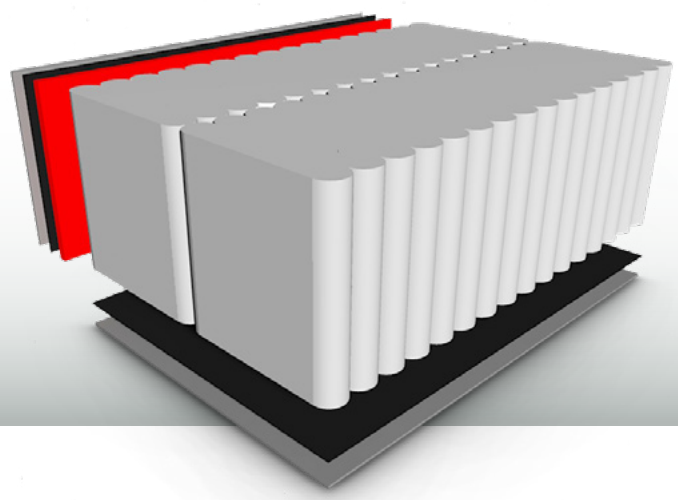
WÜRTH ELEKTRONIK

WE-TGS Design Guideline

Thermally conductive Synthetic Graphite Sheet



Content:

Thermally conductive Synthetic Graphite Sheet

Thermal Management is the term used to describe the methods used take care of the excess heat that electronic devices and components generate. It is a field of upmost importance in order to guarantee reliability of electronic devices and components as well as to prevent premature failure.

1. What is the WE-TGS used for?

The WE-TGS is a synthetic graphite heat spreader. This implies that most of the thermal conductivity provided by the material occurs at the horizontal or XY axis. This effect enables the final application to use even larger cooling surfaces instead of being limited by the contact surfaces of the component that needs to be cooled.

The standard Synthetic Graphite sheet itself is composed by three main components as illustrated in Figure 1:

- **PET film:** The WE-TGS is protected by two PET films that protect the surfaces of the product from scratches.
- **Graphite layer:** This is the component that provides the heat spreading capabilities to the product. The thermal conductivity of the graphite layer will change depending on 2 main parameters: the thickness of the graphite layer and the density of the graphite. The thinner and more dense it is, the higher is the thermal conductivity.
- **Acrylic layer:** These layers provide electrical insulation to the product. One of them has an adhesive surface for applications where the device is affected by vibration and/or movement. It is recommended to add an external mechanical force, having the graphite fixed by the adhesive tape and the external mechanical force.

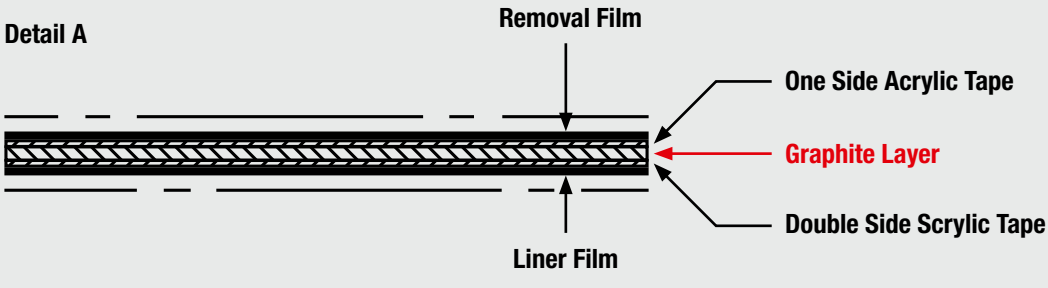


Fig. 1: *WE-PCM components*

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2. Where can the WE-TGS be used?

Besides being a heat spreader, its high thermal conductivity as well as flexibility provide a solution to the problems normal interface materials cannot solve. One example is shown in **Figure 2**.

A hot component that needs to be cooled is limited by the size of its contact surfaces, by using a heat spreader the contact surface is extended and thus the cooling capabilities are enhanced.

All the parts made from graphite sheets have high resistance and reliability against different types of degradation and corrosion.

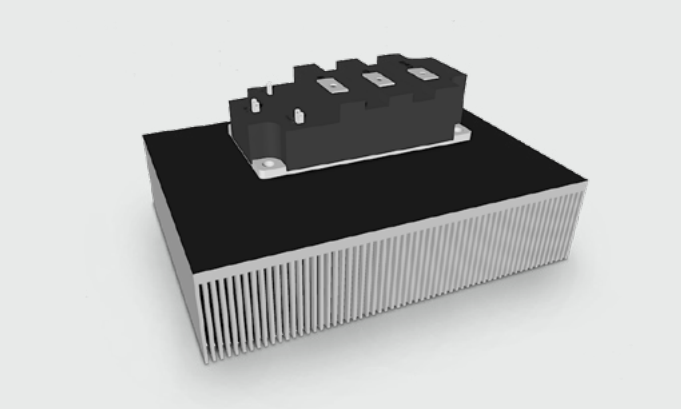

Fig. 2: *An IGBT making an effective use of a larger heatsink*

Since it is a general-purpose heat spreading solution, it covers a wide range of application requirements:

- **Thermal Conductivity:** Wide range from 1000 up to 1800 W/mK.
- **Graphite Thickness:** From 17 to 70 µm.

