TN1393

Technical note

Mounting instruction for STPOWER module ACEPACK DMT-32

Introduction

ACEPACK DMT-32 is an advanced power module designed to integrate power devices with different nature. Making use of power module simplifies the design and increase reliability while optimizing PCB size and system costs.

This mounting instructions paper gives the main recommendations to appropriately handle, assemble and rework the ACEPACK DMT-32 power module. It is necessary to follow some basic assembly rules either to limit thermal and mechanical stresses or assure the best thermal conduction and electrical insulation.

1 Heat sink

When attaching a heat sink to a ACEPACK DMT-32 make sure not to apply excessive force to the device for assembly. Drill holes for screws in the heat sink exactly as specified. Smooth the surface by removing burrs and protrusions of indentations. Do not touch the heat sink when the ACEPACK DMT-32 is operational to avoid a burn injury.

1.1 Basic guidelines

The following table gives designers basic guidelines.

Table 1. Mounting torque and heat sink flatness specifications

Item	Condition		Min.	Typ.	Max.	Unit
Mounting torque	Mounting screw:M3	Recommended 7 kgf•cm	4	7	10	Kgf.cm
		Recommended 0.68 N•m	0.39	0.68	0.98	N•m
Device flatness	See Figure 1. Device flatness specification		0		+120	µm
Heat sink flatness	See Figure 2. Heat sink flatness specification		-50	-	+100	µm

Device and heat sink flatness are prescribed as seen in Figure 1. Device flatness specification and in Figure 2. Heat sink flatness specification.

Increasing the contact pressure between package and heat sink will maximize the contact area between the two surfaces. Increasing the mounting torque in the fastening screw, or using a clip with a high spring constant, will increase the contact areas and provide solid conduction heat-flow paths, which are more effective than conduction across an air gap. Applying the proper mounting torque is the key factor in obtaining adequate pressure along the contact surfaces of the package and the heat sink, in order to minimize the contact thermal resistance. If mounting torque is too low, the contact thermal resistance increases due to bad thermal contact under insufficient contact pressure. If mounting torque is too high package crack may be occurring. Hence, appropriate mounting torque must be applied to produce minimal thermal resistance and avoid damaging the package or changing the device characteristics.

The thermal contact resistance depends on the force generated by the applied torque on the screw:

$$F = \frac{2 * T * \pi}{P + r * D * \pi}$$

Where:

- 1108T is applied torque on the screw in N*m
- P is pitch in m
- D is screw diameter in m
- r is rubbing factor: # 0.12 for steel-steel with grease and # 0.2 for steel-aluminum

