USER GUIDE

UG014 | Thermal Transfer Tape – WE-TTT

Sebastian Mirasol-Menacho

1. INTRODUCTION TO WE-TTT

The WE-TTT series is a thermal interface solution designed to attach a cooling assembly to low-power heat sources without requiring additional mechanical fixation methods such as screws, bolts, or clips. This thermally conductive double-sided adhesive tape helps to save space in your PCB designs.

The acrylic adhesive present on both sides of the pad allows it effective adhesion with moderately rough surfaces, filling gaps and displacing air bubbles. This ensures a secure and consistent bond, which is essential for maintaining thermal performance over time.

This adaptability makes it suitable for a wide range of applications, from consumer electronics to industrial equipment. Additionally, WE-TTT series' double-sided adhesive design simplifies the installation process.

The WE-TTT series is ideal for various applications where efficient thermal management is critical. In consumer electronics such as smartphones, tablets, and laptops, where space is at a premium and efficient heat dissipation is essential, this tape proves invaluable. In LED lighting, it ensures optimal performance and longevity of the LED modules by effectively managing heat.

2. MATERIAL SPECIFICATIONS

The thermally conductive double-sided adhesive pad has three main components as shown in Figure 1.

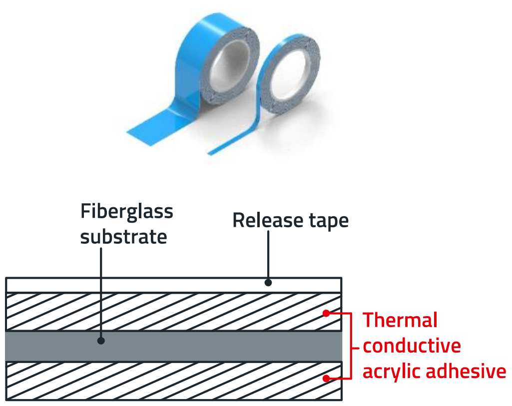

Figure 1: WE-TTT cross-section.

- Release Tape:
  This component protects the adhesive from any foreign particles. In roll format, it is only present on the top side, while in the sheet format, it is present on both top and bottom sides.
- Thermal Conductive Acrylic Adhesive:
  This is the primary heat transfer component, and it also provides the pad with adhesive properties.
- Fiberglass substrate:
  This element provides the pad with mechanical stability during the compression of the pressure sensitive adhesive.

The properties of the WE-TTT thermally conductive double-sided adhesive pads can be grouped into three categories: material, thermal and electrical (Table 1, Table 2 and Table 3).

Material Properties	
Color	White with protective film in blue color
Thickness	0.2 mm
Adhesive strength	5.79 N/cm
Specific gravity	1.3 g/cm^3
Hardness	45 Shore A
Operating Temperature	-20 up to 90°C

Table 1: Material properties of WE-TTT.

Thermal Properties	
Bulk Thermal Conductivity	1 W/m · K
Thermal Impedance	5.49 K · cm^2/W

Table 2: Thermal properties of WE-TTT.

Electrical Properties	
Breakdown Voltage	4 kV

Table 3: Electrical properties of WE-TTT.

3. DESIGN CONSIDERATIONS

One very popular application for thermally conductive tapes is to attach strips of LED lights to metal housings that also serve to transfer heat energy to the ambient, essentially acting as a heatsink. The adhesive not only secures the PCB in position during assembly, but also ensures a good surface wet-out to achieve a minimum thermal resistance bond line.

3.1 How to design-in the WE-TTT

Let's consider a scenario where we are designing an LED lamp that has 25 high power diodes, as can be seen in Figure 2.

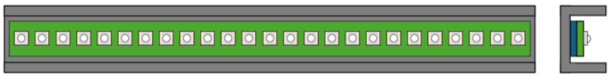

Figure 2: Structure of LED lamp.

A metal housing is used to house the board and to help to transfer the heat to the ambient. This lamp is for interior use, so we can rely on a stable and continuous room temperature.

We can find all the thermal characteristics of each diode in its datasheet (Table 4):

Parameter	Value
Dissipated power (P_{LOSS})	2.52 W
Thermal resistance junction to solder (R_{JS})	8 K/W
Maximum junction temperature (T_{jMax})	150°C

Table 4: Datasheet parameters of the diodes.

We will also define the other design parameters for the heatsink and ambient (Table 5):

Parameter	Value
Heatsink area (A_{HSA})	0.15 m^2
Contact area (A)	144 cm^2
Ambient temperature (T_A)	25°C

Table 5: Design parameters of heatsink and ambient.

Since these are high power LEDs, one thermal strategy for the PCB design could be the use of thermal vias to provide a path to flow from the junction of the diode to the board's opposite side through the solder points. However, due to the power density and to draw as much heat away from of the diodes as possible, our design will be built upon a Metal Core PCB (MCPCB).

