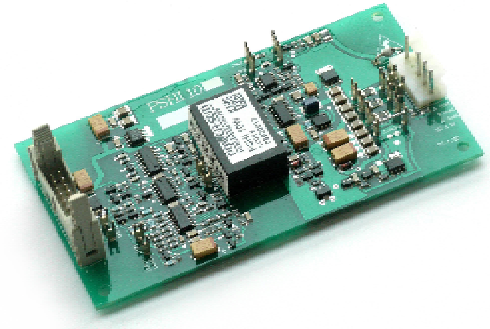


1. Absolute Maximum Ratings(Ta=25°C)

Symbol	Terms	Values	Units
V _S	Supply voltage primary	18	V
V _{iH}	Input signal voltage(HIGH)	V _S +0.3	V
I _{outPEAK}	Output peak current	±8	A
I _{outAV}	Output average current	±100	mA
V _{CE}	Collector-emitter voltage sense	1200 / 1700	V
dv/dt	Rate of rise and fall of voltage	75	kV/μs
V _{isol IO}	Isolation test volt.IN-OUT(1min.AC)	4000	V
R _{Gon min}	Minimal R _{Gon}	1.5	Ω
R _{Goff min}	Minimal R _{Goff}	1.5	Ω
Q _{out/pulse}	Charge per pulse	9.6	μC
T _{op}	Operating temperature	-25~85	°C
T _{stg}	Storage temperature	-25~85	°C



POWER-SEM PCB IGBT Driver PSHI 1012 PSHI 1017

High Power Single IGBT Driver

2. Electrical Characteristics(Ta=25°C)

Symbol	Terms	Values			Unit
		min	typ	max	
V _S	Supply voltage primary	14.4	15	15.6	V
I _S	Supply current(max.)		0.3 ¹⁾		A
I _{SO} ²⁾	Supply current primary side(standby)		0.09		A
V _{IT+}	Input threshold voltage(HIGH)min For 15V input level For 5V input level	12.5 2.4			V
V _{IT-}	Input threshold voltage(LOW)max For 15V input level For 5V input level			3.6 0.5	V
R _{in}	Input resistance		10		kΩ
V _{G(on)}	Turn-on output gate voltage		15		V
V _{G(off)}	Turn-off output gate voltage		-8		V
f	Maximum operating frequency		see Fig.1		
t _{d(on)IO}	Input-output turn-on propagation time		1.4		μs
t _{d(off)IO}	Input-output turn-off propagation time		1.4		μs
t _{d(err)}	Error input-output propagation time		1 ³⁾		μs
V _{CEstat}	Reference voltage for V _{CE} monitoring		5.2 ⁴⁾ /6.3 ⁵⁾		V
C _{PS}	Primary to secondary capacitance		12		Pf

- 1) This current value is a function of the output load condition
- 2) Operating fsw=0Hz
- 3) This value is not considered by t_{on} and t_{dead} of IGBT, but adjusted by R_{CE} and C_{CE}
- 4) With R_{CE}=18k Ω, C_{CE}=330pF (PSHI1012 used for 1200V IGBT)
- 5) With R_{CE}=36k Ω, C_{CE}=470pF (PSHI1017 used for 1700V IGBT)

Features

- PSHI 10/12 drives all series IGBTs with V_{CEs} up to 1200V(V_{CE}-monitoring adjusted from factory for 1200V IGBT)
- PSHI 10/17 drives all series IGBTs with V_{CEs} up to 1700V(V_{CE}-monitoring adjusted from factory for 1700V IGBT)
- CMOS/TTL(HCMOS) compatible input buffers
- Short circuit protection by V_{CE} monitoring
- Soft short circuit turn-off
- Isolation due to transformers(no opto couplers)
- Supply undervoltage protection(<13V)
- Error memory/output signal (LOW OR HIGH LOGIC)
- Internal isolated power supply

Typical Applications

- Single and bridge circuit
- Inverter
- Welding machine
- Induction heating
- Chopper circuit
- High power UPS
- High frequency SMPS