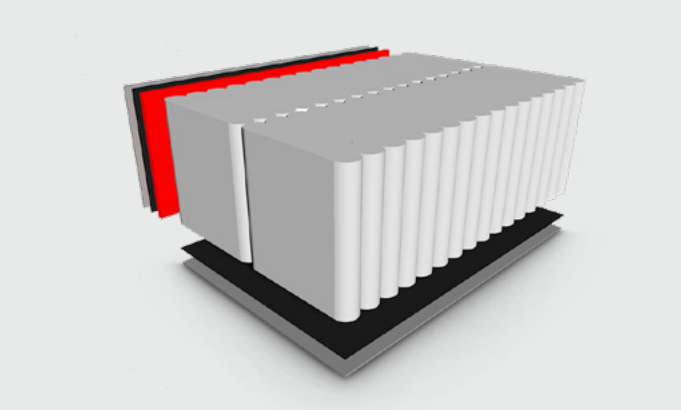

Fig. 3: *Graphite sheets (black) used on a battery array together with a silicone gap filler (red)*

One of the most recent applications where the graphite sheets can be found is on the different batteries, which act as power sources for modern portable devices (**Figure 3**). In these applications, the graphite is used to evenly spread the heat, generated by batteries, providing a stable temperature for all the cells in order to avoid rapid performance degradation. It can be combined with traditional gap fillers in order to ensure both vertical and horizontal thermal interfaces.

Another example of the presence of graphite as a thermal management solution is on E-Mobility batteries for hybrid or fully electric cars, in those cases graphite sheet and graphite gaskets are used as alternative to aluminium plates to reduce the total weight of the batteries and to offer a more resistive product against corrosion and aging.

As mentioned before, one of the main advantages from graphite sheets is their lightweight and thinness, which in combination with its high thermal conductivity it makes the perfect match for applications like hand held devices.

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3. Solutions specially tailored for you

Another benefit of the WE-TGS that adds value to its versatility is the ease of shape customization. Würth Elektronik brings this value to you by providing a customization service with no **MOQ** and **no tooling costs**.

Reach out to your Würth Elektronik representative with the following information and they will get back to you with a personized quotation:

- Thermal Conductivity needed for the application
- Desired thickness
- Volume or number of parts needed
- Technical drawing of the tailored solution
- Any other requirement you may have

4. General use of the WE-TGS recommendations

- For optimal adhesion properties, the surface must be clean and dry. It is recommended use Isopropyl alcohol applied with a lint-free wipe or swab for removing surface contamination.
- Gaps and/or air bubbles between the gap filler and the contact surface must be avoided. Otherwise, the performance of the product may be affected.
- The temperature rise of the component must be taken into consideration. The operating temperature is comprised of ambient temperature and temperature rise of the component.
- Standard parts come with adhesive on one side; this implies the use of mechanical force to ensure contact on both surfaces.

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5. Frequently Asked Questions

Q: Can I modify standard parts? What if I need aluminium foil embedded in the part?

A: There are many ways to tailor the part to fulfil your requirements, please contact your Würth Elektronik representative for your specific solution:

- Dimensions
- Thickness
- Shapes
- Adhesive surfaces

Q: What test method has been used for the thermal performance measurements provided by the datasheet?

A: All thermal related measurements have been performed following ASTM E1461.

Q: Will the material change its mechanical properties under high temperatures?

A: If the material is used under the parameters specified in the datasheet there should not be any significant change in its hardness or any other mechanical property.

Q: Is the adhesive from the WE-TGS conductive or non-conductive?

A: The standard parts have a non-conductive acrylic adhesive.

Q: Is it possible to request the WE-TGS without any adhesive tape?

A: Yes, the WE-TGS can be manufactured without adhesive layers.

Q: Can the WE-TGS be reworked / re-attached?

A: This is not recommended, since foreign particles may end up on the contact surfaces that could lead to an under performance in the final assembly.

Q: How is the WE-TGS modified in shape?

A: The cutting process is done by kiss cutting. An oscillating knife cuts through the top PET film and the material the desired shape, but it does not go through the bottom PET film that acts as a carrier.

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6. Thermal Properties & Glossary

Thermal interface materials (TIMs) are materials that are inserted between two surfaces to improve the thermal coupling between them. The usual application is between a heat source and a cooling assembly.

TIMs can be categorized in two main groups:

- **Vertical Thermal Interfaces:** The commonly used gap filling solution such as silicone elastomers, thermal transfer tapes or greases.
- **Heat spreaders:** These materials work great distributing heat from one spot to a whole surface.

Besides providing a path for heat energy to flow through, these materials provide a seamless interface between all contact surfaces, conforming to any microscopic irregularities in either the heat source or the cooling assembly. This is an important characteristic, since air is a thermal insulator and it can become a barrier, that affects the overall performance of the solution.

