SwissSEM Technologies AG

MOUNTING INSTRUCTION

SEM AN 22-0001

Application note for ED-Type modules

swiss semicon ductors.

MOUNTING INSTRUCTION

Basic guidelines for the application, environmental conditions and installation of ED-type product platform are provided within this application note. Obeying these guidelines ensures safe mechanical, electrical and thermal connections which are crucial for a reliable operation of such power modules.

1 GENERAL REMARKS AND PRECAUSIONS

The recommendations and guidelines provided here cannot replace a detailed assessment and evaluation of all aspects of the application related to the intended use of the power-module. All ED-type modules pass a final production test-sequence according to IEC60747-9 and IEC0747-15 prior shipment.

1.1 ESD

IGBT power modules are sensitive to electrostatic discharge (ESD). All ED-type power modules are protected during transportation and storage in the provided packings. A short circuit with ESD-protection between the gate and the auxiliary terminals of high-side and low-side switch should be guaranteed, when handling the modules, to prevent ESD related damages by static charges (IEC60747-1, chapter VIII). A conductive-grounded wrist strap and a conductive-grounded workstation are strongly recommended during the assembly process.

1.2 Climatic conditions

During transportation and storage of the ED-type modules, extreme forces such as shock and vibration should be avoided as well as environmental conditions exceeding the recommended limits. The ED-type modules are not hermetically sealed. The housings and the silicone gel used for the electrical isolation within the housing, are permeable by humidity and gases in both directions. Humidity differences will therefore be equalized.

1.2.1 Storage

Storing the modules at the specified temperature limits stated in the datasheet is possible, however not recommended. The recommended storage conditions according to Table 1-1 should be assured for the recommended storage time of maximum two years.

Table 1-1 Climatic conditions for storage

POS	PARAMETER	VALUE
1	Temperature	5 °C to 40 °C
2	Relative humidity	20 % to 75 %
3	Precipitation, condensation, ice, frost and similar	Not allowed at any time

1.2.2 Operation

The climate conditions for the non-hermetically sealed ED-type power modules in active, current carrying operation are specified as EN60721-3-3 class 3K3. In the case of a humid atmosphere that causes condensation, or operation in climatic conditions surpassing class 3K3 of EN60721-3-3, appropriate measures must be taken to avoid liquid droplet depositions on the module in all circumstances. Corrosive gases must be avoided during operation and storage of the devices.

2 ELECTRICAL

2.1 Terminals and circuitry

The connection between gate-drive circuit and the control terminals of the ED-type module should be as short as possible. Coaxial cables, twisted wires or mounting of the gate-drive PCB directly on the auxiliary terminals are recommended to prevent any electromagnetic interference (EMI) from the power circuitry to the gate signals.