3. Product Overview

The new intelligent single IGBT driver, PSHI1012 respectively PSHI1017 is a standard driver for all power IGBTs in the market. PSHI1012 drives all IGBTs with V_{CE} up to 1200V. PSHI1017 drives all IGBTs with V_{CE} up to 1700V. To protect the driver against moisture, dust and salt fog, it is coated with three-proof protective agents. The adaption of the drivers to the application has been improved by using pins to changing several parameters and functions, different types of IGBT can be drove easily by adjusting R_{Gon} , R_{Goff} and $R_{Goff-sc}$ value. The connections to the IGBTs can be made by using 1 connector with 5 pins for each IGBT. The high drive capability was designed to make it possible to switch up to 400A IGBT modules at frequencies up to 20kHz. High power output can be achieved by paralleling more IGBTs.

A new function has been added to the short circuit protection circuit (Soft Turn Off), this automatically increases the IGBT turn off time and hence reduces the DC voltage overshoot enabling the use of higher DC-bus voltages. This means an increase in the final output power.

Integrated DC/DC converters with high galvanic isolation (4kV/1minute) ensures that the user is protected from the high voltage (secondary side). The power supply for the driver may be the same as used in the control board (0/+15V) without the requirement of isolation. All information that is transmitted between input and output uses ferrite transformers, resulting in high dv/dt immunity (75kV/us) which has high anti-jamming ability.

The driver input stages integrated a input level selector (15V/5V input level), which suitable for different output level of control board.

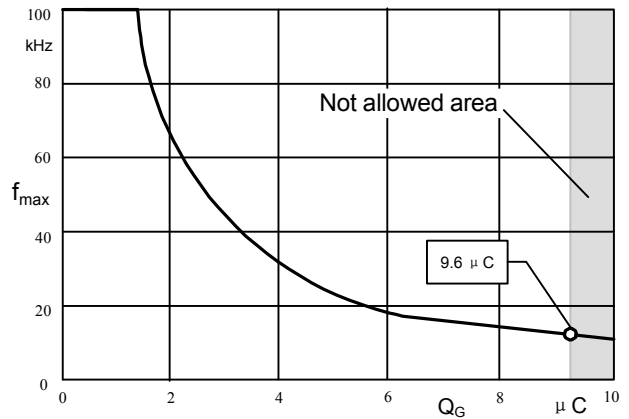


Fig.1 Relationship between maximum operating frequency and charge per pulse

4. Block diagram PSHI 10

System structure features (see Fig 2)

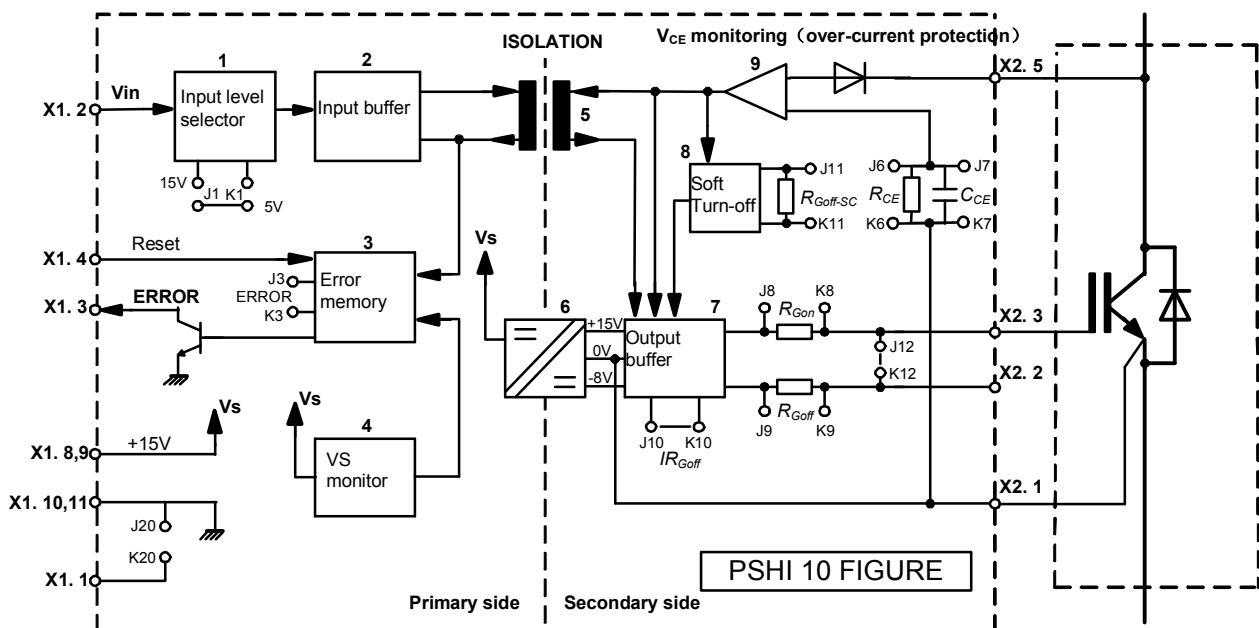
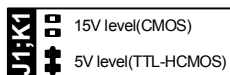


