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INTEGRATION OF AN FSM EXCITER MODULE TO THE MAIN COOLER BY MEANS OF TIM ADHESIVE CONNECTION

Axel Unger
Bertrandt Ingenieurbüro GmbH

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Initial situation:
Currently, the circuit part "exciter circuit" incl. exciter module as well as exciter board is mounted on the cooler within the drive inverter. Figure 1 shows the power box (three half-bridge modules phase U, V, W as well as the exciter module on the common cooler).
In the assembly process, the exciter module is first pressed and screwed to the printed circuit board (PCB). Then a "thermal interface material" in the form of a "gap pad" is applied to the cooler (support surface of the exciter module). The PCB is then pressed onto the half-bridge modules and the exciter module is screwed onto the cooler through cut-outs in the PCB and thus fixed.
For this purpose, large recesses (holes) must be provided in the PCB through which the screw connection can be realised. In addition, a TIM "thermal interface material" in the form of a gap pad is inserted between the exciter module and the cooler to ensure the best possible thermal connection to the cooler. Depending on the design of the exciter module, this thermal interface material is either electrically conductive or electrically insulating.
The cut-outs in the PCB in particular lead to considerable difficulties in the layout and the mechanical robustness of the PCB, as there are minimum distances between mech. cut-outs and components on the PCB.

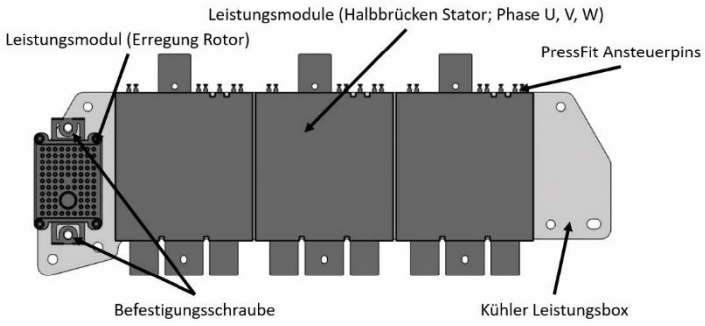

Figure 1: Power box with exciter module

Figure 2 shows the cross-section of the power box with pressed-in printed circuit board (PCB) in green. The three half-bridge modules are sintered onto the common cooler in advance (solder connection is also possible). Shown on the left is the screwed exciter module with the "thermal interface material" for the best possible thermal connection to the cooler.

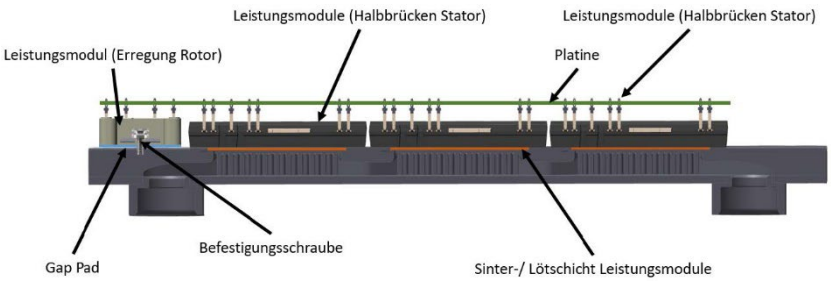

Figure 2: Power box with exciter module/ cross-section

Due to the screw connection of the exciter module, large recesses/holes must be provided in the printed circuit board (PCB), through which the screwing tool dips during assembly. Figure 3 shows a cross-section of the screw connection of the exciter module in detail, including the screw connection shown in orange.

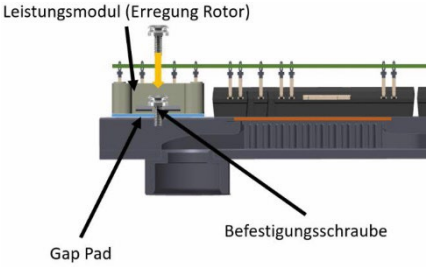

Figure 3: Detail - screw connection of exciter module

Disadvantages

The mounting concept, especially the necessity to screw the module to the cooler, has the following disadvantages:

- Increased material costs
  - Thicker copper layers in the PCB to ensure current conduction (little space due to cut-outs in the PCB)
  - Provision of screws/washers
  - Provision of GapPad
- Increased manufacturing costs
  - Additional parts - screws, GapPad
  - Monitored screwing process in production
  - Necessity of high, low manufacturing tolerances due to poor tolerance compensation in Z-direction
- Increased effort in production
  - No design for highly automated large-scale production, as bolting and attachment of the GapPad must be done manually
- Degradation of robustness
  - Layout not optimal due to large holes for screw connection
- Increase in losses of the excitation circuit
- Deterioration of the EMC behaviour of the entire drive inverter.
  - Layout must be "tinkered with" around the holes in the circuit board.
- No best possible layout of the circuit part possible

Solution:

The invention is based on the task of improving the mounting or integration of the exciter module and thereby generating advantages for the technical implementation.

For this purpose, the exciter module is attached to the cooler via an adhesive connection. The exciter module is sufficiently fixed by the circuit board so that the connection to the cooler can be realised by means of an adhesive device - cf. figure 4.

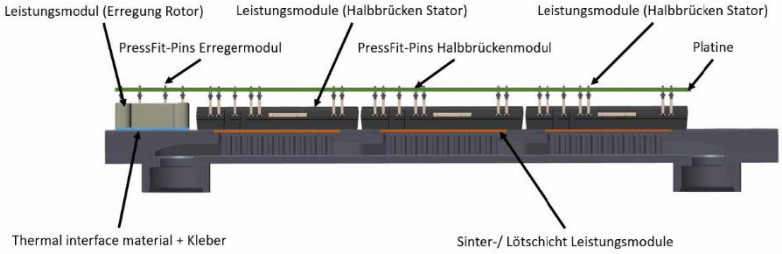

Figure 4: Power box with exciter module - adhesive connection

Figure 5 shows the construction of the cooler without screw connection in detail. The exciter module only has an adhesive connection for fastening to the cooler. The special feature of the adhesive connection is that it also creates the best possible thermal connection between the exciter module and the cooler. (The thermally conductive adhesive is applied to the radiator in liquid form and hardens after the exciter module is attached. In addition, the thermally conductive adhesive can be designed to be electrically insulating as well as electrically conductive.

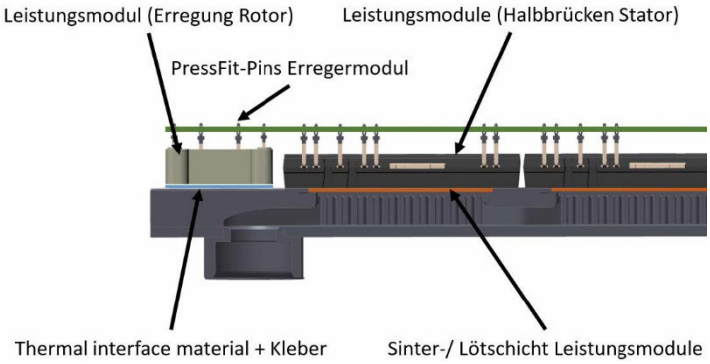

Figure 5: Detail - Adhesive connection of exciter module

Simplification of assembly:
1. exciter module is pressed onto the printed circuit board (PCB)
2. heat conductive adhesive is applied to the cooler (liquid dispenser)
3. the PCB is pressed onto the half-bridge modules.

Advantages:

- Reduction of material costs
  - Thinner copper layers in the PCB to ensure current conduction
  - Elimination of screws/washers
  - Elimination of GapPad
- Reduction in manufacturing costs
  - No additional parts required - screws, GapPad
  - No screwing process only adhesive dispenser
  - GapFiller/ adhesive also enables tolerance compensation in Z-direction
- Optimisation in production
  - Design suitable for highly automated large-scale production
- Increase in robustness
  - Layout can be optimised as there are no holes in the PCB
- Deterioration of the EMC behaviour of the entire drive inverter.
  - Layout must be "tinkered around" the holes in the PCB
  - No best possible layout of the circuit part possible
- Reduction of material costs due to one PCB
  - Connectors between the PCBs are no longer necessary
- Reduction of manufacturing costs through one PCB
  - Manufacturer/ assembly
  - Inspection/ Testing
- Reduction of manufacturing costs
  - Highly automated mass production possible