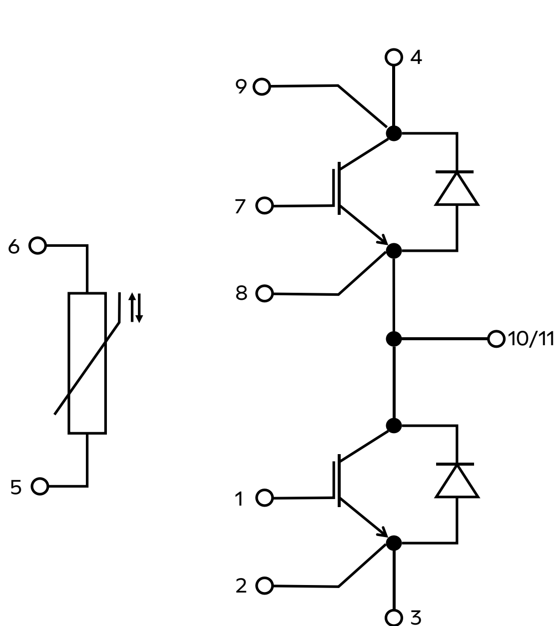


Figure 2-1 Schematic circuit diagram

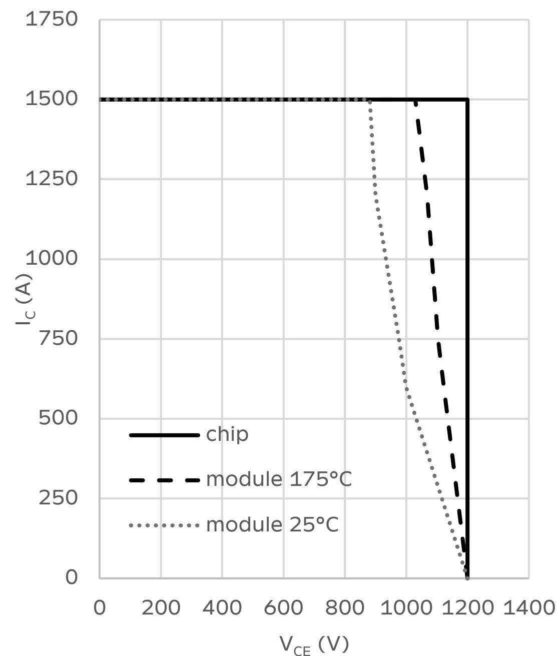


Figure 2-2 IGBT RBSOA $I_c = f(V_{CEM})$, $R_{Goff} = 1.5\ \Omega$, VGE = ±15 V, highest current rating variant.

A low inductance symmetrical copper busbar, mounted directly on top of the module, is recommended for all ED-type power modules.

2.2 Safe operating area / Voltage rating

It is imperative to keep the peak turn-off over-voltage V_{CEM} below the maximum rated collector-emitter voltage V_{CES} for each switch in the ED-type power module. Hence, it is recommended to apply a busbar with low inductance L_s. Please, refer to the datasheet for the internal module stray inductance L_{sCE}.

The safe operating area (RBSOA) turn-off graph in the datasheet (Figure 2-2) indicates the maximum allowed operating conditions with the peak turn-off over-voltage measured at the module power terminals and at the chip that is considered equivalent to values measured between auxiliary Collector and auxiliary Emitter of the HS-switch and HS-auxiliary Emitter and LS-auxiliary Emitter for the LS-switch (Figure 2-1). Several factors limit the voltage and operating range of the power module in applications running at altitudes higher than 2000 m above sea level. The lower air pressure will affect the cooling performance, the changed dielectric strength of the air will reduce the clearance distance of the device and the statistical failure rate due to higher cosmic radiation levels will also impact the maximum operating voltage.

3 INSTALLATION

3.1 Heatsink

Maximum thermal conductivity between the power module bottom-side and the heatsink must be ensured by using a clean heatsink, being free of any particles or ridges of more than 10 µm. There is a risk that such objects deform the Cu-baseplate and result in cracks of the ceramic layers inside the power module. The following conditions must be obeyed in the application:

- Roughness: R_z ~15 µm
- Flatness: 30 µm (valid for entire contact area)

3.2 Applying thermal paste

The application of thermal paste is a must to ensure good thermal conductivity between the power module and the heat sink and will prevent “dry” contact and enables a metal-to-metal contact wherever possible. Typical thermal pastes include but are not exclusively limited to: Honeywell PTM6000HV-SP, Wacker P12, Electrolube HTC(P), Dow Corning TC-5121. Please obey the guidelines provided by the manufacturers.

Please ensure the following by applying thermal paste:

- Generate a reproducible, homogeneous, and even layer. Inhomogeneities might result either in dry contacts or act like particles and result in a cracked ceramic.
- Clean all interfaces the thermal paste will be in contact with prior applying thermal paste (e.g. IPA ethylene glycol etc.)
- A stencil or screen printer is recommended to ensure an even distribution of the grease
- In case of a manual application of the grease a thickness of 50 µm to 100 µm is recommended de-pending on paste type, its viscosity and stencil thickness.
- A subsequent process control (e.g. concerning thickness, volume, pattern etc.) is recommended.