Figure 1. Device flatness specification

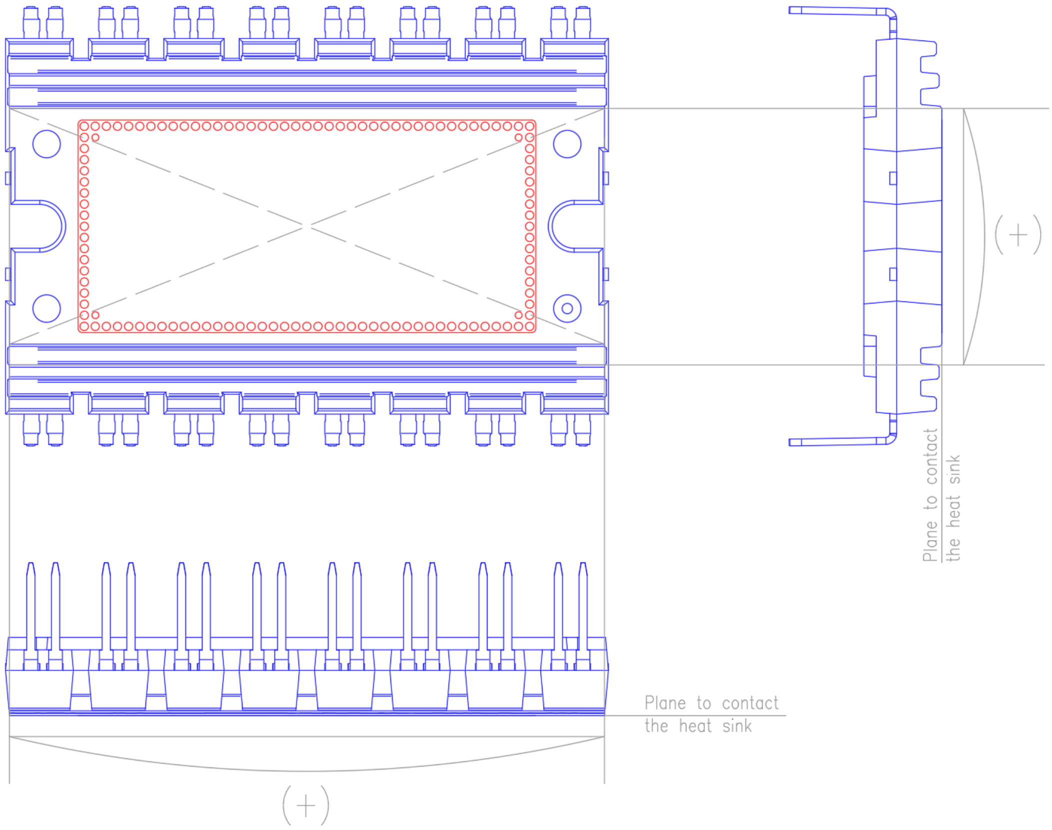
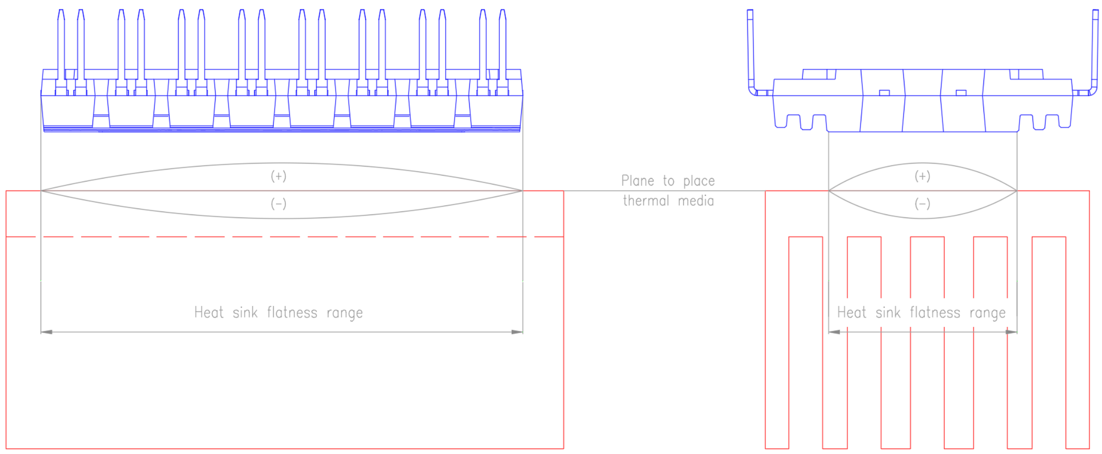


Figure 2. Heat sink flatness specification



1.2 Thermal conductive grease

To get the most effective heat dissipation, it is necessary to enlarge the contact area as much as possible, which minimizes the contact thermal resistance. Properly apply thermal-conductive grease over the contact surface between a module and heat sink, which is also useful for preventing the contact surface from corrosion. Ensure that the grease has constant in time quality and long-term endurance within a wide operating temperature range. Use a torque screwdriver to fasten up to the max specified torque rating. Exceeding the maximum torque limitation might cause a module to be damaged or degraded. Pay attention not to have any dirt remaining on the contact surface.

1.3 Screw tightening torque

Do not exceed the specified fastening torque. Over tightening the screws may cause ceramic or molding compound crack, as shown in Figure 3. Molding compound crack, and heat-fin threaded hole destruction. Tightening the screws beyond a certain torque can cause saturation of the contact thermal resistance.

