<IGBT module>

PC-TIM (Phase Change Thermal Interface Material)

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1. General

PC-TIM is in solid state such as a wax of the candle at less than approximately 45°C. PC-TIM begins to soften when more than approximately 45°C and becomes such as thermally-conductive grease.

Even if power module pushes PC-TIM to heat sink, PC-TIM in solid state does not spread as thinly as a thermally-conductive grease. When more than approximately 45°C, PC-TIM spreads laterally by influence of clamping pressure. In the spreading process, PC-TIM pushes out air between power module and heat sink by filling the both wide and narrow gap effectively. As the result, good thermal contact resistance between power module and heat sink is achieved.

Advantages of using the power module with PC-TIM are:
- Assembling period (takt time) can be reduced by removing process of applying thermally-conductive grease
- Well-controlled application of thermal interface material

PC-TIM option is available for NX-type(7th gen), std-type(7th gen) and LV100-type for industrial.
2. Module mounting

2.1 Selection of heat sink

In order to maximize heat dissipation, it is necessary to minimize the contact thermal resistance by maximizing the contact area as much as possible.

The flatness of the heat sink should be p-p <100㎛ for the module mounting surface (see Fig.1). (※For std type, the flatness p-p <50㎛ for 100mm length.) Also, the surface roughness should be within 10㎛ for a length of 100 mm. Sufficient flatness must be provided on the surface of the heat sink. Excessive minus (concave) warpage will increase the contact thermal resistance Rth(c-s) and affect the heat dissipation of the module. Excessive plus (convex) warpage may cause stress to be applied to the inside of the module during installation, which may cause damage to the module.

Please judge the decision from user's side by deeply investigating possibility of any failure and decrease of thermal resistance performance in case recommended condition is not kept by actual usage.

![Fig.1](a). Flatness of the heat sink  ![Fig.1](b). Flatness of the heat sink for std type

2.2 Screwing

When mounting a power module on a heat sink, the power module could get damage or degrade if a one-sided tightening torque is applied (e.g. high torque at only one mounting hole), due to stress on a insulation substrate and/or silicon chips inside the power module.

![Example) power module with 4 mounting holes](attachment)

Pre-tightening : ①→②→③→④
Final tightening : ④→③→②→①

Example: screw with spring washer and flat washer.
2.3 Replacement

① Remove the screws from heatsink.
   (It is not necessary to make inverse order as shown in chapter 2.2 but care should be taken not to apply unnecessarily high force)

② Remove the power module. The module is removed such as Fig.3(a). (PC-TIM will remain on the module and/or heatsink)

③ Wipe off the remaining PC-TIM by a scraper made of resin or dry cloth. (Fig.3(b))
   Finally, Clean up the PC-TIM by using ethanol and cloth and prevent damage at surface of the power module and heatsink. (Fig.3(c))

④ Prepare a new power module with PC-TIM and mount it to heatsink according to chapter 2.2.

2.4 PC-TIM removal from module

For the PC-TIM removal from module, the same method can be used as instructed in chapter 2.3.③. Terminals of the module should be carefully handled so that ESD destruction will not be occurred.

2.5 Others

- In the case a honeycomb shape is crushed, remove and re-apply PC-TIM.
- When inserting printed circuit board to press-fit type module, prevent the pressing jig from contacting PC-TIM.

![Fig 3. PC-TIM removal process](image)
3. **Storage**

3.1 **Storage method**
The temperature and humidity of the storage place should be 5～35℃ and 45～75% respectively.
※It is same condition for modules without PC-TIM

3.2 **Transportation method**
Keep shipping cartons right side up during transit. Avoid applying additional force unnecessarily such as inverting or leaning the packing box, although PC-TIM will not be deformed or slipped easily.

3.3 **Long-term storage**
Even if it is a temperature-humidity range as described in chapter 3.1, power module shelf life is one year.
※It is same condition for modules without PC-TIM

When storing the product for a long term (over 1 year), take measures for dehumidification. In addition, confirm that there is no scratch, dirt, rust etc. on the device when using after long term storage. Re-application of PC-TIM may be needed in some case.

3.4 **Packing**
The packing box of the module is the same condition for modules without PC-TIM. The packing box was designed so that PC-TIM will not be damaged by the packing box. The packing box uses antistatic material for electrostatic prevention.
※Be careful not to scratch PC-TIM when picking up the module.

![Fig.4. PC-TIM pre-applied product with packing box (NX-type)](image)
4. Long-term operation

Similar as thermal conductive grease, long term performance related to PC-TIM (including but not limited to aspects such as the increase of thermal resistance due to pumping out, etc.) should be verified under user’s specific application conditions. Each temperature condition ($T_{v_j \text{max}}$, $T_{v_j \text{op}}$, $T_{c \text{max}}$) must be maintained below the maximum rated temperature throughout consideration of the temperature rise even for long term usage.

Fig.5 shows an example of thermal cycle test with PC-TIM pre-applied module. It is indicated by this testing that operating temperature ($T_c$) can affect the temperature stability behavior in long term. Carefully verify the actual operation of the application since the long term performance can be affected by operating conditions.

![Thermal cycle test result](image)

Fig.5. Thermal cycle test result (a)Test circuit (b)Start from $T_c=120^\circ{\text{C}}$ (c)Start from $T_c=105^\circ{\text{C}}$

(Testing conditions: CM225DX-34T, DC current applied (IGBT), Ton/off=6min/6min, forced-air cooling)
5. Method to apply PC-TIM

Use printing machine when applying PC-TIM with careful control of the thickness and the shape of PC-TIM.

When PC-TIM is too thin, the contact thermal resistance will increase by remaining air between power module and heat sink. When too thick, it will increase as well by excessive amount of PC-TIM material.

It is necessary to use appropriate stencil pattern to apply PC-TIM with an appropriate thickness and pattern for better contact thermal resistance. After printing, heating and drying process is necessary to remove a volatile solvent. The conditions (e.g. temperature, time, etc.) may be different by capacity or load of drying equipment. Please contact us when you need the detailed information.

Fig.6. PC-TIM stencil pattern example
6. Product appearance sample of product with PC-TIM

A crack or a blur of PC-TIM materials may be occurred during PC-TIM application process. These do not influence the heat dissipation capability. The good sample (reference) of a crack and a blur are described below table.

<table>
<thead>
<tr>
<th>Mode</th>
<th>Example of good sample</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crack</td>
<td><img src="image" alt="Crack Example" /></td>
<td>It is good even if a part of the honeycomb shape is missing.</td>
</tr>
<tr>
<td>Blur</td>
<td><img src="image" alt="Blur Example" /></td>
<td>It is good even if the edge of the honeycomb shape spreads.</td>
</tr>
</tbody>
</table>

7. PC-TIM material information

Please contact us for the detailed information (e.g. manufacturer) of the applied PC-TIM material.
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