SwissSEM provides a stencil mask design Figure 3-1. LINK

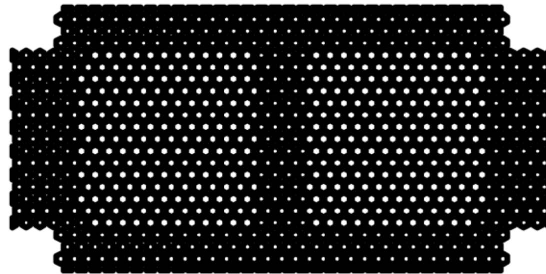
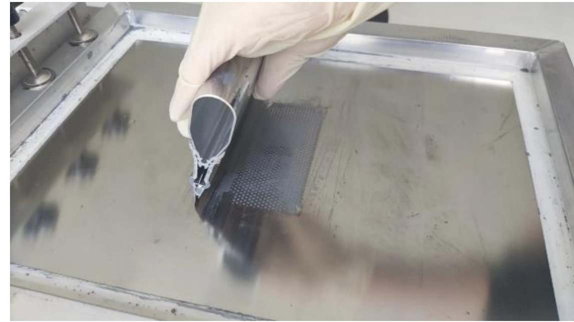


Figure 3-1 Stencil mask drawing provided by SwissSEM (available on request)

Stencil printing tooling



Thermal grease application onto the stencil using a scraper (suitable for low viscosity pastes)

Example of an ED-type module after stecil printing

Example of good thermal grease coverage (module removed after mounting)

Figure 3-2 ED-type power module and typical grease application

3.3 Power module mounting

It is assumed that the ED-type power module has an even, homogeneous, and reproducible layer of thermal grease attached. Avoid any lateral movement of the module after the module got placed on the heat sink. The screws for fixing the module to the heat sink are inserted and evenly tightened by hand or by electric or pneumatic screwdrivers with a torque of 0.5 Nm according to the sequence provided in Figure 3-3. Afterwards the screws are tightened again to the final torque provided in the datasheet, following the same procedure. It is recommended to limit the maximum torque to the datasheet values by using torque wrenches with automatic release.

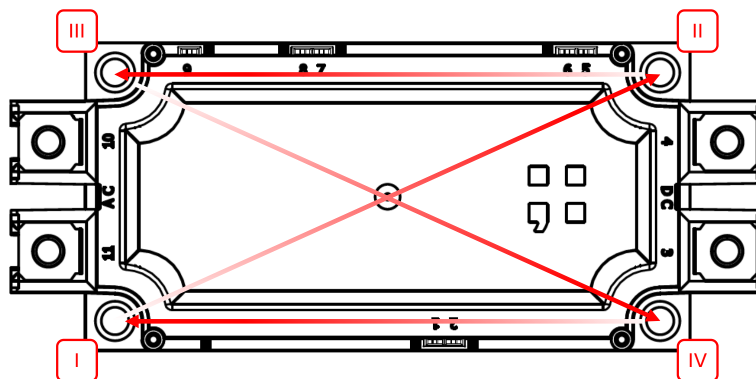


Figure 3-3 Sequence for tightening the ED-type power module to the heatsink

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3.4 Gate drive

ED-type modules should be operated with a turn-on gate voltage of +15 V for low on-state and good short-circuit ruggedness. Although higher turn-on voltages provide lower conduction losses the downside is a resulting reduced short-circuit ruggedness. A turn-off gate voltage of -5 to -15 V is recommended for low turn-off losses and high dv/dt capability. The gate drive can be connected by soldering the auxiliary pins. For modules operated in vibrating environment it is strongly advised to additionally fix the gate-driver PCB with four screws (e.g.: EJOT PT WN 1451 K25x10). The self-tapping screws must be torqued to 0.41 Nm to 0.49 Nm. The effective screw thread length in the module case must be between 4 and 10 mm.