Figure 3. Molding compound crack

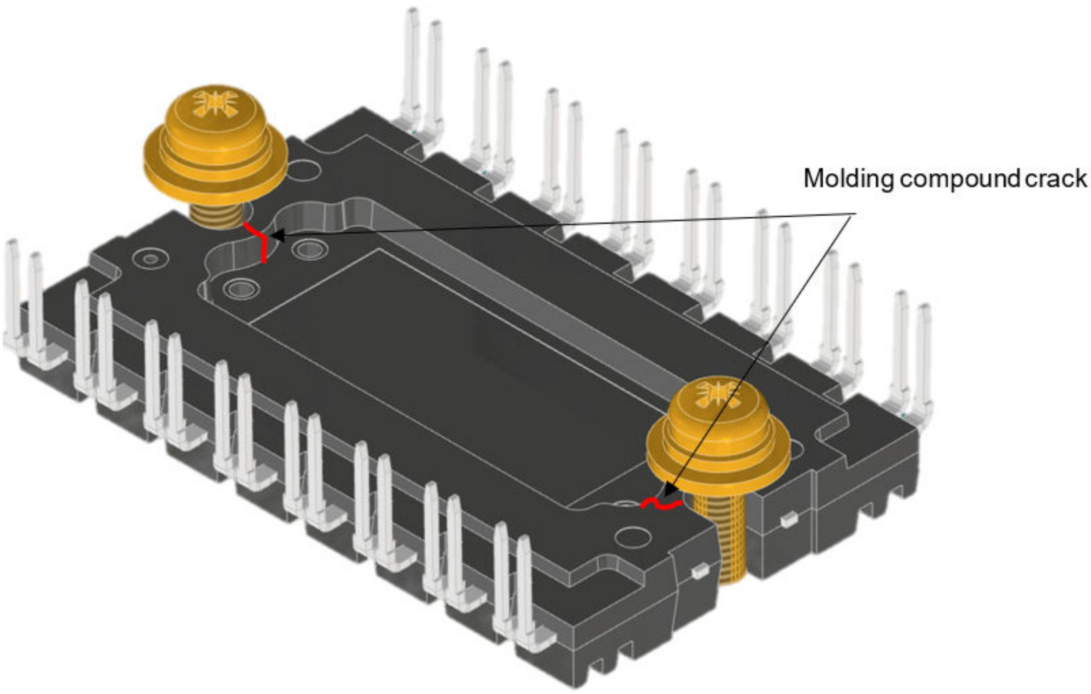


Figure 4 shows the recommended fastening sequence for mounting screws.

STMicroelectronics recommends to temporary tight mounting screws with fixing torque set at 0.2/0.3N•m and permanently tight mounting screws with the suggested torque of 0.68 N•m (0.98 N•m max.).

Use screwdriver temporary fastening ①→②

Use screwdriver permanent fastening ①→②

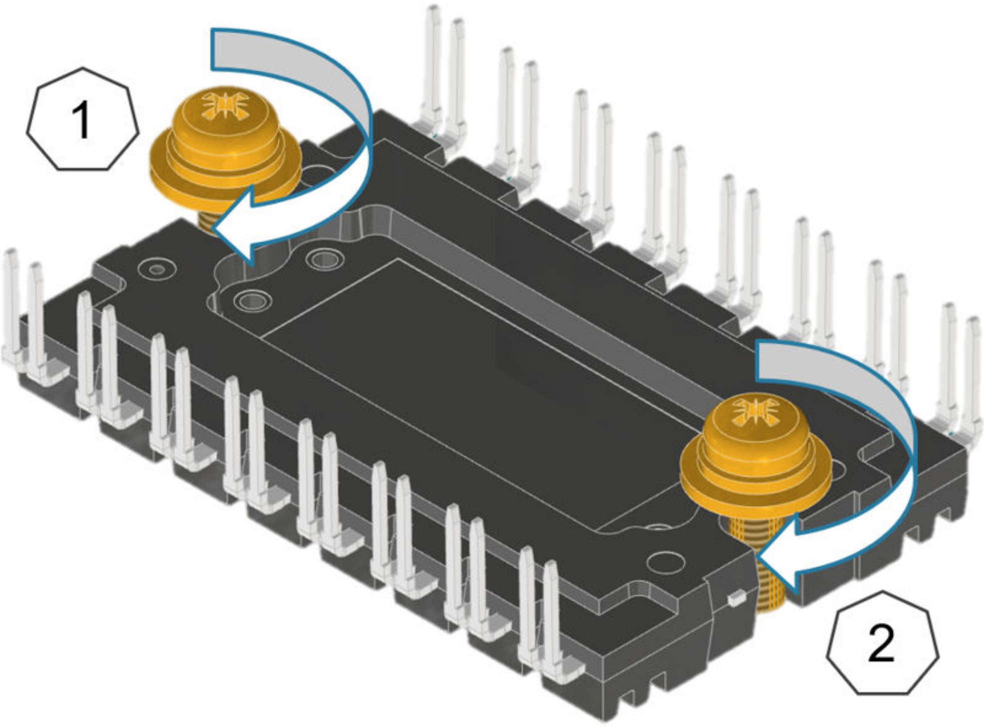
To reduce fastening process cycle time, two-steps permanently tightening is also possible:

Use screwdriver permanent fastening ①→②

If two-steps permanent tightening is applied, thermal grease may not evenly distribute in between the module and external heat sink.

