Mounting Instructions for HiPak™ Modules

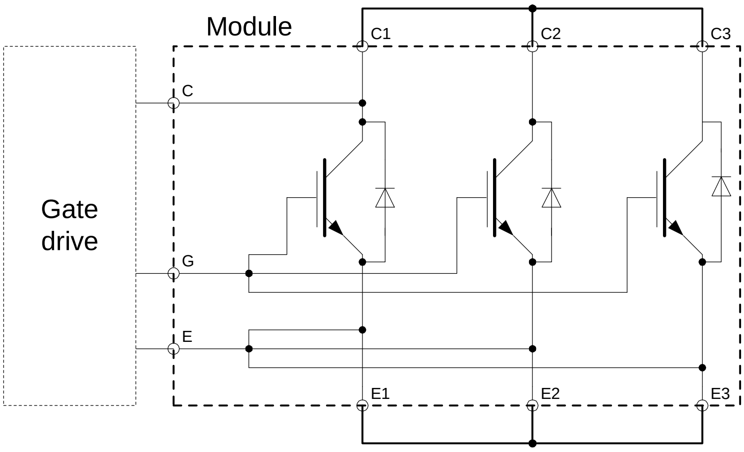
Raffael Schnell
ABB Switzerland Ltd, Semiconductors

1. Handling

IGBTs are sensitive to electrostatic discharge (ESD). All HiPak™ modules are ESD protected during transportation and storage. While handling the modules the gate and auxiliary terminals should be short-circuited with the wire provided or with a metal strip to prevent damage by static charges (IEC60747-1, chap. IX). A conductive-grounded wristlet and a conductive-grounded working place are strongly recommended during assembly.

2. Terminals

The connection between gate-drive circuit and the control terminals of the HiPak™ modules should be as short as possible. Coaxial or twisted wires or mounting of the gate-drive PCB directly on the auxiliary terminals is highly recommended to prevent any electromagnetic interference (EMI) from the power circuitry to the gate signals.
The power terminals of the collector and the emitter must be interconnected before use as there is no internal high current connection (Fig. 1). A low inductance symmetrical copper bus-bar, mounted directly on top of the module, is highly recommended.



gate-drive connections
C: aux. collector (Ic < 1A)
connection not required
G: gate
E: auxiliary emitter

power circuit
C1..C3: collector
E1..E3: emitter

Fig. 1: Module connections

3. Safe operating area

The peak turn-off over-voltage (V_{CEM}) must be kept below the maximum rated collector-emitter voltage (V_{CES}) of the HiPak™ module. Therefore it is important to use a bus-bar of low inductance L_σ. Please refer to the module data-sheet for the internal module stray inductance ($L_{\sigma\ CE}$).

i.e.:

$$V_{CEM} = \left| di/dt \right| \cdot (L_{d\ CE} + L_s) + V_{DC} \leq V_{CES} \qquad (1)$$

The figure designated "Turn-off safe operating area (RBSOA)" in the module data-sheet shows the maximum allowed operating conditions with the peak turn-off over-voltage measured at the module power terminals and at the chip (Fig. 2).

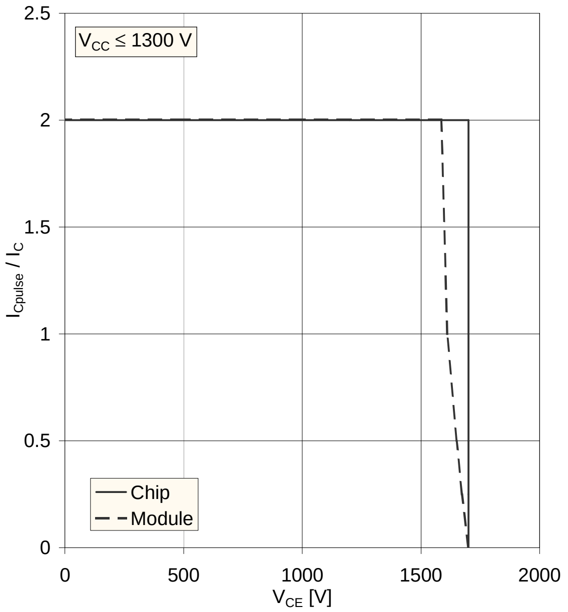


Fig. 2: Turn-off safe operating area (RBSOA)

4. Gate drive

It is recommended to operate the HiPak™ modules with a turn-on gate voltage of +15V for low on-state losses and good short-circuit ruggedness. Turn-on gate-voltages of more than +15V result in slightly less on-state losses but have a negative impact on short-circuit ruggedness.
A turn-off gate voltage of -5V...-15V is recommended for low turn-off losses and high dv/dt immunity.
Clamping of the gate voltage to 15V for protection against high inductive short-circuit events is also recommended. This can be achieved by either clamping the gate-voltage as close as possible to the gate-emitter auxiliary terminals of the module with anti-series fast zener diodes, or by a feedback from the gate to the +15V supply capacitor via a fast Schottky barrier diode (Fig. 3).
If the turn-off over-voltage of the module cannot be kept below V_{CES} (1), due to high stray inductance or dc-link voltage, an active clamp circuit can be used, as shown in Fig. 3. This is particularly important for HiPak™ modules with a rated blocking voltage of 1700V or lower, since these devices exhibit faster switching speeds.

