

# Mounting considerations for TO-220 Full-PAK – fully isolated package

## About this document

### Scope and purpose

Mounting power electronic devices accurately is critical for their reliability and performance. Therefore, precise instructions are required.

This application note focuses on the assembly of through-hole devices, particularly the TO-220 Full-PAK devices.

### Intended audience

The intended audience for this document are design engineers, technicians, and developers of electronic systems.

## Table of contents

<b>About this document</b> .....	<b>1</b>
<b>Table of contents</b> .....	<b>2</b>
<b>1 Introduction</b> .....	<b>3</b>
<b>2 Correct mounting procedures</b> .....	<b>3</b>
2.1 General.....	3
2.2 Screw mounting .....	3
2.3 Clip mounting.....	4
<b>3 Thermal performance</b> .....	<b>4</b>
<b>4 Heat sink requirements</b> .....	<b>5</b>
<b>Revision history</b> .....	<b>6</b>
<b>Disclaimer</b> .....	<b>7</b>

## Introduction

### 1 Introduction

It is important to mount the power semiconductors correctly to achieve their full functionality. Incorrect mounting may lead to both thermal and mechanical problems as well as de-rated performance.

### 2 Correct mounting procedures

#### 2.1 General

It must be ensured that no mechanical damage is caused to the package.

#### 2.2 Screw mounting

It is recommended that a rectangular washer be inserted between the screw head and the mounting tab. However, it must be ensured that the washer does not damage the plastic body of the package during the mounting process. The recommended mounting torque is 0.5 Nm and must not be exceeded.

Self-tapping screws should not be used.