Fig 2. System structure of PSHI 10

System structure and performance features:

- “INPUT LEVEL SELECTOR circuit” can choose 5V (TTL,HCMOS) or 15V (CMOS) signal. By comparing a signal with a level, it fix input signals and enhance improve driver’s anti-jamming ability. COMS is adjusted from factory for 15V, but can be changed by the user to 5V HCMOS level by solder bridging between J1 and K1. The standard level is +15V (factory adjusted) intended for noisy environments or when long connections (L>50cm) between the external control circuit and PSHI 10 are used, where noise immunity must be considerate.For lower power, and short connections between control board and driver, the TTL-HCMOS level (+5V) can be selected by solder bridging between J1 and K1, specially useful for signals from uP based controllers.



5V level is not commended to be used for long input cable because of existing interference.

When connecting PSHI10 to control board using short connecting lead, no special attention needs to be taken. Otherwise, if the length is 50cm or more (we suggest to limit the cable length to about 1 meter), some care must be taken. The TTL (5V) level should be avoided and CMOS(15V) is to be used instead; flat cable must have the pairs of conductors twisted or be shielded cable is used, it can be connected to pins J20 & K20 and x1.1 coupled to ground through a capacitor, resistor or jumper.

An internal pull-down resistor of driver signal inputs keeps the IGBT in OFF state in case V_{in} connection is interrupted or left non connected.

The following overview is showing the input threshold voltages:

V_{T+} (High)	min	typ	max
15 V	9.5 V	11.0 V	12.5 V
5 V	1.8 V	2.0 V	2.4 V

V_{T-} (Low)	min	typ	max
15 V	3.6 V	4.2 V	4.8 V
5 V	0.50 V	0.65 V	0.80 V

- “INPUT BUFFER” circuit converts input signals in order to make them meet the needs of ferrite transformers and avoid other false signals being transmitted to output side.
- The “ERROR MEMORY” blocks the transmission of all turn-on signals to the IGBT and output error signal by a OC transistor if either over-current or under-voltage is detected. Default error signal output is high level active, while needing low level active, just soldering bridged J3 with K3.
- The “ V_s MONITOR” ensures that V_s actual is not below 13V. Once V_s below 13V, system will blocks the transmission of all input signals to the IGBT.
- With a “FERRITE TRANSFORMER” the information between primary and secondary may flow in both directions and high levels of dv/dt (75kV/us) and high isolation voltage(AC4kV,1 min.).At the same time, it can also restrain the short-pulse signals below 500ns.
- A high frequency “DC/DC power supply” used in “power output circuit” to supply isolation power supply with output voltage:+15V/-8V. Power supply use full-bridge circuit,filtering and stablization, which make the driver get enough gate voltage without external isolation power supply.The drivers and controlled system can use same power supply(+15V), even if we are using more than one PSHI10.
- In case of short-circuit, a further circuit (SOFT TURN-OFF) increases the resistance in series with R_{Goff} and turns-off the IGBT at a lower speed.This produces a smaller voltage spike above the DC link by reducing the di/dt value.Because in short-circuit conditions the Homogeneous IGBT’s peak current increases up to 6-8 times the nominal current, and some stray inductance is always present in power circuits, it must fall to zero in a longer time than at normal operation to avoid damage IGBT by high voltage spike.The default resistor used for soft turn-off is 22 Ω , this “soft turn-off time” can be reduced by connecting a parallel resistor $R_{Goff-SC}$ on J11,K11 with those already on the printed circuit board(see Fig.3)