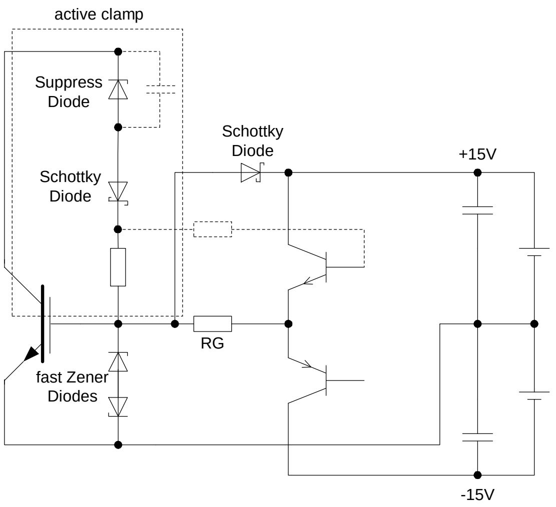


Fig. 3: Gate-drive recommendations

5. Heat sink specification

The mounting area on the heat-sink and the module must be clean and free of particles in order to obtain the maximum thermal conductivity between the module and the heat-sink.
The mechanical specification of the mounting area is:

Flatness:	≤ 30µm over entire contact area
Roughness:	Rz ≤ 10µm

6. Application of thermal grease

In order to avoid air gaps at the interface between the module and the heat sink, thermal grease must be applied. The function of the grease is to minimise the interface resistance by filling the remaining voids and allowing a metal-to-metal contact wherever possible.
The recommended thermal grease is Wacker-Chemie P 12.
Thermal grease can be applied either to the mounting area of the heat-sink or to the base area of the module. A rubber roller or screen print (mesh-size 43T) is recommended for an even distribution of the grease.
The thickness of the applied grease layer should be 100µm ±10µm. The thickness can be checked by a measuring gauge (Fa. ELCOMETER Instruments GmbH, Himmlingstr.18, D 73434 Aalen, Tel. +49-7366-919283: Sechseck-Kamm 5-150µm).

7. Mounting the module

After applying the thermal grease, the module is placed on the heat sink. Any movement of the module should be avoided once positioned on the heat-sink. The fixing screws are inserted and evenly tightened by hand (~0.5Nm) or by electric or pneumatic screwdrivers with a torque limit of 0.5Nm according to the sequence of Fig. 4. Then the screws are tightened again to the final torque (per Table 1), following the same sequence. The use of torque wrenches with automatic release is recommended.

The two step procedure must be strictly followed to allow the module base-plate to relax and conform to the heat-sink.

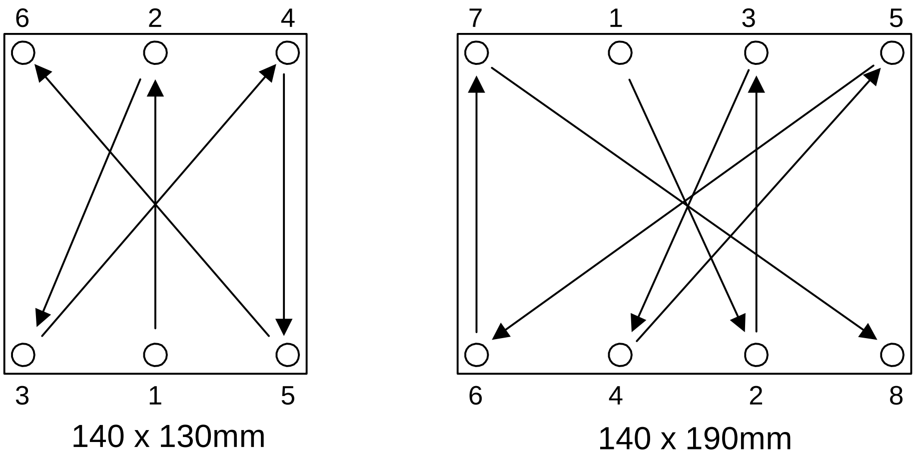


Fig. 4: Torquing sequence

The bus-bars must be mounted onto the collector and emitter power terminals with the recommended torque of Table 1. It is important that the mounting torque be above the minimum requirement to allow good electrical and thermal contact. The cross sections of the bus-bars must be sufficiently large to avoid heating of the module by bus-bar resistive losses. Stress to the power terminals from bus-bar forces must be minimised during assembly, transportation and operation (e.g. though shock and vibration), Supporting the bus-bar with additional fixing posts close to the module is recommended.

The auxiliary terminals must be connected with the required torque (Table 1), while observing the ESD guidelines. The auxiliary emitter and collector terminals are not designed to carry any load current.

	Screw	**torque values**		
		min. [Nm]	**typ. [Nm]**	**max. [Nm]**
module mounting	M6	4	5	6
power terminals	M8	8	9	10
auxiliary terminals	M4	1.8	2	2.1

Table 1: recommended mounting torques

8. Further application support

For reliable operation of power semiconductors it is crucial not to exceed the maximum specified junction temperature (usually 125°C) and to take care of temperature ripples and temperature swings.
For this reason ABB offers a simulation-tool whereby the customer can enter his specific application conditions and directly calculate static and transient temperature rises in IGBT modules and associated heat-sinks.
The simulation-tool can be downloaded from the ABB homepage: http://www.abb.com/semiconductors.

ABB Switzerland Ltd
Semiconductors
Fabrikstrasse 3
CH-5600 Lenzburg, Switzerland

Telephone +41 (0)58 586 1419
Fax +41 (0)58 586 1306
Email abbsem@ch.abb.com
Internet www.abb.com/semiconductors