In case of use of electrical or pneumatic screwdriver, it is suggested to keep revolution at 200 rpm max. as quick impact of screw may damage the module plastic body.

Figure 4. **Recommended fastening order of mounting screws**



1.4 Recommended screws

All mounting screws should have washers and spring washer for best mounting results. It is recommended to use SEMS screw (included spring/plain washer M3) as shown in the following figure.

Figure 5. **SEMS screw (size M3, spring washer 5.0Φ, plain washer 7.5Φ)**

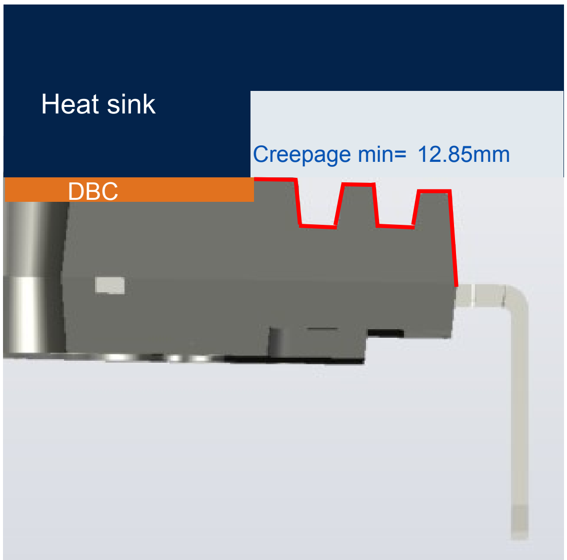
1.5 Electrical insulation: creepage and clearance

The electrical insulation is compliant with the IEC60664-1: the minimum creepage and clearance distances are guaranteed according to the material class, pollution degree, altitude and voltage.

The creepage distance is defined as the shortest distance along the surface of a solid insulating material between two conductive parts. Thanks to the grooves specifically designed on the molded surface, the DMT-32 ensure higher creepage.

The figure below shows the minimum creepage of 12.85 mm, defined as the minimum distance guaranteed and to be considered as a reference for the heat sink positioning. The creepage distance is depicted with the red line.

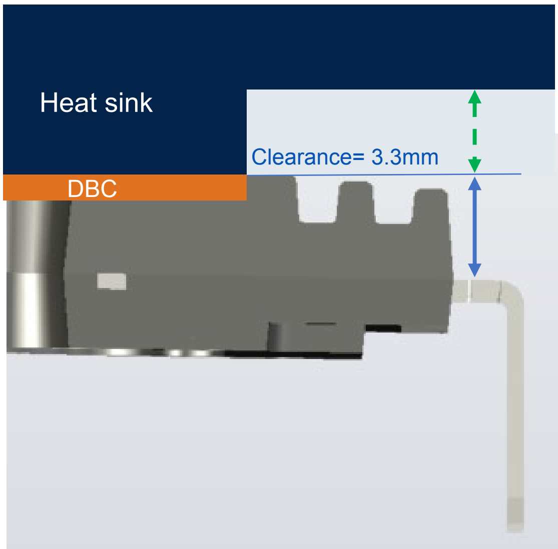
Figure 6. Creepage distance allowed



The clearance distance is defined as shortest distance in air between two conductive parts. The clearance distance, referred to the shoulder of the pin and the top of the groove is 3.30 mm, considered as typical value. This represent the typical distance at which a generic heat sink can be located.

In the figure below it is highlighted the typical clearance can be guaranteed, considering the surface of a heat sink on the top of the DBC substrate. This is represented by the solid arrow in blue. Additional clearance distance can be achieved by specific design of the heat sink, that is as indicated in the figure below by the dashed green arrow.

Figure 7. Clearance distance allowed



2 Package handling

2.1 ESD protective measures

Semiconductors are normally electrostatic discharge sensitive devices (ESDS) requiring specific precautionary measures regarding handling and processing. Static discharges caused by human touch or by processing tools may cause high-current and/or high-voltage pulses, which may damage or even destroy sensitive semiconductor structures. On the other hand, integrated circuits (ICs) may also be charged by static during processing. If discharging takes place too quickly ("hard" discharge), it may cause peak loads and damages, too. ESD protective measures must therefore prevent contact with charged parts as well as charging of the ICs. Protective measures against ESD include proper procedures for the handling, processing, and the packing of ESDS. A few hints are provided below on handling and processing.

