Mechanical Guideline for QDual3 Liquid Cool System

AND90313/D

Introduction

This application note deals with mounting instructions of QDual3 module. It includes specification of soldering, thermal interface material and mounting guide.

Picture

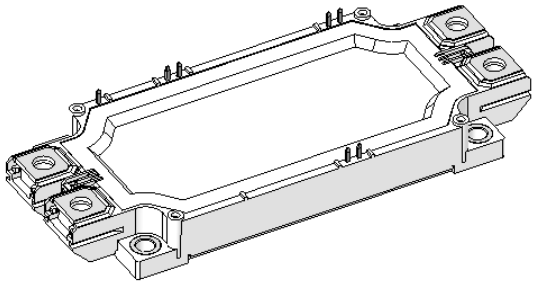


Figure 1. Package Photo

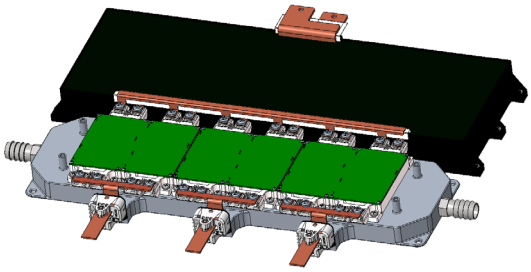


Figure 2. Liquid Cool System Modeling

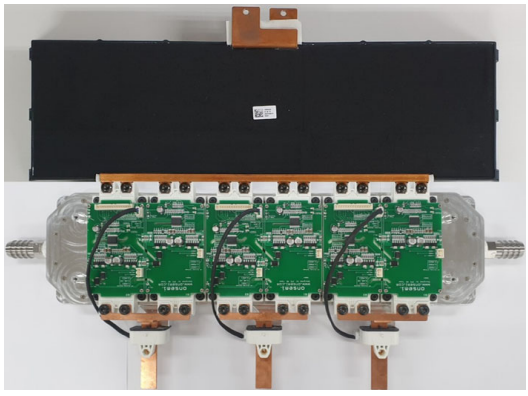


Figure 3. Liquid Cool System Reference Kit

Basic System Configuration

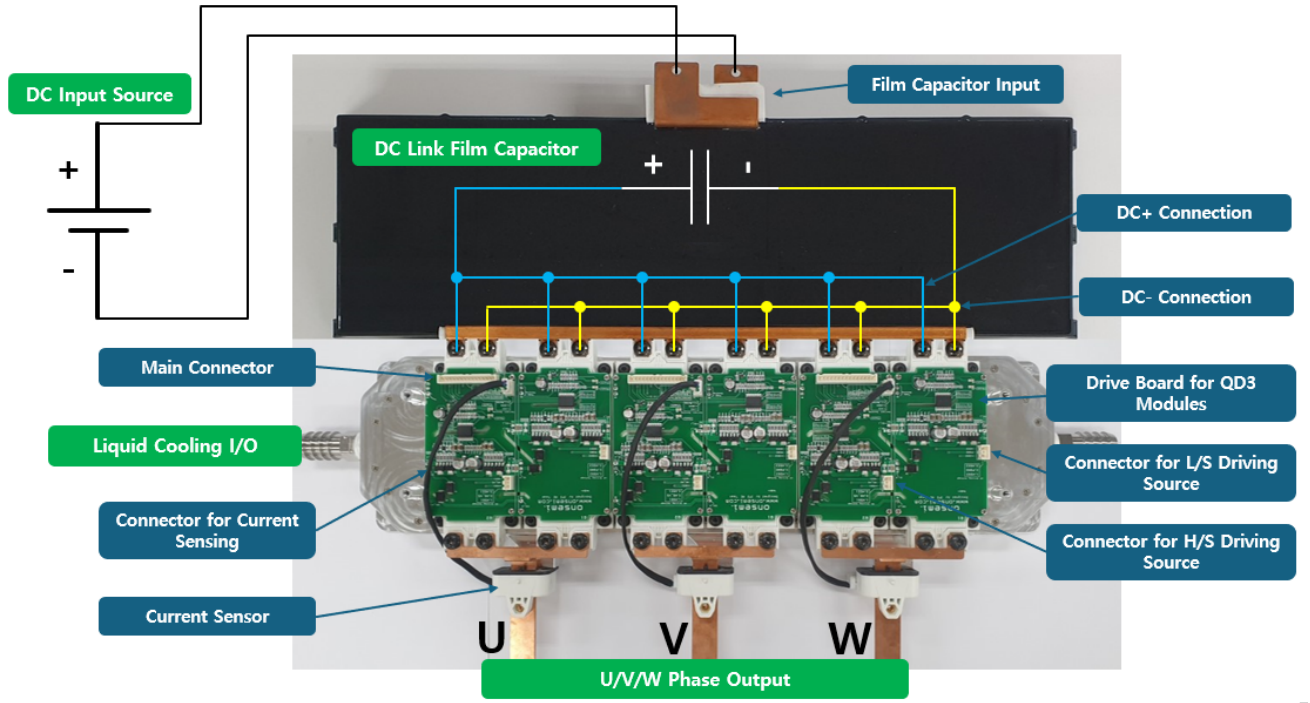


Figure 4. System Overview

Assembly Mounting Introduction

BOM & Material