As represented in **figure 4**, we can combine two different TIMs to take advantage of a combination between vertical and horizontal interfaces. In the example TIM 2 could be a WE-TGF silicone gap filler and TIM 1 a WE-TGS graphite heat spreader. This combination would allow the use of a larger heatsink than the footprint of the heat source would allow, thus enhancing the cooling capabilities of the whole assembly.

There are many factors that should be taken into consideration when selecting the optimal Thermal Management Solution of your application. The most common ones are:

- **Thermal conductivity:** eterminines the overall performance of the heat transfer between contact surfaces.
- **Thermal resistance:** Opposition of the material to transfer heat, the lower the resistance the more efficient the TIM is.
- **Electrical conductivity:** Depending on the TIM electrical insulation can be an intrinsic property of the material. But for those that are not, other layers can be added to the material in order to insulate it.
- **Operating temperature range:** TIMs work at different temperature ranges so it must be taken into consideration when selecting a solution.
- **Thickness/Height:** The distance between the mating surfaces is a key factor in order to select a TIM. Depending on the solutions, it must be taken into consideration that the material should be compressed (as recommended in the datasheet) to achieve optimal thermal performance.
- **Pressure:** Depending on the final application, some materials are designed to withstand higher pressure such as the WE-TINS.

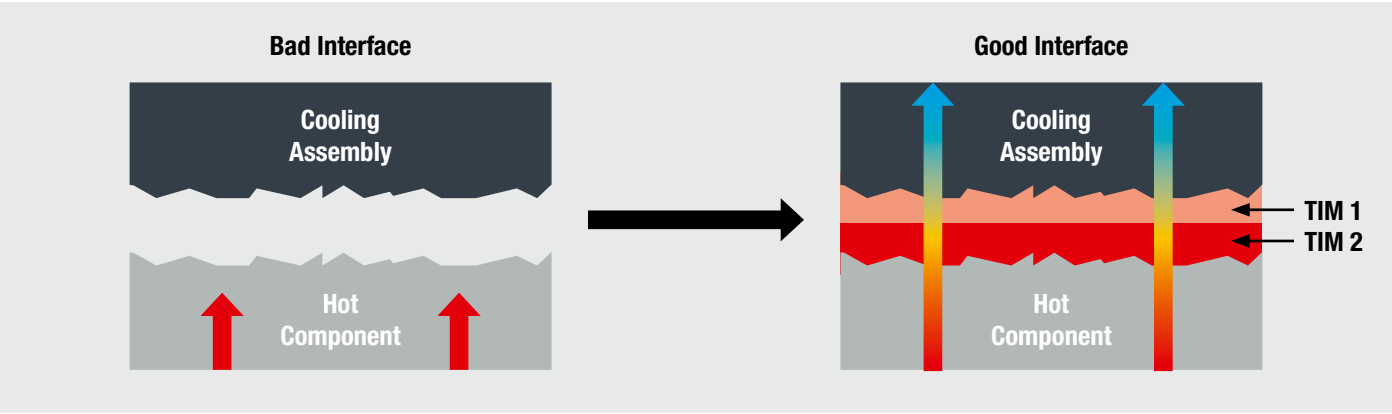

Fig. 4: *Detail of contact surfaces*

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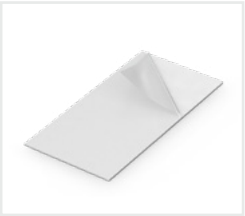
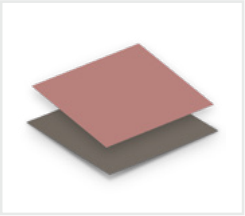
7. Würth Elektronik's Thermal Management Solutions

Gap filling solutions vary in shape and form, there are different criteria to be considered when looking for a solution: dimensions of the gap that needs filling, evaluation of the heat energy that needs to be managed and if electrical insulation is required between the hot component and the cooling assembly.

Würth Elektronik brings to you a broad portfolio with solutions for any gap, interface type and thermal conductivity.



WE-TGF
Silicone Gap Filler Pad
K: 1 – 10 W/mK
Thickness: 0.5 – 18 mm

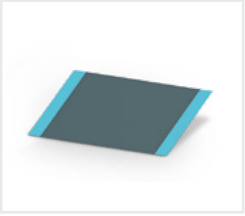


WE-TINS
Thermally Conductive Insulator
K: 1.6 – 3.5 W/mK
Thickness: 0.23 mm

WE-PCM
Phase Changing Material
K: 1.6 – 5 W/mK
Thickness: 0.2 mm

WE-TTT
Thermal Transfer Tape
K: 1 W/mK
Thickness: 0.2 mm

WE-TGFG
Graphite Foam Gasket
K: 400 W/mK
Thickness: 1.5 – 25 mm



WE-TGS
Graphite Sheet
K: 1800 W/mK
Thickness: 0.03 mm