2.1.1 ESD protective measures in the workplace

- Standard marking of ESD-protected areas
- Access controls, with wrist strap and footwear testers
- Air conditioning
- Dissipative and grounded floor
- Dissipative and grounded working and storage areas
- Dissipative chairs
- Ground bonding point for wrist strap
- Trolleys with dissipative surfaces and wheels
- Suitable shipping and storage containers
- No sources of electrostatic fields

2.1.2 Equipment for personal

- Dissipative/conductive footwear or heel straps
- Suitable garments made of fabrics that do not generate excessive static electricity
- Wrist strap with safety resistor
- Volume conductive gloves or finger cots

2.1.3 Production installations and processing tools

- Machine and tool parts made of dissipative or metallic materials
- No materials having thin insulating layers for sliding tracks
- All parts reliably connected to ground potential
- No potential difference between individual machine and tool parts
- No sources of electrostatic fields

Our recommendations are based on the internationally applicable standards IEC 61340-5-1 and ANSI/ESD S2020.

2.2 Packing of components

Please refer to product and package specifications and our sales department to get information about what packaging is available for a given product.

Generally the following list of standards dealing with packing should be considered if applicable for a given package and packing:

- IEC 60286-4 Packaging of components for automatic handling - Part 4: Stick magazines for dual-in-line packages
- IEC 60286-5 Packaging of components for automatic handling - Part 5: Matrix trays

2.3 Storage and transportation conditions

Improper transportation and unsuitable storage of components can lead to a number of problems during subsequent processing, such as poor solderability, delamination, and package cracking effects.

These relevant standards should be taken into account as appropriate:

- IEC 60721-3-0 Classification of environmental conditions: Part 3: Classification of groups of environmental parameters and their severities; introduction
- IEC 60721-3-1 Classification of environmental conditions: Part 3: Classification of groups of environmental parameters and their severities; Section 1: Storage
- IEC 60721-3-2 Classification of environmental conditions: Part 3: Classification of groups of environmental parameters and their severities; Section 2: Transportation
- IEC 61760-2 Surface mounting technology - Part 2: Transportation and storage conditions of surface mounting devices (SMD) - Application guide
- IEC 62258-3 Semiconductor Die Products - Part 3: Recommendations for good practice in handling, packing and storage
- ISO 14644-1 Clean rooms and associated controlled environments Part 1: Classification of airborne particulates

Table 2. General storage conditions, overview

Product	Condition for storing
Wafer/die	N2 or MBB(1) (IEC 62258-3)
Component - not moisture sensitive	1K2 (IEC 60721-3-1)

1. *Moisture barrier bag*

Maximum storage time

The conditions to be complied with in order to ensure problem-free processing of active and passive components are described in standard IEC 61760-2.

Internet links to standards institutes

- American national standards institute (ANSI)
- Electronics industries alliance (EIA)
- Association connecting electronics industries (IPC)

2.4 Handling damage and contamination

Any mechanical damage during automatic or manual handling of components (in or out of the component packing) that may harm package leads and/or body has to be avoided. In particular, unintentional bending of leads may cause a loosening in the package body which can result in electrical malfunction.

Along with other factors, any contamination applied to a component or packing may cause:

- Solderability problems
- Corrosion
- Electrical shorts (due to conductive particles)

2.5 Component solderability

The final plating of most semiconductor packages are sufficiently thick and wettable to assure good solderability, even after a long storage time. Note that the cut edges of the pins should be ignored in any assessment of solderability. Suitable methods for the assessment of solderability can be derived from JESD22B 102 or IEC6068-2-58.

Components are plated with pure Sn, or pre-plated with noble metals on a Ni carrier (e.g. NiAu, NiPdAu). Tin-plated and pre-plated components are compatible with both SnPb and Pb-free soldering.

3 Soldering

ACEPACK DMT-32 is parts THD packages that are typically soldered by wave soldering.