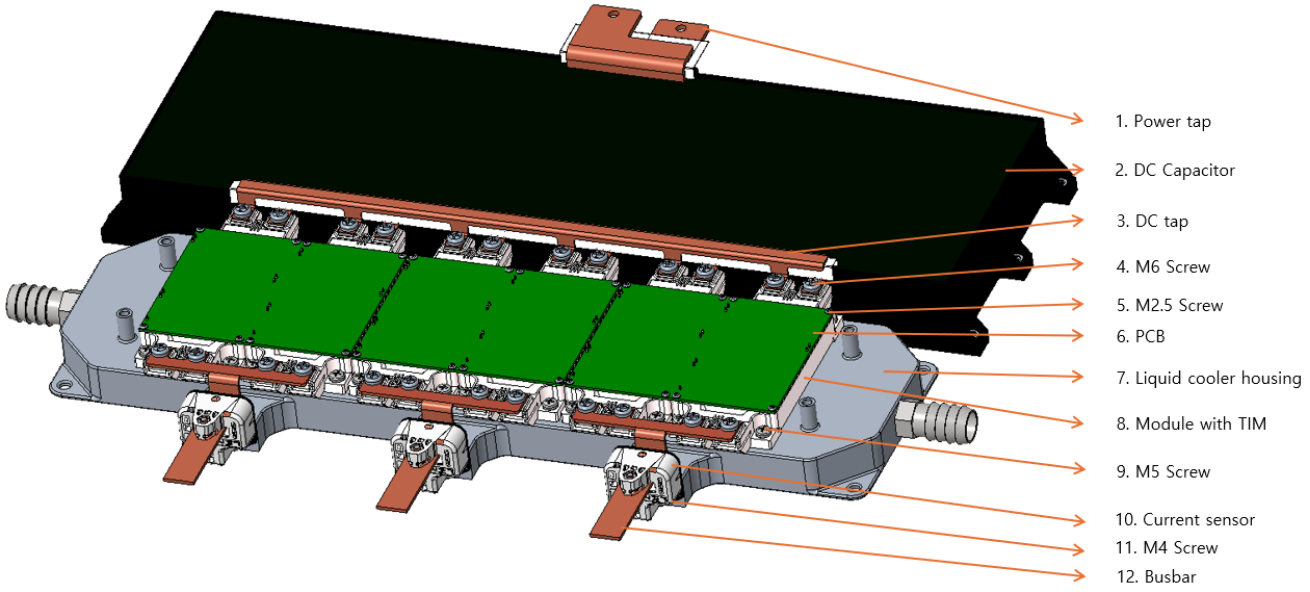


Figure 5. Assembly View

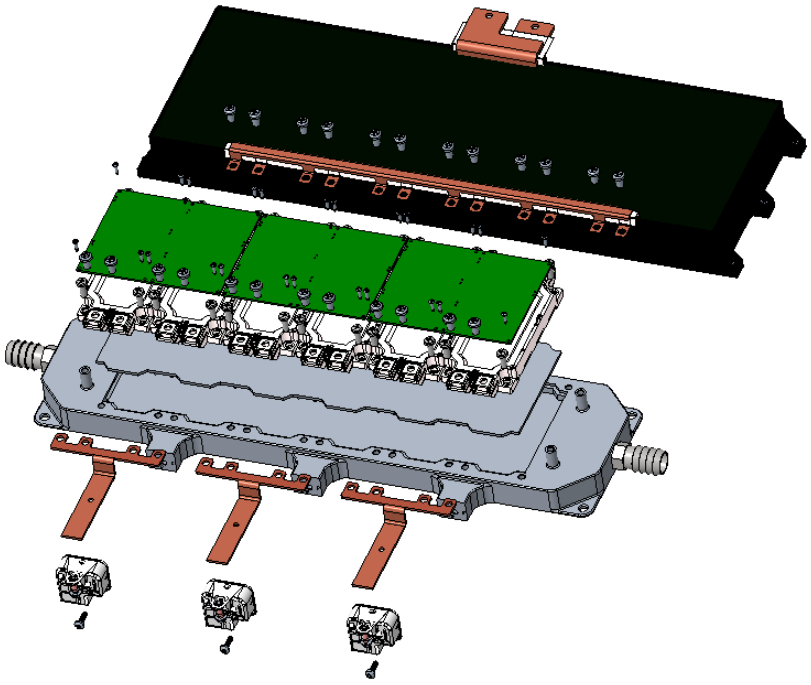


Figure 6. Exploded View

Table 1. BOM (BILL OF MATERIAL) OF SYSTEM

Part	Quantity	Remark
DC capacitor	1ea	Material : Case : PPS Power tap / DC tap : C1100(Copper)
QDual3 + TIM	6ea	TIM Material : DOWSIL TC-5121C LV TIM Thickness : 120 μm
Liquid cooler housing	1ea	Material : Housing+ Top plate : Al6062 Nozzle : SUS304(Stainless steel)
Current sensor	3ea	Vendor : LEM Part number : HAH1DRW SP5
Busbar	3ea	Material : C1100(Copper)
M6 screw	24ea	Usage : Module + DC tap / Module + Busbar Material : S1021B(Alloy steel) Metric screw
