Application Note 5SYA 2037-04

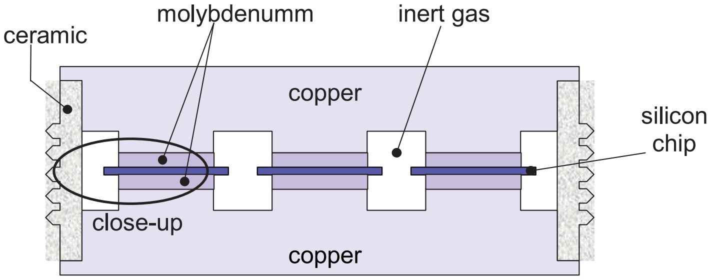
Mounting instructions for StakPaks

Hitachi Energy's StakPak IGBT press-pack differs from conventional press-packs in the uniform pressure on all individually sprung chips. This technology makes the StakPak more forgiving of mechanical tolerances and allows the assembly of long stacks.

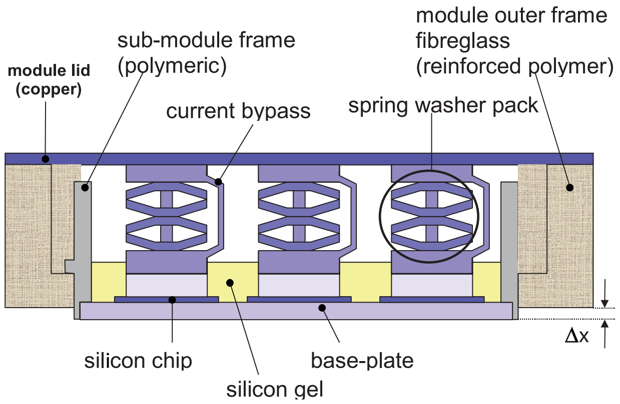
1. Introduction

Figures 1 and 2 illustrate the fundamental difference between conventional and StakPak technology. The collector side of the submodule pictured in the figure 2 can be seen as the gray plates in the frame of figure 3. The force needed for a long stack may be far higher than that tolerated by the silicon chips being contacted via their sensitive surface microstructures. The rigidity and stability of a stack subjected to shock or vibration in service or during transportation depends on a mounting force that may not always coincide with that required by the encapsulated chips. It is therefore important to decouple the two forces allowing the optimal force on the chips to be lower than the (optimal) force on the stack: the individual springs of the StakPak allow this as excess force is transferred to the frame walls.

This mounting instruction applies to all StakPak versions with 4 and 6 submodules.



01 Sectional view of classic multi-chip press-pack with common pole-pieces: each chip bears the device force divided by the number of chips



02 Sectional view of Hitachi Energy multi-chip press-pack with individual spring contacts: the chip bears the force determined by the spring; excess force is borne by the housing walls. The drawing illustrates one multi-chip submodule in one press-pack housing.

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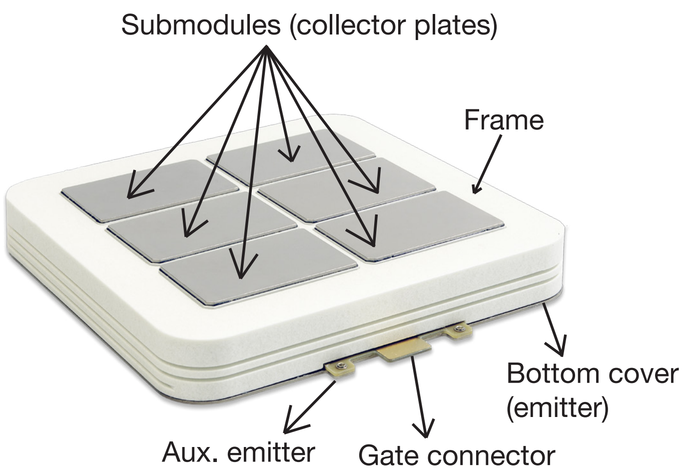
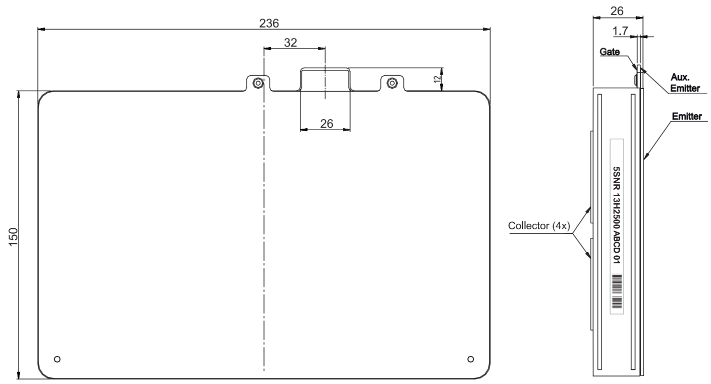
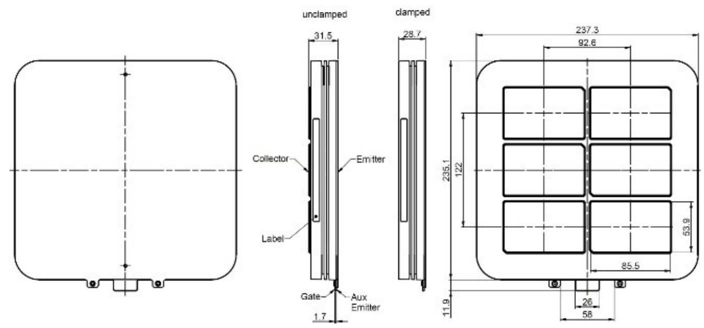