The thermal model for our design is as follows in Figure 3:

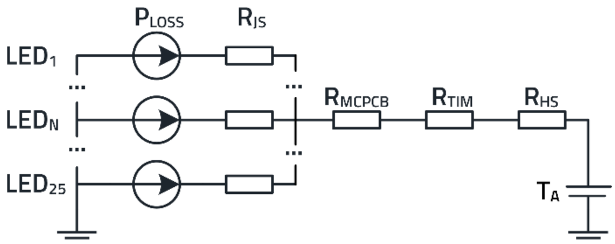

Figure 3: Circuit diagram of the diode built on MCPCB.

The total dissipated power is that of all diodes.

$$P = \sum P_{LOSS} = 63\ \text{W} \qquad (1)$$

To calculate the equivalent thermal resistance of the 25 parallel R_{JS} we apply the parallel resistor equation:

$$R_{JS\text{-}EQ} = \sum_{i=1}^{25} \frac{1}{R_i} = 0.32\ \frac{\text{K}}{\text{W}} \qquad (2)$$

For the MCPCB we can calculate the equivalent thermal resistance by assuming that the whole 1.6 mm thickness is aluminum. We can also disregard the thermal resistance of the copper layer and the electrical insulator due to how thin they are (nominally around 70 µm). To calculate the equivalent thermal resistance between contact surfaces we will apply the thermal resistance formula for solids.

$$R_{MCPCB} = \frac{L}{\lambda \cdot A} = \frac{0.016\ \text{m}}{220\ \frac{\text{W}}{\text{m} \cdot \text{K}} \cdot 0.0144\ \text{m}^2}$$
$$R_{MCPCB} = 0.005\ \frac{\text{K}}{\text{W}} \qquad (3)$$

where:

λ is the thermal conductivity of the material (W/m · K)
L is the thickness of the material (m)
A is the surface area (m^2)

The thermal resistance of the WE-TTT can be obtained from the thermal impedance value in Table 2 and the contact area in Table 5.

$$R_{TIM} = \frac{Z_{WE\text{-}TTT}}{A} = \frac{5.49\ \frac{\text{K} \cdot \text{cm}^2}{\text{W}}}{144\ \text{cm}^2} = 0.038\ \frac{\text{K}}{\text{W}} \qquad (4)$$

The heatsink thermal resistance can normally be found through the manufacturer datasheet. However, since we are designing the concept, we can calculate an estimate value by knowing the area in contact with the ambient. Since we are relying on natural convection, we can assume a heat transfer coefficient (h_{CONV}) of 10 W/m · K.

$$R_{HS} = \frac{1}{h_{CONV} \cdot A} = \frac{1}{10\ \frac{W}{m \cdot K} \cdot 0.15\ m^2} = 0.66\ \frac{K}{W} \qquad (5)$$

With all the thermal resistance values of each different component of the thermal stack, we can calculate a total thermal resistance value.

$$R_{EQ} = R_{JS\text{-}EQ} + R_{MCPCB} + R_{TIM} + R_{HS}$$

$$R_{EQ} = 0.32\ \frac{K}{W} + 0.005\ \frac{K}{W} + 0.038\ \frac{K}{W} + 0.66\ \frac{K}{W} \qquad (6)$$

$$R_{EQ} = 1.07\ \frac{K}{W}$$

Finally, we can estimate a value for the diode's junction temperature.

$$T_j = T_A + P \cdot R_{EQ} = 25°C + 63\ W \cdot 1.07\ \frac{K}{W} \qquad (7)$$

$$T_j = 92.4°C$$

If we check the LED's datasheet we can see that the maximum junction temperature is 150°C. With the calculation we performed we can estimate that our design will be within the operating limits of the components.

4. THERMAL MEASUREMENT SETUP

All thermal parameters mentioned in this guideline have been measured in-house following ASTM D5470 - Standard Test Method for Thermal Transmission Properties of Thermally Conductive Electrical Insulation Materials. The testing setup is shown in Figure 4.

The standard focuses on steady-state heat transfer conditions. During testing, a constant heat source is applied to one side of the TIM specimen, while a cooling assembly ensures a temperature difference to create a heat flow through the material under test. This setup, shown in Figure 4, allows for the measurement of thermal conductivity and impedance under different temperature and mechanical conditions.