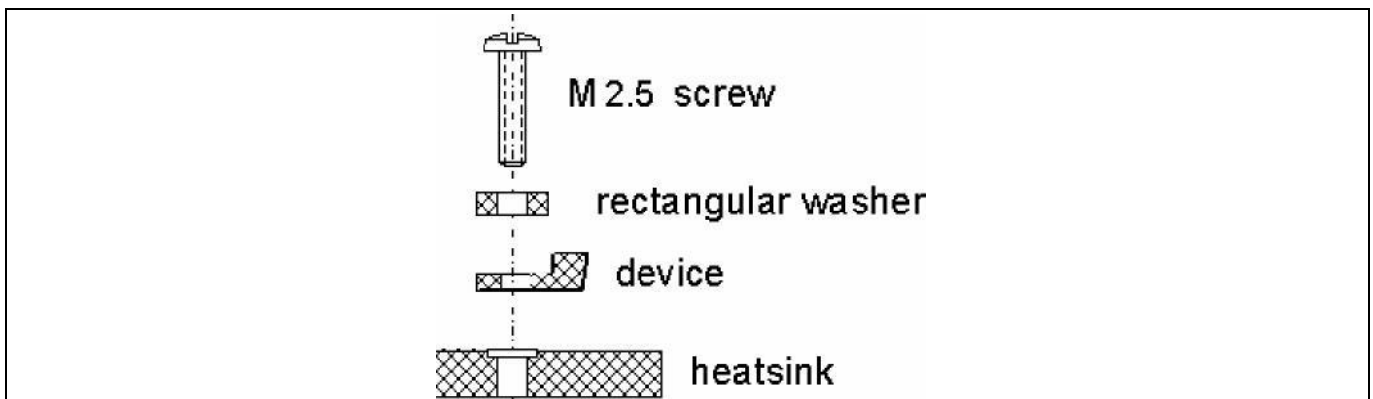


Figure 1 Screw mounting into a tapped heat sink

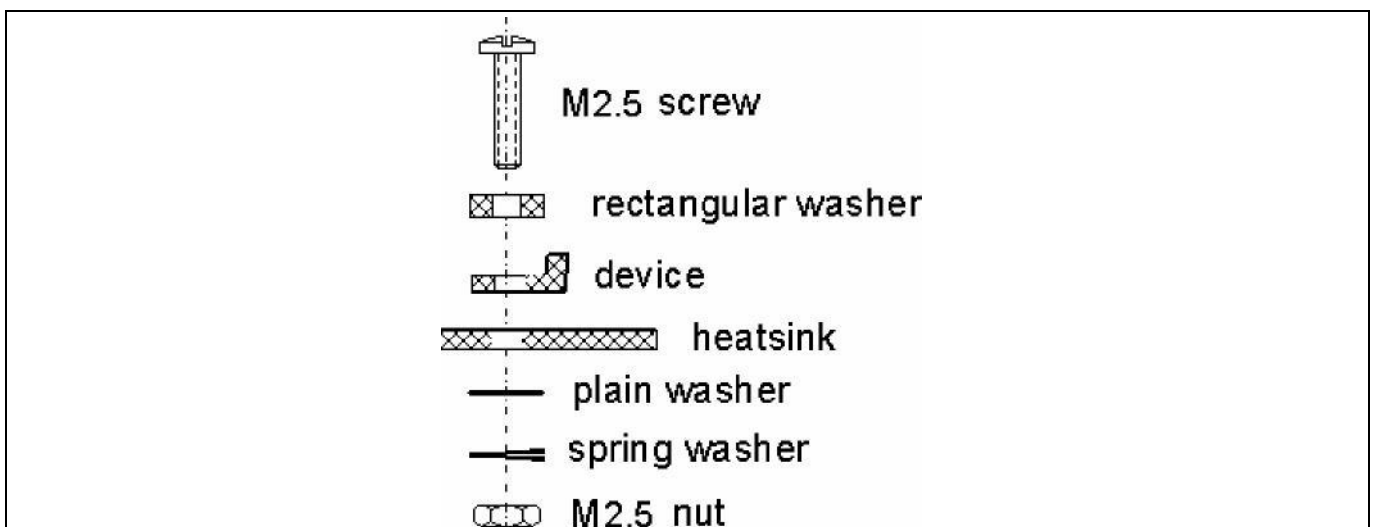


Figure 2 Screw mounting through a heat sink using a nut

## Thermal performance

### 2.3 Clip mounting

Clip mounting ensures that force is applied above the silicon die and thermal contact is good.

- For heat sinks of less than 5 mm thickness, saddle clips should be used (see Figure 3). These clips provide contact forces between 15 N and 50 N depending on their specification
- For heat sinks of more than 5 mm thickness, U-clips should be used. These clips provide contact forces between 15 N and 50 N depending on their specification

There are a number of proprietary clip solutions, where the clip is anchored in a groove in an extruded heat sink. With such clips, contact forces between 25 N and 50 N can be achieved.

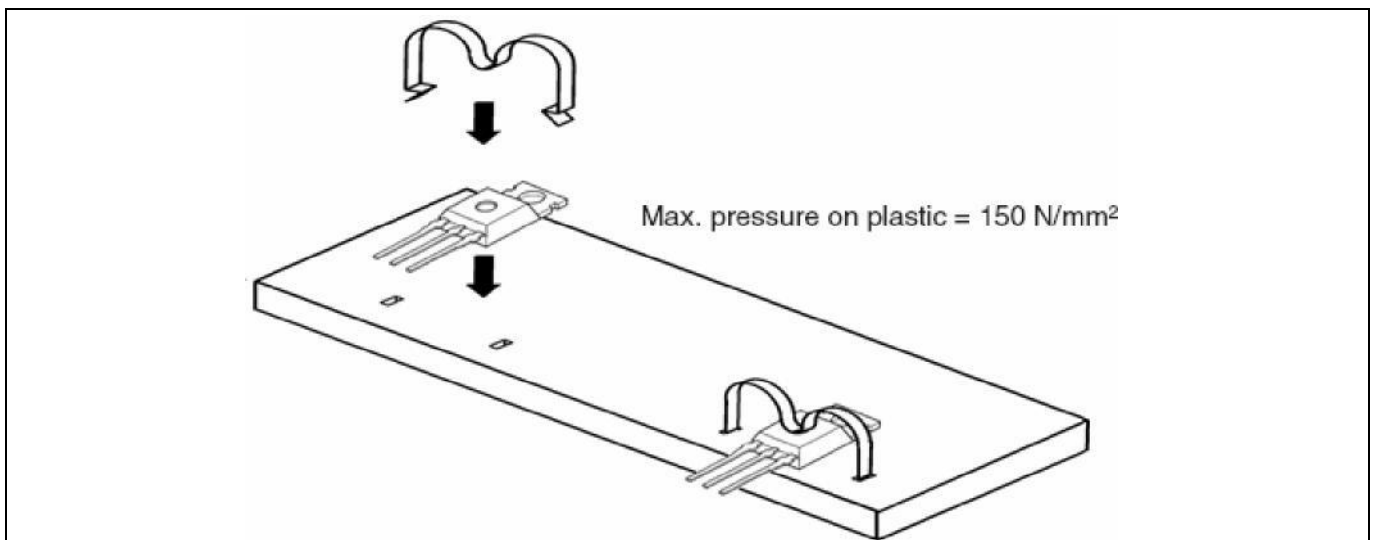


Figure 3 Example of clip mounting (saddle-clip)

## 3 Thermal performance

The overall thermal performance of a package with a heat sink is characterized by the junction-to-ambient thermal resistance  $R_{thJA}$  (see Fig. 4).