3.1 Selective wave soldering

Wave soldering is a large-scale soldering process by which electronic components are soldered to a PCB to form an electronic assembly. The name is derived from the fact that the process uses a tank to hold a quantity of molten solder; the components are inserted into or placed on the PCB and the loaded PCB is passed across a pumped wave or cascade of solder. The solder wets the exposed metallic areas of the board (those not protected with solder mask), creating a reliable mechanical and electrical connection.

For THD, only the leads that extend through the drill holes in the PCB contact the hot solder. The body of the package is heated by the hot leads. This has two consequences:

1. The package body is cooler than in the case of reflow soldering
2. The temperature gradient between leads and body and inside the package is greater than in the case of reflow soldering.

Therefore, for wave-solderable THD packages the heat resistance is tested according to JESD22-B106 and IEC668 2-20 (typically 260 °C, 10 s).

Note: immersion of the whole package body into the molten solder is not recommended since THD packages are not designated for such a harsh temperature shock.

There are many types of wave-soldering machines, but their basic components and principles are the same. A standard wave-soldering machine consists of three zones: the fluxing zone, the preheating zone, and the soldering zone. A fourth zone, the cleaning zone, may be used depending on the type of flux applied.

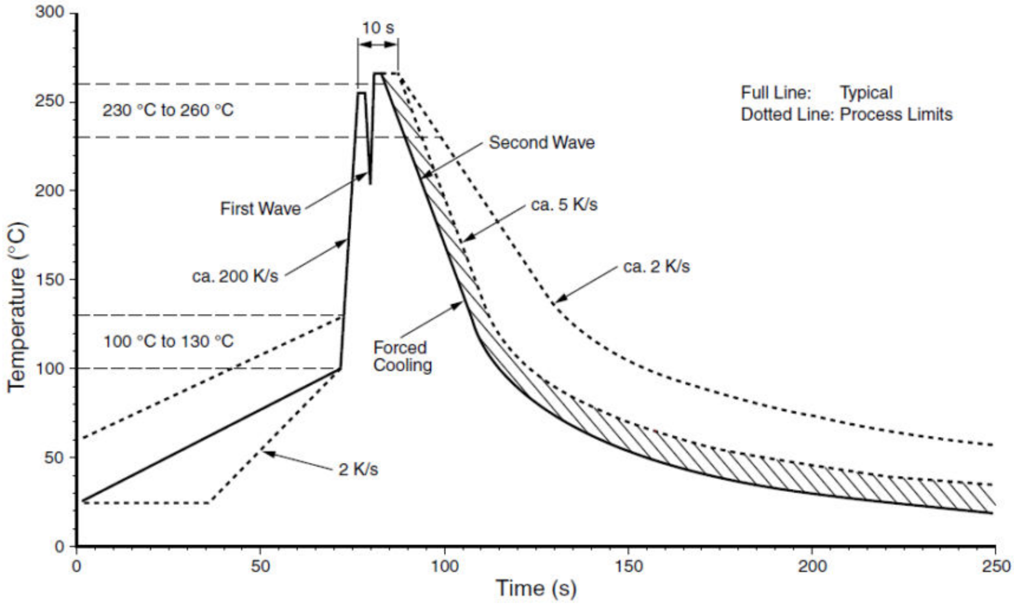
Dual-wave soldering is the most commonly used wave-soldering method (see Figure 8. Typical dual-wave soldering profile). The peak temperatures, ramp rates, and times that are used depend on the materials and the wave-soldering equipment.

The first wave has a turbulent flow and therefore guarantees a wetting of nearly all shapes of leads and board pads, but also creates an increased number of unwanted solder bridges. These solder bridges have to be removed by the second, laminar wave.

When using lead-free solder alloys, a nitrogen atmosphere is recommended.

Selective wave soldering is used when only a few THD packages have to be soldered onto the board. Generally this is done after the other components are already soldered by reflow soldering. This requires effective protection of these components undergoing the selective wave soldering. This protection can be achieved either by using special fixtures and deflectors for the PCB or/ and a small wave shape achieved by using special wave-guiding tubes or covers.

Figure 8. **Typical dual-wave soldering profile**



3.2 Other soldering techniques

Beside wave and reflow soldering, other techniques are used in special applications. Examples include selective wave soldering, laser welding and laser soldering, hot bar soldering, and manual soldering with solder irons and hot air guns.

