65 series always become active when the voltage at ME (measurement drain / collector) is higher than that at REF.

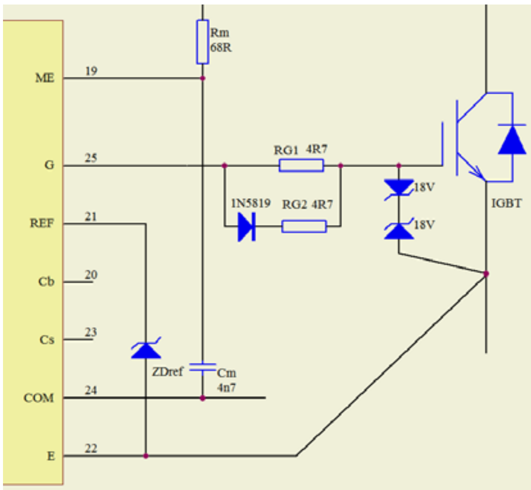
The reference potential is the emitter (or source) of the power transistor. The reference must never under any circumstances be capacitively blocked. The reference diode should be placed as closed as possible to the driver module.

Pin E: E collector output terminal

Pin Cs: 15V output terminal

It can charge the fault feedback fiber, 220uF/25V filtering capacitance is recommended between Cs and COM.

Pin G: G collector output terminal
Try to use shorter lead wire as possible to connect G collector from IGBTs to Pin 25. Two gate electrode resistors and a diode compose a gate electrode circuit which used to ensure the switch speed for turn on and turn off respectively.



Anisomerous gate pole resistor

Reverse connection a zener diode (18V) between collector G and E in order to avoid engendering stray voltage and over rated gate pole voltage to break IGBTs. Pin G connected to G & E of IGBTs. Connection lead wire can be as shorter as possible and it would be best to be connected with Pin 22 directly with driver module. It is better to use twisted wire to connect G, E and C of IGBTs.

Pin IGND
This Pin is the ground Pin for the interface electronics, especially for the FOL receiver.

Pin +5V: Terminal +5V
A voltage of +5V with respect to IGND is applied to this Pin.
Filtering capacitor 100uF is suggested to be connected between +5V and IGND.

Pin INPUT
It is recommended to receive signal by FOL.

Pin INV
This Pin allows the input signal INPUT to be inverted.
The input INV allows connection of a FOL receiver with a “high” or “low” output signal in the driven status.

Pin SDOSA

This Pin is used for mode selection.

In normal operation, the SDOSA terminal remains open. When over current occurs on IGBT, the power semiconductor is immediately turned off and transmit status to SO. When SDOSA connected to +5V, it is Chaining mode of IGBTs. When over current occurs, IGBT does not turn-off, only transmit status to SO, then transmit to the control part of the system by fiber. The controller will turn-off all IGBTs. This function is workable for parallel circuit of MOSFETs and IGBTs. Each power semiconductor is controlled by one drive, in this way to turn-off the drive will cause the current distributed balanceable.

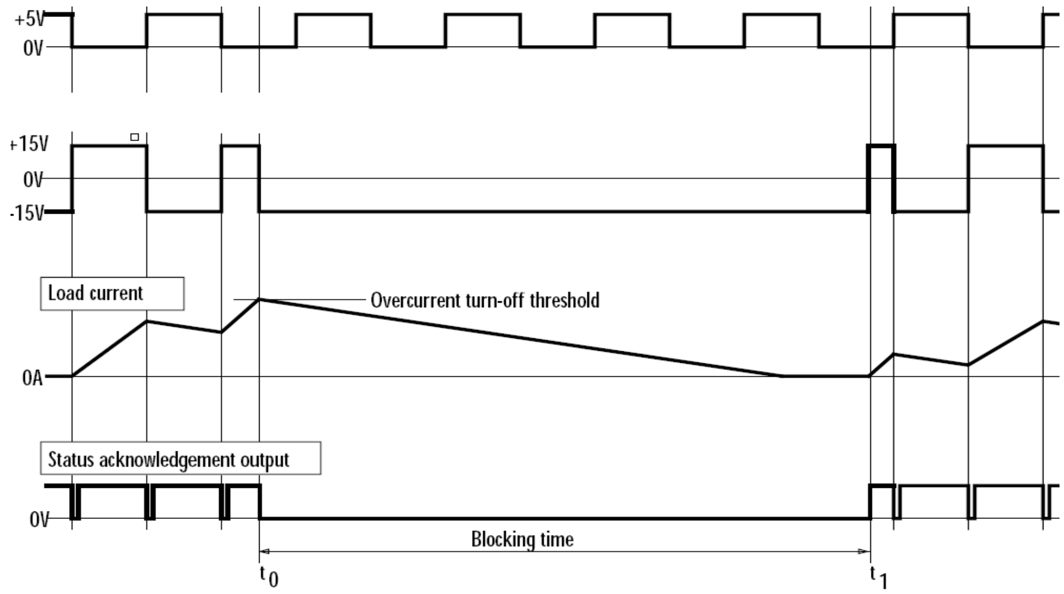
This function can also be used in bridge circuits, for example to ensure that all power semiconductors are turned off simultaneously in the case of a fault.

Pin SO

This Pin is the fault output of the driver module.

If there is no fault the SO will be high-impedance, i.e. the current flows the status acknowledgement circuit of FOL transmitter. If the protection circuit (Under-saturated detection) is detected with fault signal, the SO will be "conduction through" within the cut-off time. This output also can identify the pulse edge of each drive signal. This signal is a short pulse signal and its width will be confirmed by Pin 36 (CQ) connection a capacitor. This identification function enables the control circuit detect the SO output status (e.g. drive wire and status identification) and the working status of the drive at the same time. If fault feedback fiber is fall off, poor contact, or the bad quality of transmit diode with insufficient light, it will cause following danger condition. One is the receiver will produce a megacycle level high frequency noise signal, the power semiconductor will be burned within few uS. Another is the drive module will be damaged. On the edge of each input pulse SO output will appear an identification pulse. So the fault status can be detected thru a logic circuit, and thus to turn off the system.

SO output logic and blocking time as below:



SO output logic and blocking time

Pin Cq: Acknowledgement Pulse Capacitor

After each module received a pulse successfully, it will feedback a pulse signal through SO. The width of the pulse signal will be set by an external connection capacitor from Cq to COM.

5.5 Notes

(1) The capacitor value between Pin 10 VDC & Pin 9 GND should be not less than the one between Pin 23 Cs and Pin 24 COM. And this capacitor value is less than 250uF.

(2) The connection wire should be less than 10 cm between IGD drive and power semiconductor. Twisted wire should be used for connection each power tube grid and Emitter electrode and measurement electrode (drain electrode, collector electrode).

(3) Try to reduce parasitic inductance of the circuit. The drive circuit and equalizer circuit are designed as printed plate in our modulator and assembled on the Pins of IGBTs directly, in this case to reduce the big counter potential phenomena caused by distributed inductance.

(4) The value for current-limiting resistance of fiber emitter terminal should be suitable. If the value is big, the fiber emitter current will be not enough, and this will affect the output pulse of the module.

6. Calculation of driving power

Gate input capacitance (Cin) can be found in the data sheet. The total power need to drive IGBT can be calculated by the following simple formula:

$P=f*Cin*\triangle V^2$ OR $P=f*Q*\triangle V$

Gate charge $Q=\int idt=C*\triangle V$

(Note: P stands for the real driving power not including the losses in drive channel and drive power supply.)

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