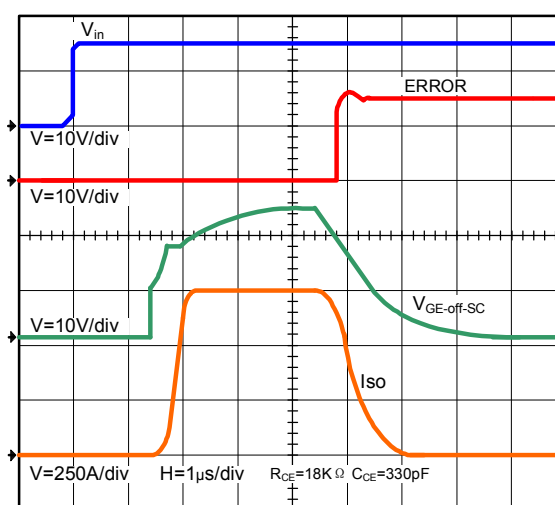


Fig.3 Soft turn-off waveform

■ “V_{CE} monitoring circuit” is responsible for short-circuit sensing. Due to the direct measurement of V_{CEstat} on the IGBT’s collector, it blocks the output buffer (through the soft turn-off circuit) in case of short-circuit and sends a signal to the ERROR memory on the primary side.

The reference voltage V_{CEref} adjusted dynamically according to IGBT switch characteristics, and reset when IGBT turn-off. The V_{CEref} is not static but a dynamic reference which has an exponential shape starting at about 15 V and decreases to V_{CEstat} (determined by R_{CE}), with a time constant τ (controlled by C_{CE}) (see Fig.4).

V_{CEsat} threshold is a static value of V_{CEref} which is controlled by resistor R_{CE} (see Fig.5a). It can be adjusted by resistor R_{CE} (J6,K6) to reach the maximum value as per IGBT’s demand. V_{CEstat} > V_{CEsat} under normal conditions, but will not exceed 10V. The decay time of V_{CEref} is determined by capacitor C_{CE} and resistor R_{CE} (see Fig.5b), It controls the dead time t_{dead} when IGBT just starts to conduct till V_{CEstat} monitoring starts.

To avoid a false failure indication when the IGBT just starts to conduct (V_{CE} > V_{CEref}), some decay time t_{dead} must be provided for the V_{CEref}. As the V_{CE} signal is internally limited at 10 V, “V_{CE} monitoring circuit” will be trigger and cut off IGBT by “soft turn-off circuit” when V_{CEref} drops to 10V (ie. leave monitor dead area t_{dead}) and V_{CE} voltage rises above the reference voltage at any time (V_{CE} > V_{CEref}). The various different operating conditions are depicted in Fig.6.