03 StakPak with 6 submodules



04 Outline drawing of 5SNR 13H2500 IGBT press-pack



05 Outline drawing of 5SNA 2000K450300 IGBT press-pack

The electrical interfaces are the sub-module base-plates (collector), the cover (emitter) and the gate connector including the auxiliary emitter. Even though the main heat transfer is by design through the sub-module base plates we recommend double-sided cooling to avoid overheating the cover

2. Heat-sink mounting area properties

To achieve the specified performance of the device, the mounting surfaces should meet the following mechanical specifications:

- Flatness ≤ 20 µm over the submodule area
- Flatness ≤ 100 µm over whole heat-sink
- Roughness Ra ≤ 1.6 µm

The heat-sink contact surfaces should be machined without ridges, steps or grooves. Hitachi Energy recommends the use of nickel-plated heat-sinks. StakPaks have a nickel-plated copper cover and the submodules nickel-plated molybdenum-copper baseplates.

3. Clamp design

The device must be clamped with the force specified in the data sheets. To verify pressure distribution, Hitachi Energy recommends the use of Fuji Prescale film or a similar product. For information on Fuji Prescale film, see: www.fujiprescale.com or www.fujiprescale.net.

StakPak press-packs are designed to have a large pressure tolerance. As a result, the clamp assembly may be similar to that used for conventional, cylindrical devices as illustrated in figure 6. A clamp arrangement applying point force to a thick, rigid (e.g. hard steel) plate at the top and bottom of the stack, will allow sufficient pressure uniformity provided the plate has a minimum thickness. “a”. This thickness “a” is such that the contact surface of the StakPak beneath the heat-sink falls within the footprint of an imaginary cone having a 90° apex. The distance “a” is calculated as the greatest distance from the axis of applied force at its intersection with the StakPak surface to the farthest corner of the device. This is illustrated in figure. 6.

Clamping must also be designed to allow the parts within the stack to adapt to inherent non-parallelisms and skewness. There are inevitably inherent non-parallelisms in any stack as it is impossible to manufacture heat-sinks and press-packs components with perfectly parallel surfaces, the internal spring contacts of the StakPak allow a far higher degree of non-parallelism than permitted for conventional IGBT press-packs (i.e. with rigid internal contacts). Excessive non-parallelism in long stacks can nevertheless, cause problems of misalignment for the stack assembly and its connection points. The allowable non-parallelism between the emitter cover and the collector side of the frame is ≤ 300 µm per device.

The heat-sinks must have adequate mechanical robustness to withstand compression at the maximum rated clamping force without deformation which would otherwise lead to inhomogeneous pressure distribution.

The clamp springs must be chosen to ensure that the mounting force on the components remains within the specified limits over