M2.5 screw	24ea	Usage : Module + PCBA Material : S1021B(Alloy steel) Self−tapping screw
M5 screw	24ea	Usage : Module + Liquid cooler housing Material : S1021B(Alloy steel) Metric screw
M4 screw	3ea	Usage : Current sensor + Liquid cooler housing Material : S1021B(Alloy steel) Metric screw

Assembly Process

Below is the recommended assembly process for **onsemi**'s liquid cooling reference kit. The production method and parameter have to be selected by user depending on each environment and conditions.

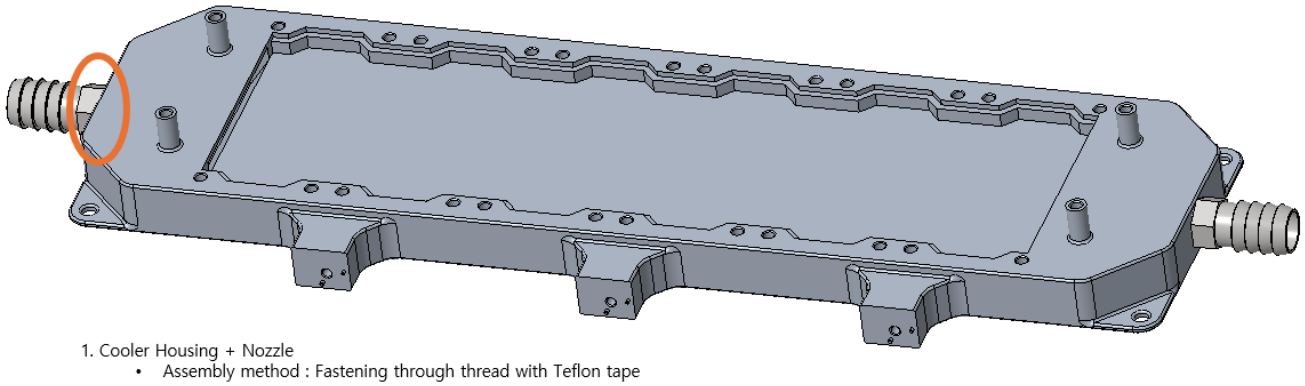


Figure 7.

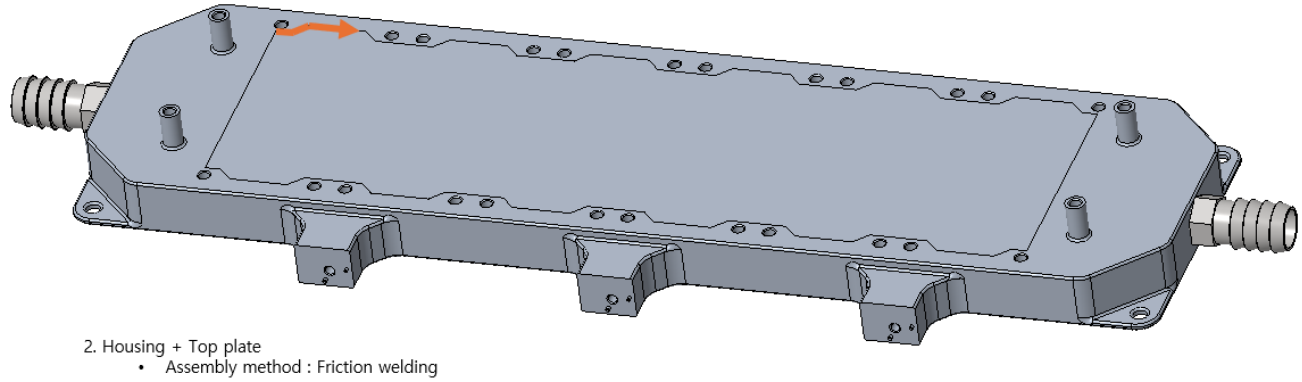


Figure 8.