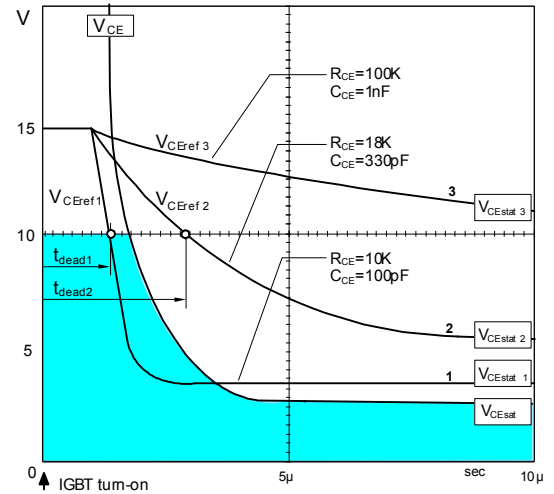


Fig.4 V_{CEref} protection waveform with parameters

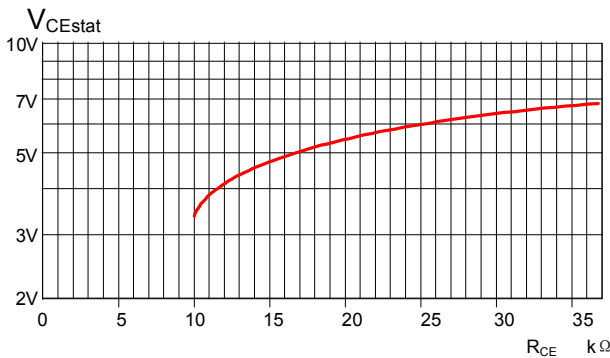


Fig.5a V_{CEstat} as function of R_{CE}

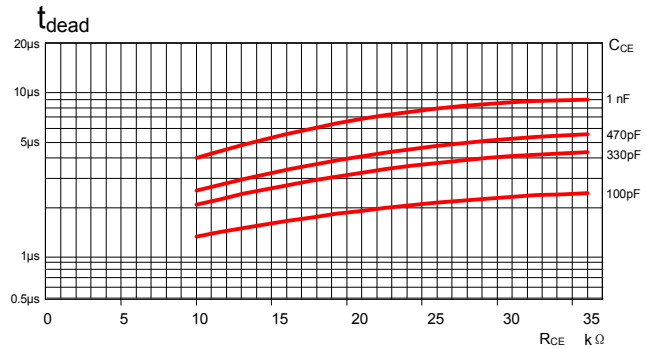


Fig.5b T_{dead} as function of R_{CE} & C_{CE}

The monitor sensitivity of “V_{CE} monitoring circuit” is adjusted by changing dead time t_{dead}. This can be realized by extending monitoring dead area via adjusting C_{CE} (J7,K7) under certain applications, such as TOP & BOT IGBT connected instantly. Please make sure the total time from IGBT conduct (start from short circuit) to IGBT totally turn-off by soft turn-off circuit must shorter than IGBT safe short circuit time (usually 10µs or 6µs, details pls refer to IGBT supplier). The total time includes t_{dead} + t_{err} + t_{off-SC}. IGBT turn-off trailing time and safety time.

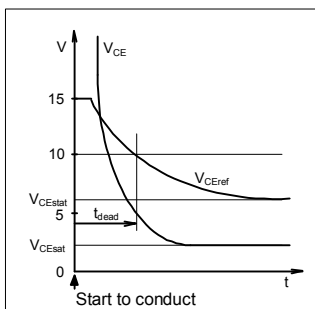


Fig 6a. Usual case

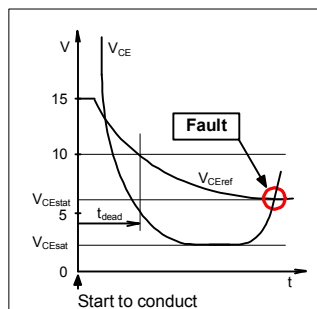


Fig 6b. Short circuit during operation

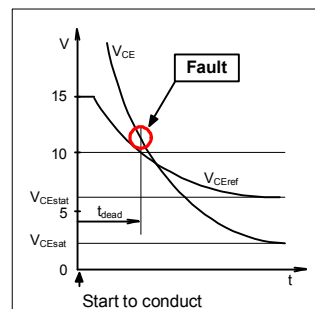


Fig 6c. IGBT turns on too slowly or dead time is too short

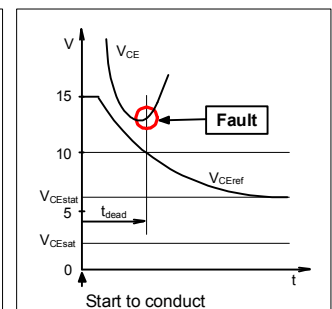


Fig 6d. Short circuit during turn-on

PSHI 1012 driver with $R_{CE} = 18k \Omega$, $C_{CE} = 330pF$ adjusted from factory.

PSHI 1017 driver with $R_{CE} = 36k \Omega$, $C_{CE} = 470pF$ adjusted from factory.