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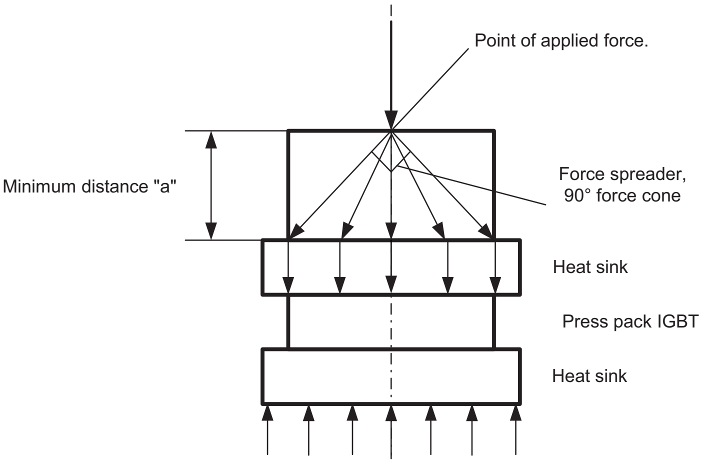
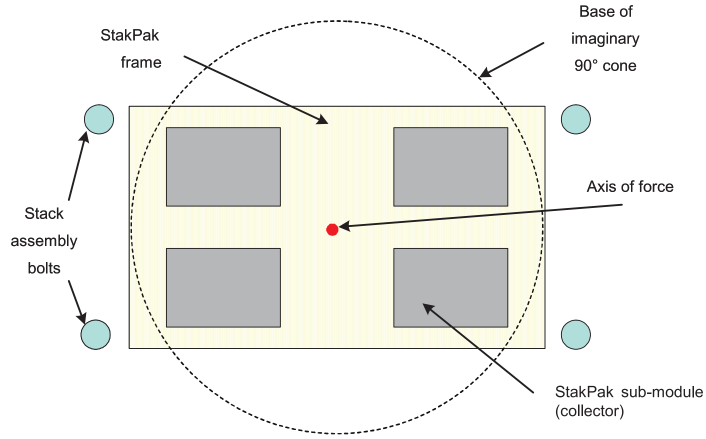


06 Sectional view of assembly in plane of applied force



07 View of StakPak surface (perpendicular to force) showing footprint of force cone

the full temperature range encountered during power cycling and variations of ambient temperature. Attention must be paid to the height difference between compressed and uncompressed devices when calculating compression distances for the spring travel. The choice of stack components (e.g. heat-sinks and isolators) must also take load cycling and its attendant wear and creepage into consideration.
Good mechanical stability is essential and though this may be achieved with only two bolts for short stacks, four bolt constructions are recommended in long stacks (figure 7). If the mounting clamp and its bolts are at ground potential, insulation materials and clearances must be correctly determined (e.g. per standards IEC 60664-1 and prEN 50124-1) Insulating materials, such as Vetresit®, can be used for the bolts allowing a more compact construction than with steel bolts (which requires additional insulation or clearances).

4. Application of silicon oil
A thin film of silicon oil could be applied to the contact surfaces before the devices are assembled onto the heat-sink. The silicon oil must be carefully chosen for its long-term chemical stability, corrosion inhibiting properties, temperature range, electrical properties and ease of use. Hitachi Energy recommends silicon oil type SF1154 (GE) supplied by ABB AB Logistics Center S-721 59 Vasteras (offer.selog@se.abb.com).

5. Assembly
The following paragraphs give advice on assembly procedures. Before assembly, the contact surfaces must be thoroughly cleaned using ethanol (or similar solvent) and a lint-free cloth. The assembly should be carried out in a clean environment free of dust and humidity as the surfaces must be kept clean during the whole assembly process. Heat-sink and semiconductor surfaces should not be touched with bare hands. We recommend the use of lint-free gloves for the handling of semiconductor devices and heat-sinks. The heat-sinks and IGBT StakPaks should be handled with care to avoid scratches and other damage to the surfaces. Small scratches should be avoided (even though they are not detrimental to contact integrity since it is the overall surface finish which determines contact quality). The surface finish must remain within the specification given earlier and the plating should be intact to avoid subsequent corrosion of the underlying metal.
Silicon oil should be applied sparingly and spread uniformly. Ensure that the devices are placed with the right polarity that the gate connection is in the right direction and that devices are correctly centred.
At the start of clamping, the mounting force indicator must be set to zero and the clamp supplier’s assembly instructions followed carefully.
StakPaks, like all press-packs, should be fully clamped prior to attaching bus-bars to the assembly. This will avoid misalignment of the components during assembly.

6. Gate drive unit mounting
The recommended gate-connector is the AVX series 6338 card edge connector (part number 00-6338-020) http://www.avxcorp.com/docs/catalogs/6338.pdf. The cable connecting the gate-drive unit should be as short as possible and preferably oriented at a 90° angle to the main current direction to reduce the risk of magnetic induction in the gate leads. The attached gate connector will protrude slightly above the plane of the StakPak cover such that the heat-sink must have minimal overhang of the device on the gate side.

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Due to the height difference between compressed and uncompressed devices, the gate connector should be connected after stack assembly to avoid damage to the gate contact.
The gate drive unit should be mechanically supported in order to withstand shock and vibration during transportation and operation. Since the gate driver unit is at emitter potential, it will need to be insulated from the rest of the assembly.

7. Electrostatic discharge (ESD) protection

IGBTs are sensitive to electrostatic discharge (ESD). All StakPak modules are ESD protected during transportation and storage. While handling the press-packs, 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 highly recommended during assembly.

8 Revision history

Version	Change	Authors
03	June 2013	Björn Backlund Evgeny Tsyplakov
04	July 2015	Björn Backlund Evgeny Tsyplakov

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