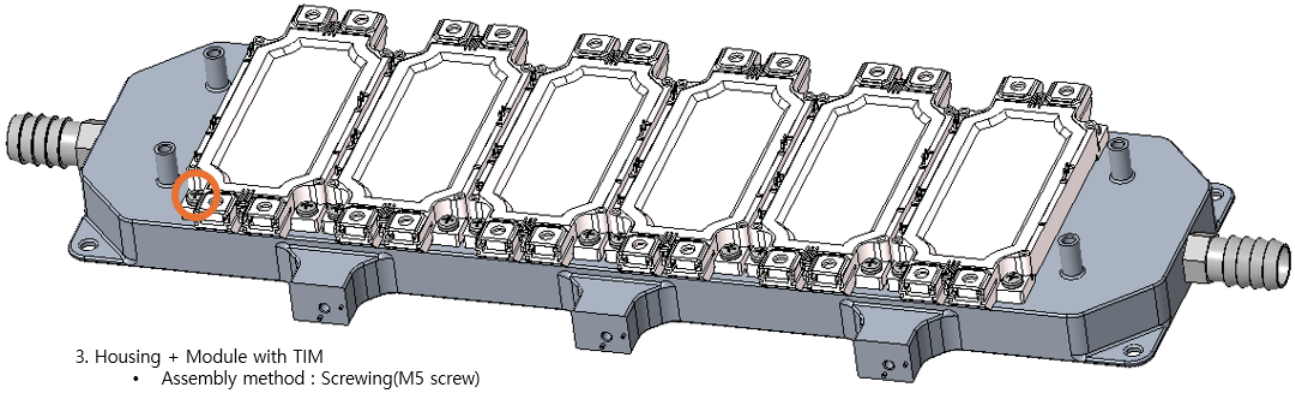
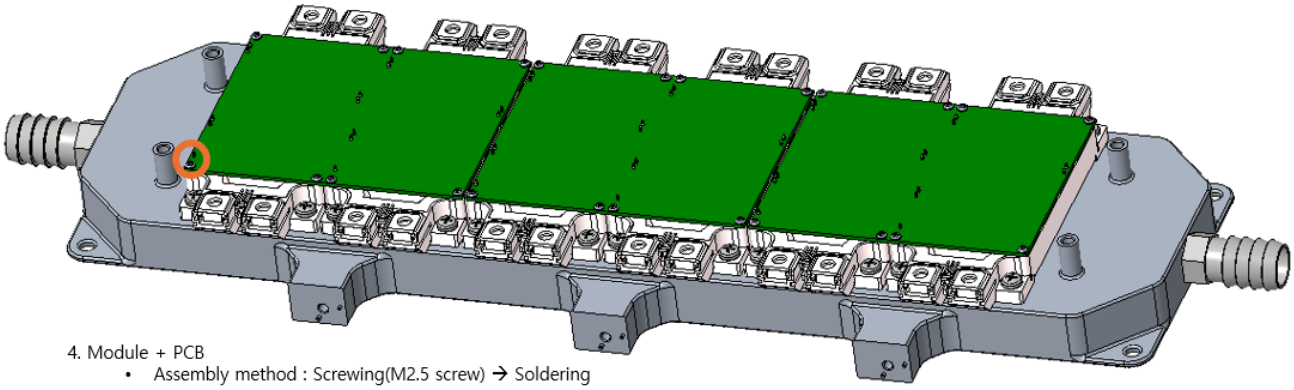
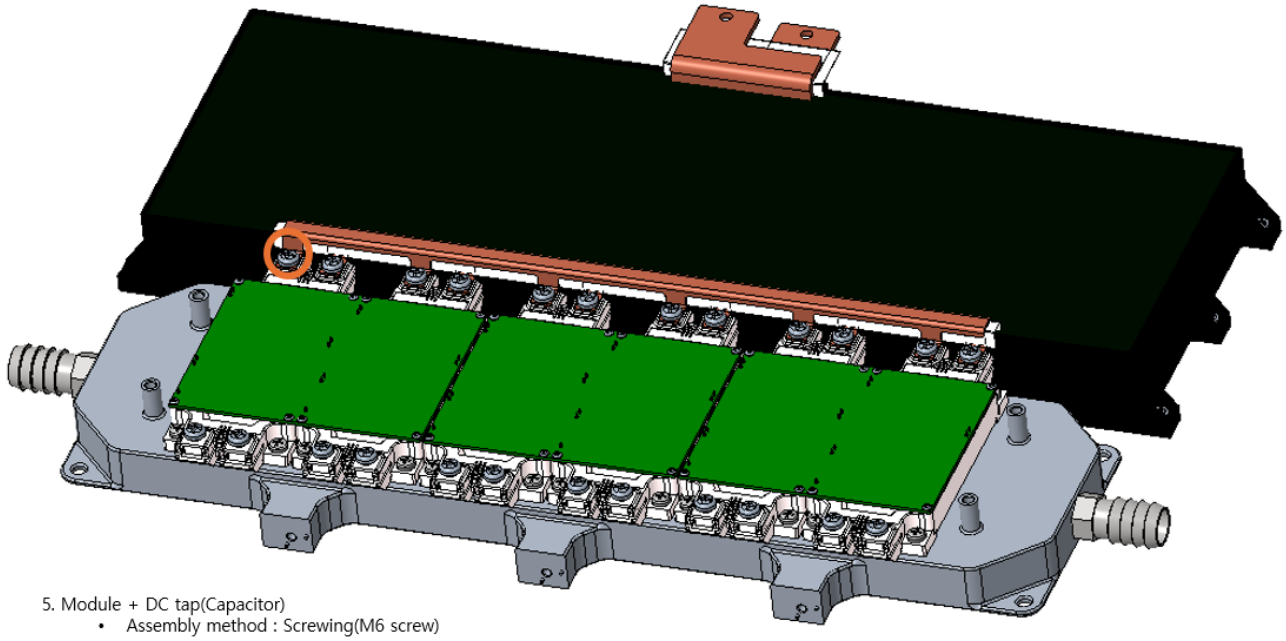


Figure 9.