(see Fig.4 curve 2)

Attention: If this function is not used, for example during the experimental phase(not connect to IGBT), the V_{CE} MONITORING(2.5) must be connected with the EMITTER output(X2.1) to avoid possible fault indication and consequent gate signal blocking.

- “The OUTPUT BUFFER” is responsible for providing +15V/-8V level from the DC/DC inverter, and inhance the control signal from the pulse transformer. The output stage has a MOSFET pair which is able to source/sink up to 8A peak current to/from the gate improving the turn-on/off capability. If these signals do not have sufficient power, the IGBT will not switch properly, and additional losses or even the destruction of the IGBT may occur. According to the application (switching frequency and gate charge of the IGBT), different R_{Gon} and R_{Goff} must be selected. The internal R_{Gon} of the driver is 22Ω , R_{Goff} is 22Ω . Need R_{Gon} value can be gained by paralleling relevant resistor on pins J8K8, and need R_{Goff} value can be gained by paralleling relevant resistor on J9K9.

Please make sure that the total value of R_{Gon} & R_{Goff} not below 1.5Ω in order to avoid damaging driver.

- Pins J10, K10 are used for selecting Source Voltage Turn-off Pattern or Source Current Turn-off Pattern, soldering bridge between them makes $I_{Rgoff} = 0$. The standard turn-off mode is Source Voltage Turn-off Pattern. Adopting Source current turn-off pattern can improve the switch off rate of IGBTs with 1700V under the condition of $R_{Goff} = 0$.

5. Input Interface Criterion

1). Input Signal Level

Input PWM signals can be 15V CMOS/5V TTL(HCMOS) level, active-logic control(high level IGBT switch on), X1.4 is up IGBT controlled signal, while X1.2 is bottom IGBT signal.

2). Error Output

When over-current occurs, driver can cut off IGBT automatically. Fault signals output X1.3 can demand high level active(high level is fault), or output low level active. When high level active, Pin X1.3 is required to be connected through a pull-up resistor. While low level active, Pin X1.3 need not to be connected with pull-up resistor when all drivers can use on error output line. The voltage of pull-up circuit should below 24V, and external power supply should below 6mA (see Fig 7). The standard output error signal is high level active.

3). Error Reset

Install X1.4 HIGH for more than 5 us, error reset automatically.

4). Connecting leads between Driver and Control Board

The length between driver and control board should be kept short. If the length is below 50cm, connect with common flat cable is OK. If the length is 50-100cm, only CMOS level can be used for signal transmission, flat cable must have the pairs of conductors twisted or be shielded. If a shielded cable is used, it can be connected to pin X1.1 and solder bridged J20 with K20. The connecting leads between driver and control board is not allowed to more than 1meter.(see Fig.8)

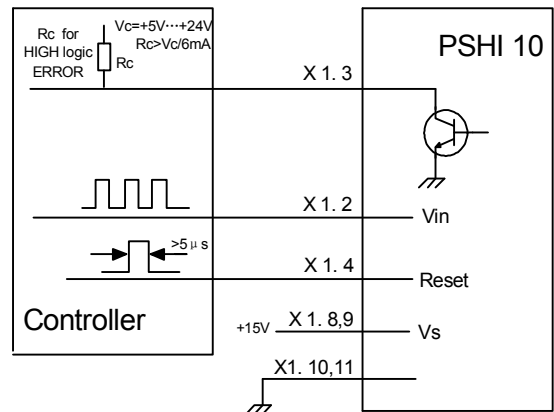


Fig. 7 Driver status information ERROR and RESET

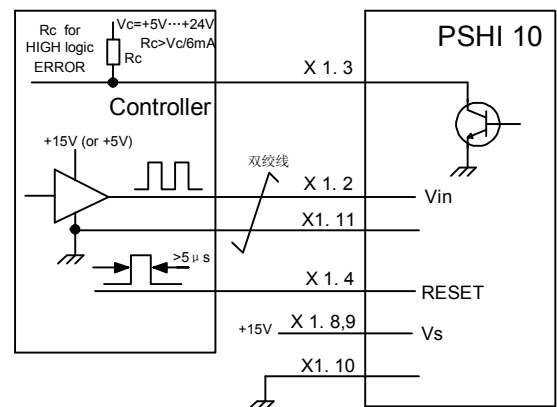


Fig.8 Connecting PSHI 10 with long cables(50-100cm)

5.)Connecting leads between driver and IGBT.