For this broad group of soldering techniques, which cannot be tested for every component, some general guidelines should be followed:

- The maximum temperature of the package body and leads must not exceed the maximum allowed temperature for reflow or wave soldering.
- The maximum allowed time at high temperatures must not exceed the maximum allowed time for reflow or wave soldering.
- If heat is applied to the leads, the maximum temperatures in the package and of the package body must not exceed the maximum allowed temperatures during reflow or wave soldering.
- For details and special arrangements, please refer to the product data sheet and/or qualification report.

If long contact and heating times are unavoidable, the resulting temperatures on different leads near the package body should be measured and compared to the temperatures and duration achieved during wave or reflow soldering, which must not be exceeded.

Please ask to your local sales, quality, or application engineer to provide you the evaluation report for further information if needed.

3.3 Heat sink mounting by reflow soldering

In special applications the heat sinks of high-power THD packages can be mounted to the board by solder paste printing, pick and place, and reflow soldering. In this case, the packages undergo a reflow profile.

Note: *THD packages are qualified for wave soldering and not for reflow soldering. Therefore, reflow soldering should not be used for heat sink mounting for THD packages.*

4 Cleaning

After the soldering process, flux residues can be found around the solder joints. However, if the solder joints have to be cleaned, the cleaning method (e.g. ultrasonic, spray, or vapor cleaning) and solution have to be selected with consideration of the packages to be cleaned, the flux used (rosin-based, water-soluble, etc.), and environmental and safety aspects.

Removing/drying even of small residues of the cleaning solution should also be done very thoroughly.

5 Inspection

After component placement:

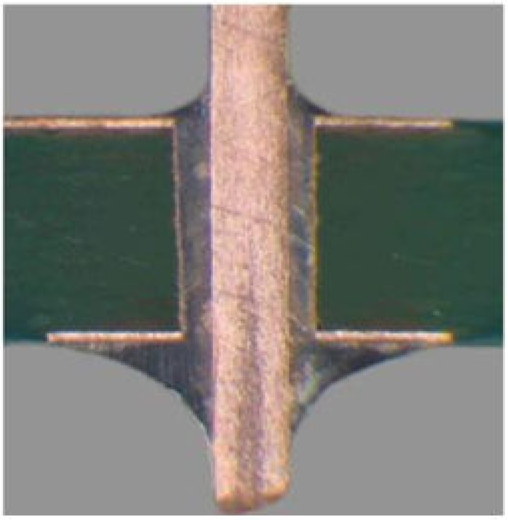
A visual inspection after component placement can be done by AOI. It is used to check if the mounting is done completely and if severe misplacements have occurred. Sometimes the correct orientation of the component can also be checked.

After soldering:

The solder joint meniscus of the leads of THD packages can be inspected by optical microscope or AOI. Acceptable solder joints are described in international standards such as IPC-A-610.

Figure 9. Example of THD package pin that is soldered into the hole is well wetted and do not show any sign of defects: shows a THD lead with optimal wetting. It has to be assured that a metallized via is filled properly. This cannot be detected by visual inspection, but can be done by x-ray and/or cross sectioning.

Figure 9. Example of THD package pin that is soldered into the hole is well wetted and do not show any sign of defects



Automatic X-ray Inspection (AXI) is the only reasonable method for efficient inline control. AXI systems are available as 2D and 3D solutions. They usually consist of an X-ray camera and the hardware and software needed for inspection, controlling, analysing, and data-transfer routines. These systems enable the user to reliably detect soldering defects such as poor soldering, bridging, voiding, and missing parts. For the acceptability of electronic assemblies, please refer also to the IPC-A-610C standard.

Cross sectioning of a soldered package as well as dye penetration analysis can serve as tools for sample monitoring only, because of their destructive character. Nonetheless, these analysis methods must be used during engineering of new products at customers' production sites to get detailed information about the solder-joint quality.

Lead-free (SnAgCu) solder joints typically do not have a bright surface. Lead-free solder joints are often dull and grainy. These surface properties are caused by the irregular solidification of the solder, as the solder alloys are not exactly eutectic .This means that SnAgCu-solders do not have a melting point but a melting range of several degrees. Although lead-free solder joints have this dull surface, this does not mean that lead-free joints are of lower quality or weak. It is therefore necessary to teach the inspection staff what these lead-free joints look like, and/or to adjust optical inspection systems to handle lead-free solder joints.

6 Rework

If a defective component is observed after board assembly, the device can be removed and replaced by a new one. Repair of single solder joints is generally possible, but requires proper tools. For example, repairing the solder joint of an exposed die pad cannot be done with a soldering iron.