4. Module + PCB
   - Assembly method : Screwing(M2.5 screw) → Soldering

Figure 10.



5. Module + DC tap(Capacitor)
   - Assembly method : Screwing(M6 screw)

Figure 11.

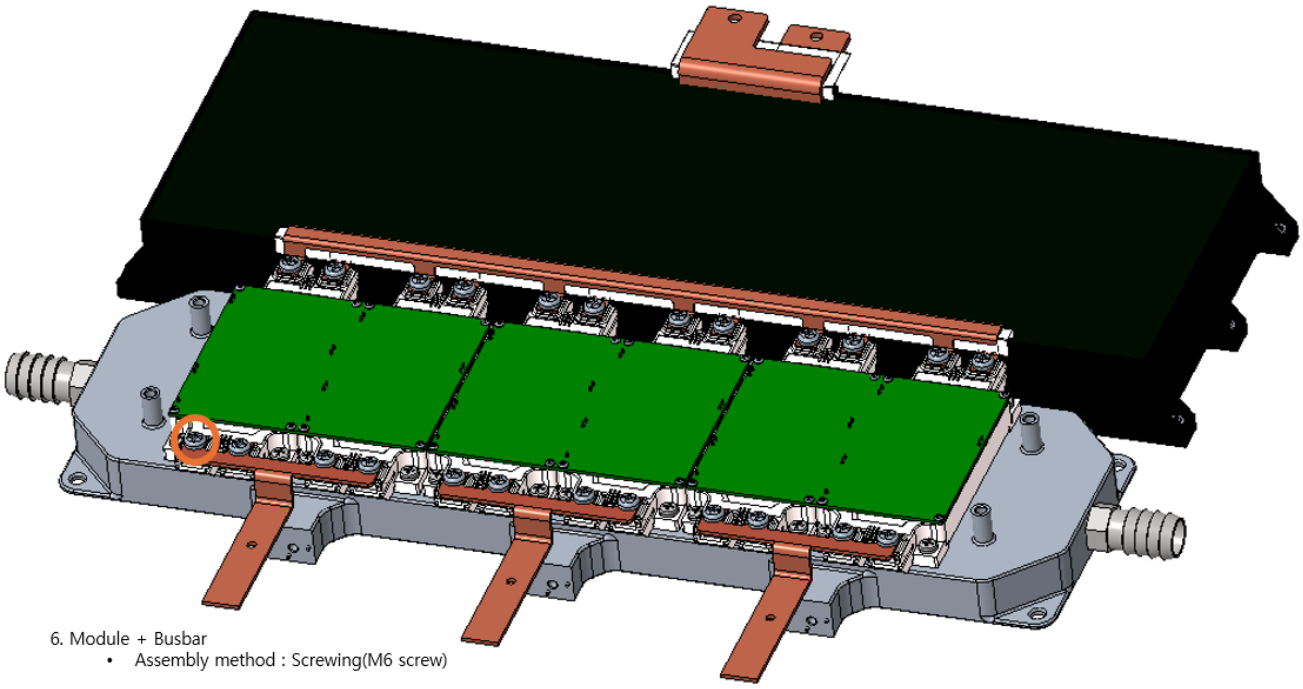


Figure 12.

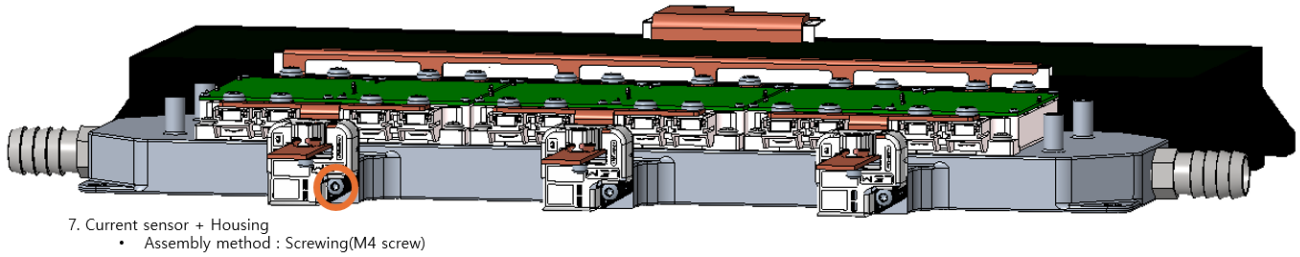


Figure 13.