If only connection with low power IGBT, turn-on and turn-off two gate outputs can be done by connecting solder bridged jumper J12 and K12 to IGBT using a gate output cable(see Fig.9). Solder bridging of installed R_{Gon} and R_{Goff} on driver board is highly recommended, and install the gate resistor R_{Gon} and R_{Goff} onto a small piece of PCB near the IGBT gate to avoid the rush rise of temperature on driver surface when high peak current going through gate resistor.

The length between driver and IGBT should be as short as possible,flat cable must have the pairs of conductors twisted.

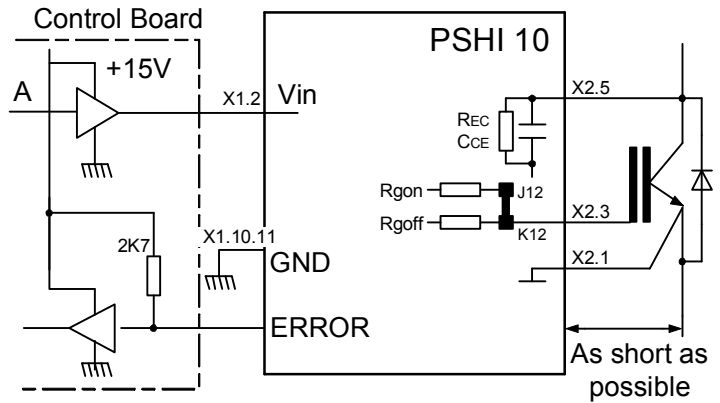


Fig.9 Preferred single IGBT-module standard circuit

6.)Parelleling IGBTs

To get high power output, paralleling IGBTs is recommended.The parallel connection is recommended only by using IGBTs with homogeneous structure, that have a positive temperature coefficient resulting in a perfect current sharing without any external auxiliary element.Care must be considered to reach an optimized circuit and to obtain the total performance of the IGBT:The IGBTs must have independent values of R_{Gon} and R_{Goff} , and an auxiliary emitter resistor R_E as well as an auxiliary collector resistor R_C must also be used. The external resistors R_{Gonx} , R_{Goffx} , R_{EX} (0.5Ω) and R_{Cx} (47Ω) should be mounted on an additional circuit board near the paralleled module, and the R_{Gon}/R_{Goff} should be solder bridged. The cable length between additional circuit board and each IGBT should keep the same (see Fig.10).