Whatever rework process is applied, it is important to recognize that heating a board and components above 200 °C may result in damage. As a precaution, every board with its components has to be baked prior to rework. For details, please refer to the international standard J-STD-033.

In any case, mechanical, thermal or thermo-mechanical overstress has to be avoided, and rework has to be done according to JEDEC J-STD-033A, IPC-7711 and IPC-7721.

6.1 Device removal

If a defective component is going to be sent back to the supplier, no further defects must be caused during the removal of this component, because this may hinder the failure analysis by the supplier.

The following recommendations should be considered:

- Temperature profile: during the de-soldering process it should be assured that the package peak temperature is not higher and temperature ramps are not steeper than for the standard assembly wave process.
- Mechanics: be careful not to apply high mechanical forces for removal. Otherwise failure analysis of the package can be impossible, or PCB can be damaged. For large packages, pipettes can be used (implemented on most rework systems); for small packages, tweezers may be more practical.

6.2 Site redressing

After removing the defective component, the pads on the PCB have to be cleaned to remove solder residues. This may be done by vacuum desoldering or wick.

Don’t use steel brushes because steel residues can lead to bad solder joints. Before placing a new component, it may be necessary to apply solder paste on PCB pads by printing (special micro-stencil) or dispensing.

6.3 Reassembly and reflow

After preparing the site, the new package can be placed onto the PCB and the leads are to be inserted into the holes. Regarding placement accuracy and placement force, the process should be comparable to the (automatic) pick and place process.

During the soldering process, it should be assured that the package peak temperature is not higher and temperature ramps are not steeper than for the standard assembly process. Soldering wire can be used to resolder the leads. Use only no-clean solder paste, solder wire, and flux for repair.

7 Coating of assembled PCB's

In some applications, coatings are used to prevent damage due to external influences such as:

- Mechanical abrasion
- Vibration
- Shock
- Humidity
- Hand perspiration
- Chemicals and corrosive gases

These influences may cause:

- Electrical leakage due to humidity.

Corrosion that leads to degradation of conductor paths, solder joints, and any other metallized areas; and/or formation of electrical leakage paths. These can eventually result in electrical shorts (electrical leakage) or open contacts.

- Mechanical damage to conductor paths, solder joints, and components. This damage can lead to electrical failures.

Coatings act as electrically isolating and impervious covers that adhere well to the different PCB materials.

A wide variety of different coatings is available on the market. They differ in:

- Price
- Simple processability (spray, dip, casting, curing, etc.)
- Reparability
- Controllability
- Homogeneity

In any case, please be aware of the chemical, electrical, mechanical and thermo-mechanical interaction between the coating and the PCB and its components. Coatings can affect component reliability.

Revision history

Table 3. **Document revision history**

Date	Revision	Changes
17-Dec-2021	1	First release.
18-Aug-2023	2	Added Section 1.5 Electrical insulation: creepage and clearance .

Contents

1 Heat sink 2

1.1 Basic guidelines 2

1.2 Thermal conductive grease 4

1.3 Screw tightening torque 4

1.4 Recommended screws 5

1.5 Electrical insulation: creepage and clearance 6

2 Package handling 7

2.1 ESD protective measures 7

2.1.1 ESD protective measures in the workplace 7

2.1.2 Equipment for personal 7

2.1.3 Production installations and processing tools 7

2.2 Packing of components 7

2.3 Storage and transportation conditions 8

2.4 Handling damage and contamination 8

2.5 Component solderability 8

3 Soldering 9

3.1 Selective wave soldering 9

3.2 Other soldering techniques 10

3.3 Heat sink mounting by reflow soldering 10

4 Cleaning 11

5 Inspection 12

6 Rework 13

6.1 Device removal 13

6.2 Site redressing 13

6.3 Reassembly and reflow 13

7 Coating of assembled PCB's 14

Revision history 15

List of figures 17

List of figures

Figure 1. Device flatness specification. . . . 3
Figure 2. Heat sink flatness specification 3
Figure 3. Molding compound crack 4
Figure 4. Recommended fastening order of mounting screws. . . . 5
Figure 5. SEMS screw (size M3, spring washer 5.0Φ, plain washer 7.5Φ) 5
Figure 6. Creepage distance allowed 6
Figure 7. Clearance distance allowed 6
Figure 8. Typical dual-wave soldering profile 10
Figure 9. Example of THD package pin that is soldered into the hole is well wetted and do not show any sign of defects . 12