Screwing Process

Below is the recommended screw clamping method. This method can be applied to all below processes which has multiple screwing process. Electric screwdrivers can tighten the screws with the specified torque. Screw holes on heatsink need to be countersunk.

Step1. Fasten all screws with pre−mounting torque according to right sequence to prevent tilting or rising of the module.

Step2. Fasten all screws again with final torque to be fully tightened with the heatsink.

<Module fixing>

- Metric screw: M5 TORX (recommended screw type DIN 7984)
  - Glue (ex. Loctite) added screw or washer added screw is recommended
  - More than 6.8 property class is recommended.
- Mounting torque range :
  - Pre mounting torque : 0.3−0.5 Nm
  - Final Mounting torque : 3.0−5.0 Nm
  - The torque range should be adjusted regarding the operation environment and production condition.
- Mounting sequence : 1 − 2 − 3 − 4
- Screw size: M5 according to DIN 6900 (ISO 10644)
- Screw thread engagement length in the heatsink ≥ 10 mm
- Screw holes on heatsink need to be countersunk. A torque wrench shall be used to tighten the mounting screws at the specified torque. Excessive torque may result in damage or degradation of the device. The inaccuracy of torque wrench tightening method can range up to ±10%. This must be considered to prevent over−tightening the fastener. Glue added screw is recommended to prevent the loosening of the screws.

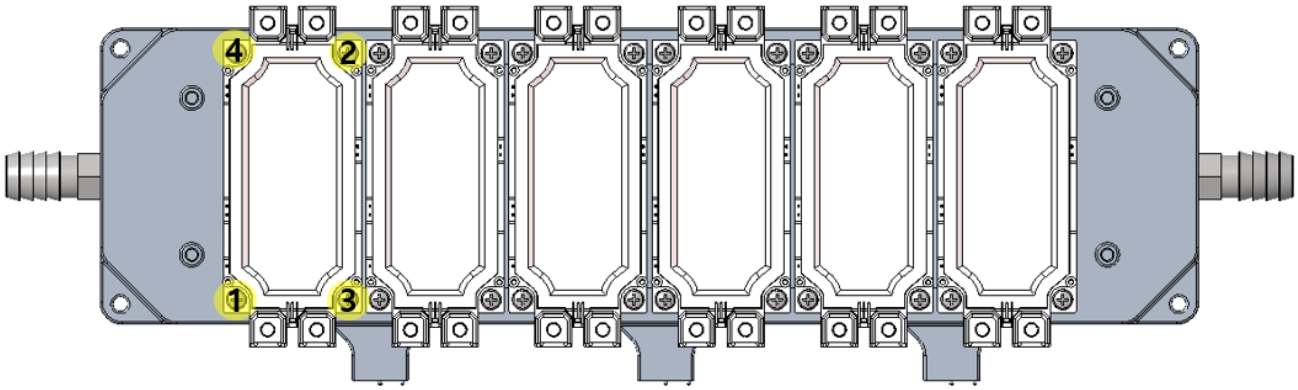


Figure 14. Sequence of M5 Screw Fixing_Module

<PCB fixing>

- Tapping screw: M2.5 TORX according to ISO 7049
  - More than 6.8 property class is recommended.
- Mounting torque range :
  - Pre mounting torque : 0.2 Nm ±10%
  - Final Mounting torque : 0.45 Nm ±10%
  - The torque range should be adjusted regarding the operation environment and production condition.
- Mounting sequence : 1 – 2 – 3 – 4 – 5 – 6 – 7 – 8
- Screw size: M2.5 according to ISO 1478
- Manual tightening is recommended than electric screwdriver to avoid the damage. A torque wrench shall be used to tighten the mounting screws at the specified torque. Excessive torque and speed may result in damage or degradation of the device. The inaccuracy of torque wrench tightening method can range up to ±10%. This must be considered to prevent over−tightening the fastener. It must be tightened in a straight line (Not tilted). After tightening need to check the damage on the product.