The maximum gate charge for PSHI 10 is 9.6uC

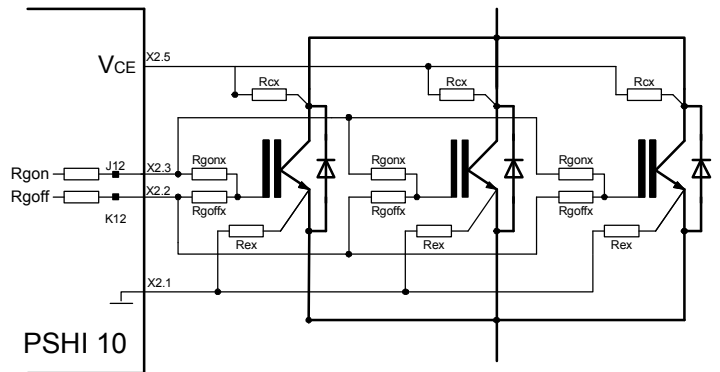


Fig.10 Preferred circuit for paralleled dual IGBT-modules

6.Dimensions and connections of the PSHI 10

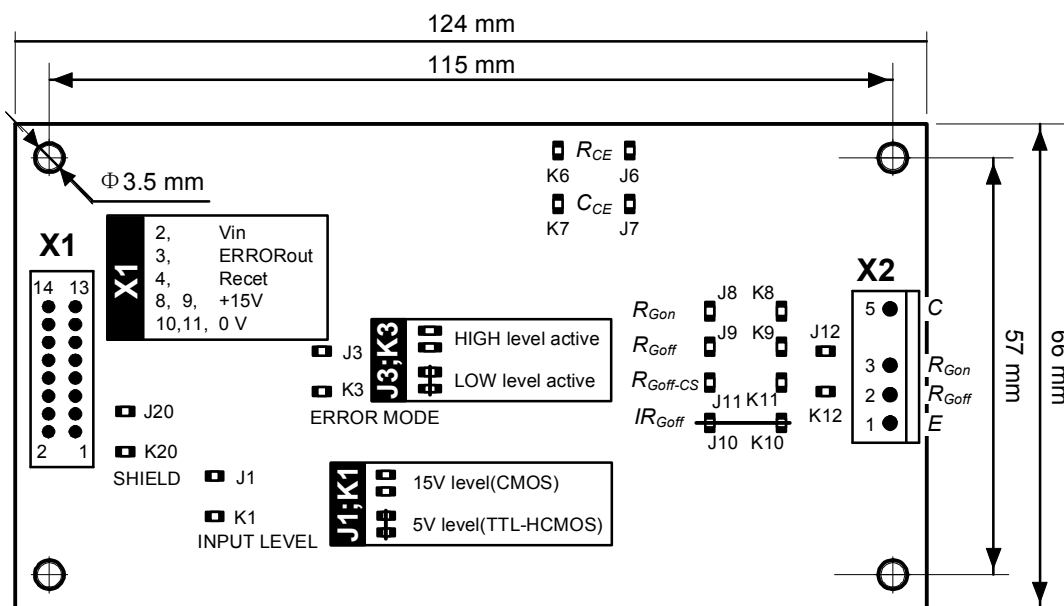


Fig.11 Installation dimensions and pins place instruction

Tab.1 Primary side X1:

PIN NO.	Designation	Explanation
1	SHIELD	Shield
2	IN	Input signal
3	ERROR	Error output
4	RESET	Reset signal
8,9	V _S	15V power supply
10,11	GND	Ground

Tab.2 Secondary side X2:

PIN NO.	Designation	Explanation
1	E	IGBT Emitter
2	Goff	IGBT gate (turn-on)
3	Gon	IGBT gate (turn-off)
4		not connect
5	C	IGBT Collector

Tab.3 Pins function

Function	Pin description	Adjustment by factory	Possibilities of functions
Input level selector	J1、K1	not bridged : 15V CMOS	soldering bridged : 5V HCMOS
Error-logic	J3、K3	not bridged : High level active	soldering bridged : Low level active
R _{CE}	J6、K6	not bridged : PSHI1012,18kΩ PSHI1017,36kΩ	adjustment according Fig.5
C _{CE}	J7、K7	not bridged : PSHI1012,330pf PSHI1017,470pf	adjustment according Fig.5
R _{Gon}	J8、K8	not bridged : 22Ω	adjustment automatically
R _{Goff}	J9、K9	not bridged : 22Ω	adjustment automatically
IR _{Goff}	J10、K10	soldering bridged	adjustment automatically
R _{Goff-SC}	J11、K11	not bridged : 22Ω	adjustment automatically
one IGBT/ paralleled IGBTs	J12、K12	not bridged : two cables to gates	soldering bridged:1 cable to gate
Shield	J20、K20	not bridged : not connect with GND	soldering bridged : screening to GND

7.Application/Handling

- 1).The CMOS inputs of the driver are extremely sensitive to overvoltage. Voltages higher than (V_S +0.3V) or under-0.3V may destroy drivers. Therefore, the signal of control board must be observed for above mentioned demand,and not-used pins should be soldering bridged with GND in order to avoid un-equipped pins. Pay more attention to electro static breakdown.
- 2).The connecting leads between the driver and the power module must be as short as possible, and should be twisted.
- 3). Any parasitic inductance should be minimized, turn-off over-voltage can be decreased by differenet snubber circuit.
- 4).It is important to feed any ERROR back to the control circuit to switch the equipment off immediately in such events.
Repeated turn-on of the IGBT into a short circuit, with a frequency of several kHz, may destroy the device.