$R_{thJA}$  can be calculated using equation (1):

$$R_{thJA} = R_{thJC} + R_{thCS} + R_{thS} + R_{thSA} \quad (1)$$

Where,

- $R_{thJA}$  : thermal resistance junction – ambient
- $R_{thJC}$  : thermal resistance junction – case
- $R_{thCS}$  : thermal resistance case – sink
- $R_{thS}$  : thermal resistance sink
- $R_{thSA}$  : thermal resistance sink - ambient

## Heat sink requirements

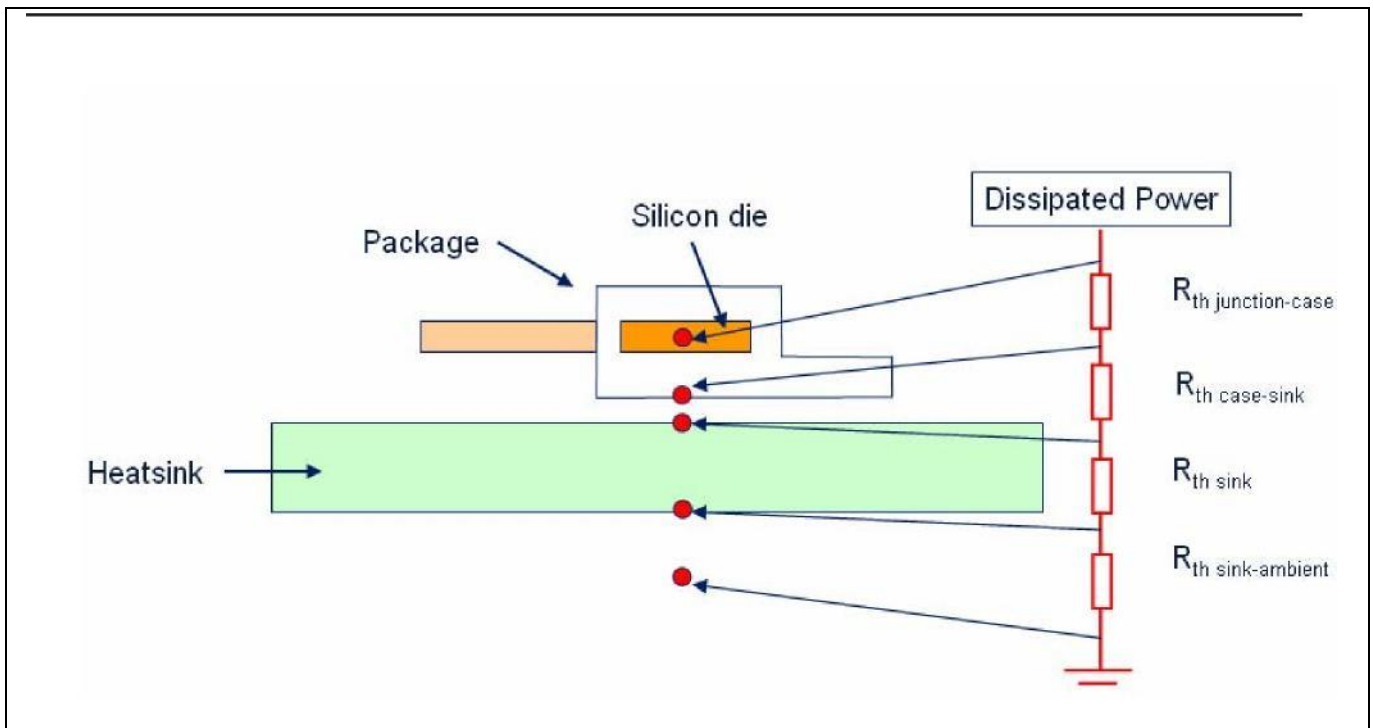


Figure 4 Thermal model

When mounting the package on a heat sink, it is important to consider the thermal contact resistance  $R_{thCS}$ . In an ideal scenario where the planarity and the roughness of the package as well as the heat sink are ideal,  $R_{thCS}$  is zero. However, manufacturing such ideal packages is not possible even with the most precise measures. A small air gap is, therefore, formed. This results in a thermal contact resistance case-to-sink  $R_{thCS}$  that is different from zero.

Since air is a good insulator, the air gap significantly increases the thermal contact resistance. To improve the conduction behavior this air gap can be filled with an interface material that has a better thermal conductivity than air.

Measurements taken during experiments show that using thermal grease reduces the interface resistance in the range of 1.2–1.5 K/W. Thus, using thermal grease is highly recommended.

## 4 Heat sink requirements

The contact area between the package and the heat sink must be free of any particles, damages, or other contaminants. The following surface conditions are recommended:

- Heat sink roughness  $R_z \leq 10 \mu\text{m}$
- Heat sink flatness  $\leq 10 \mu\text{m}$  (reference length 15 mm)

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## Revision history

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### Revision history

Document revision	Date	Description of changes
1.0	2000-07-01	First release
2.0	2006-12-01	Revised instructions
2.1	2022-09-12	Template update

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**Email: [erratum@infineon.com](mailto:erratum@infineon.com)**

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