A schematic of a typical Gate Unit output stage is depicted in figure Figure 3-4. It is recommended to clamp the gate voltage to 15 V for protection against high inductive short-circuit events or short-circuit type II events, with a suppressor diode (D3) mounted close to the module Gate and auxiliary Emitter as well as with fast Schottky diodes (D1 & D2) connected low inductive to the gate-voltage supplyFigure 3-4. An optional gate-emitter capacitor mounted low inductive to the module can improve the controllability of the IGBT. In case the turn-off overvoltage of the IGBT can't be kept below the allowed V_{CEm} of the IGBT, for instance due to too high stray inductance, an active clamp circuit compromising of suppressor diodes (D4 to Dx) a Schottky Diode D7 and a damping resistor R3 is needed. The total clamp voltage of the suppressor diodes (D4 to Dx) and the value of the damping resistor needs to be optimized to the effective power circuit and stray inductance. The clamp circuit must be low inductive connected to the module to be effective. In any case the sum of the V_{BR} of the clamp diodes needs to be above the maximum expected V_{DC} to avoid damage to the IGBT and inverter.

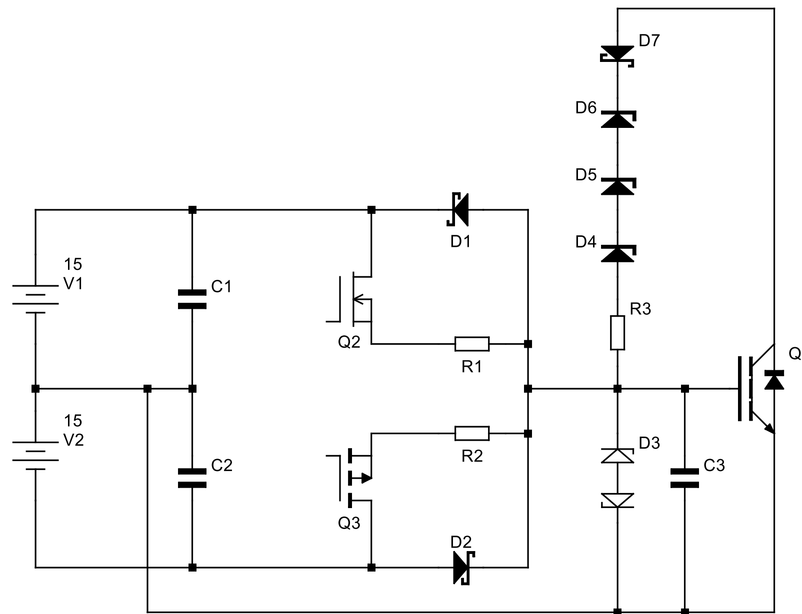

Figure 3-4 Typical Gate-drive output stage

3.5 Mounting of busbars to the module

The busbars must be mounted onto the collector and emitter terminals with the recommended torques provided in the datasheet. It is important that the torque is within the specified limits, to enable good electrical and thermal contact. The cross-section of the busbar should be tailored to the power terminal contacts to avoid heating of the power-terminals by resistive losses resulting from the busbar.

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The auxiliary pins are intended to be soldered to a printed circuit board (PCB) in through hole technology (THT). ESD guidelines must be obeyed during the hole assembly/soldering process. It is recommended that mechanical stress due to shocks and vibrations to the auxiliary pins is relieved by mounting the PCB on to the module utilizing the four PCB mounting fixing posts.

Continuous mechanical stress to power and auxiliary terminals must be avoided. Forces caused by shock and vibration or resulting from thermal expansion of the system in operation require special attention and care e.g., supporting the busbar by fixing posts close to the module at each side.

The maximum forces acting at power-terminals should not exceed 150N (in any direction). Connecting parts such as busbars and gate-drives must be designed and assembled in a way that limits are kept.

3.6 General mounting remarks

Table 3-1 The industry standards apply for this product as shown in the table below

POS	DO	DON'T	RISK
1	Apply wrenches with automatic release in case maximum torque is reached	Use impact wrenches	Damage to power module Jamming of screw
2	Limit screw speed to manageable values	Maximize screw speed	Damage to power module Jamming of screw
3	Use carbon steel screws for power terminal mounting	Compromise	
4	Use screws for module mounting that are tailored to heat sink material	Compromise	
5	Length of screws must be tailored to application	Compromise	Damage to power module

4 REVISION HISTORY

DATE	AUTHOR	REMARK
May, 2022	S. M.	Initial version