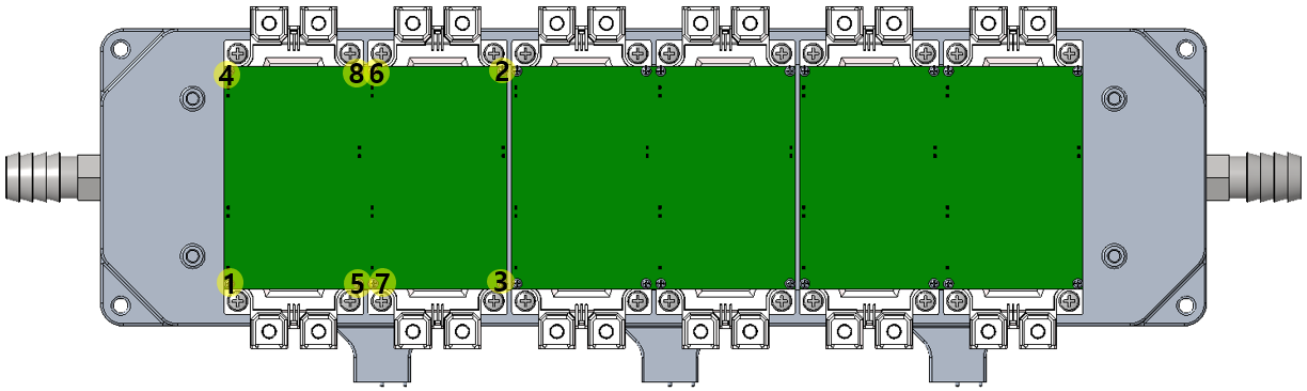


Figure 15. Sequence of M2.5 Screw Fixing_PCB

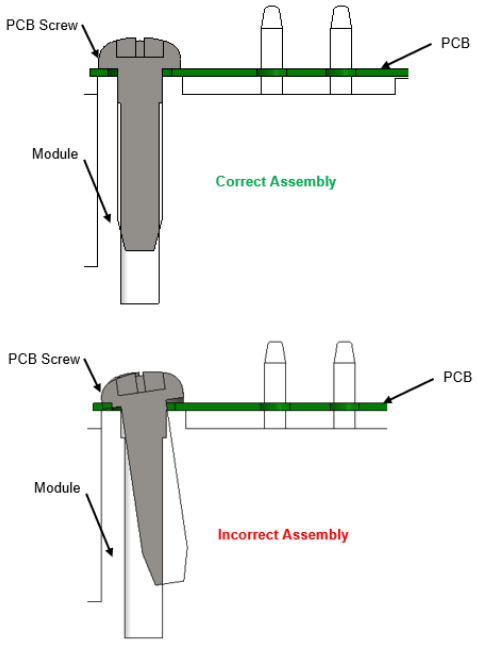


Figure 16. Section View of PCB Assembly

<DC tap / Busbar fixing>

- Metric screw: M6 TORX(recommended screw type DIN 7984)
  - Glue(ex. Loctite) added screw is recommended
  - More than 6.8 property class is recommended.
- Mounting torque range :
  - Pre mounting torque : 0.3−0.5 Nm
    - Mounting sequence : Sequentially from 1 to 24
  - Final Mounting torque : 3.0−6.0 Nm
    - Mounting sequence : 1 – 2 – 3 – 4
  - The torque range should be adjusted regarding the operation environment and production condition.
- Screw size: M6 according to DIN 6900 (ISO 10644)
- A torque wrench shall be used to tighten the mounting screws at the specified torque. Excessive torque may result in damage or degradation of the device. The inaccuracy of torque wrench tightening method can range up to ±10%. This must be considered to prevent over−tightening the fastener. Glue added screw is recommended to prevent the loosening of the screws.