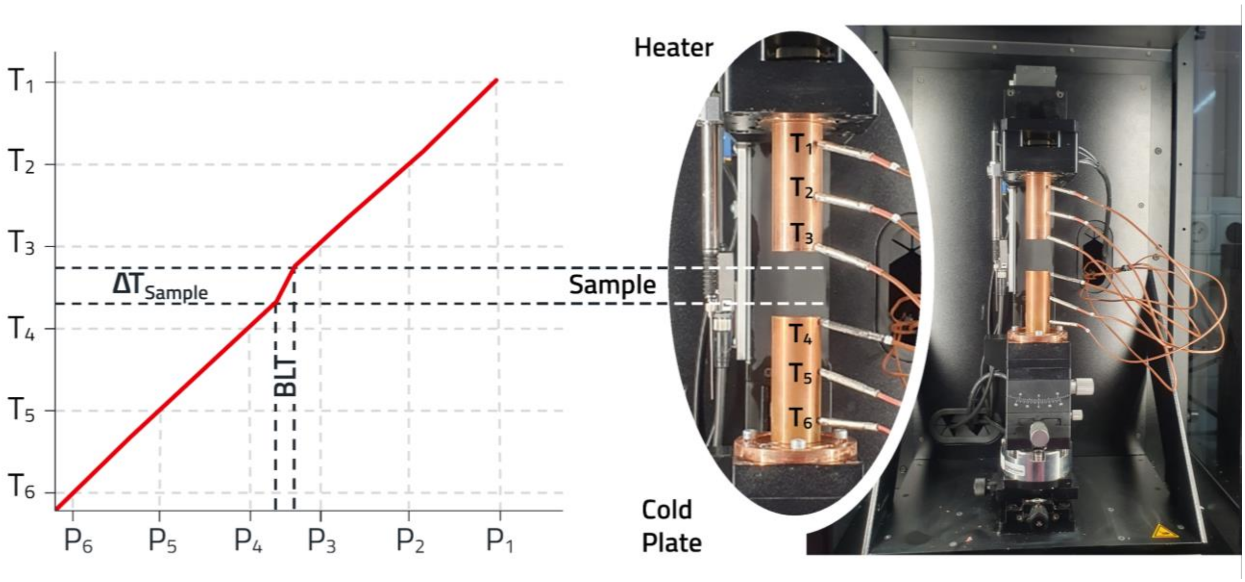

Figure 4: ASTM D5470 testing setup.

5. INSTALLATION AND HANDLING

Rigid to rigid bonding

To achieve adequate surface wetting for optimal thermal performance, add a small back-and-forth twisting motion during assembly while maintaining a compression force.

Flexible to rigid bonding

To avoid air bubbles trapped between the contact surfaces and the adhesive pad when applying a flexible material, place the edge of the pad on the surface and remove the protective liner as a 1 kg is rolled over the opposite surface. To ensure proper application, the following steps are recommended:

- The surface of the component and cooling assemblies must be clean and dry. It is recommended to use isopropyl alcohol applied with a lint-free wipe or swab to remove any particles on contact surfaces.
- Remove the protective liner from one of the pad's surfaces.
- Place the adhesive with a rolling motion to avoid air bubbles. If possible, apply pressure with a 1 kg roller to activate the adhesive.
- When the other part is ready for assembly, remove the protective liner.
- Apply the component or assembly with a rolling motion and pressure.

Cutting

The WE-TTT can be cut into shape with any sharp object. Laser cutting is discouraged because it can fuse the part with the protective liners, making handling of the adhesive pad very difficult.

Reworking

The WE-TTT is not a reworkable pad. If separation of the stack is difficult, apply heat and torque or peel to separate the substrates. This will result in the destruction of the pad.

If there is any leftover material, carefully pry it with plastic or wooden tool to avoid damaging the contact surfaces. It is recommended to clean the surface areas with isopropyl alcohol on a lint-free wipe.

6. MODIFICATION AND PROTOTYPING SERVICE

Würth Elektronik provides a shape modification service that accompanies you from prototyping to manufacturing offering no MOQ or tooling costs. The goal of this service is to support you from prototyping to manufacturing.

Modified shapes are performed by die-less cutting. This technique allows a knife to cut the adhesive pad into any desired shape within the machine's tolerances. The parts will be delivered cut into a sheet (Figure 5).

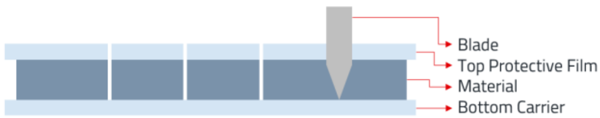

Figure 5: Die-less cutting of parts.

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

- Number of parts needed
- Technical drawing of desired part
- Any special requests may have

IMPORTANT NOTICE

USEFUL LINKS

Application Notes
www.we-online.com/appnotes

REDEXPERT Design Platform
www.we-online.com/redexpert

Toolbox
www.we-online.com/toolbox

Product Catalog
www.we-online.com/products

CONTACT INFORMATION

appnotes@we-online.com
Tel. +49 7942 945 - 0

Würth Elektronik eiSos GmbH & Co. KG
Max-Eyth-Str. 1 74638 Waldenburg Germany
www.we-online.com