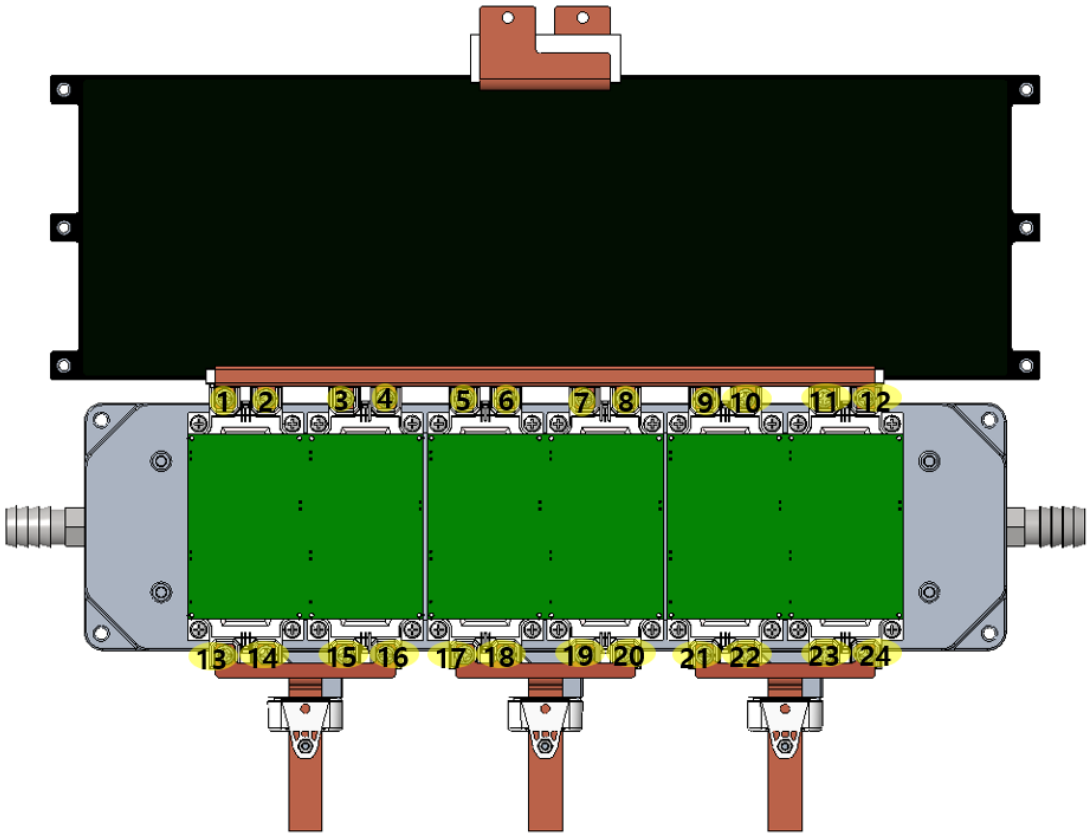


Figure 17. Sequence of M6 Screw Fixing_Pre Torque

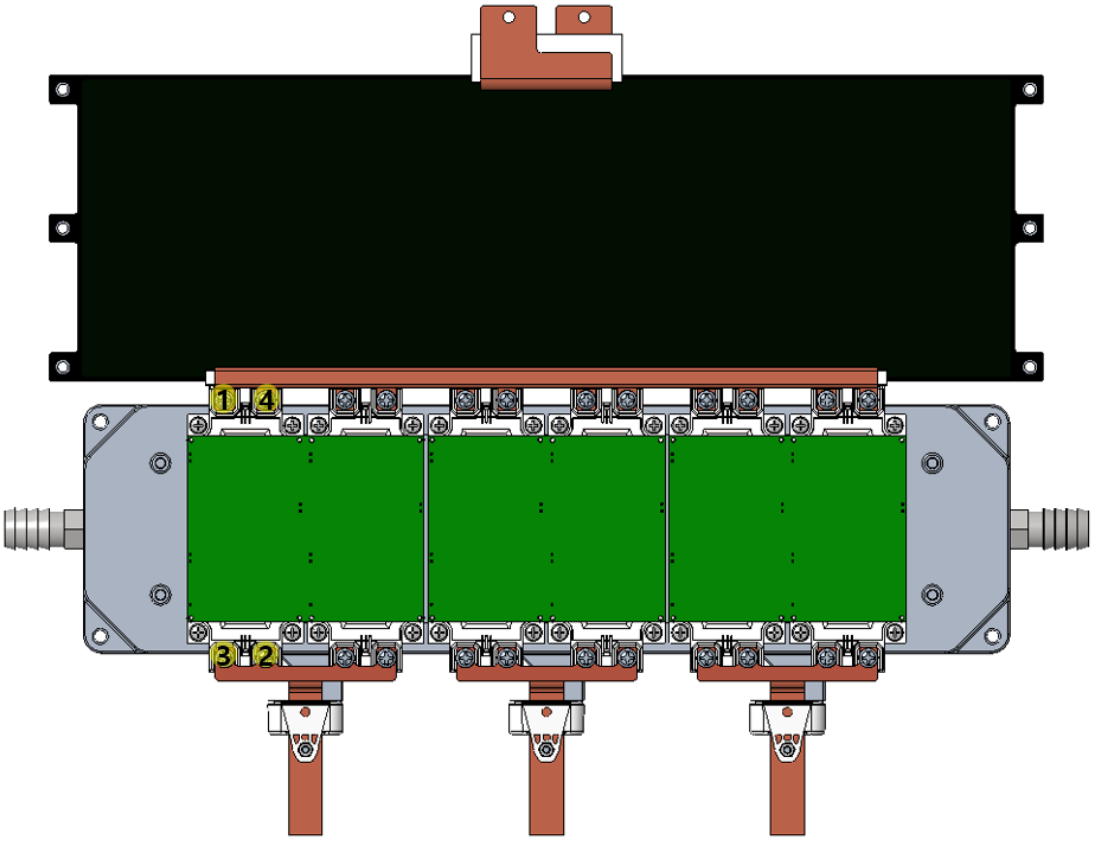


Figure 18. Sequence of M6 Screw Fixing_Final Torque

<Current sensor fixing>

- Metric screw: M4 TORX(recommended screw type DIN7984)
  - Glue(ex. Loctite) added screw or washer added screw is recommended
  - More than 6.8 property class is recommended.
- Mounting torque range :
  - Pre mounting torque : 0.3−0.5 Nm
  - Final Mounting torque : 1.5−2.0 Nm
  - The torque range should be adjusted regarding the operation environment and production condition.
- Mounting sequence : 1 – 2 – 3
- Screw size: M4 according to DIN 6900 (ISO 10644)
- Screw thread engagement length in the heatsink ≥ 10 mm
- Screw holes on heatsink need to be countersunk. A torque wrench shall be used to tighten the mounting screws at the specified torque. Excessive torque may result in damage or degradation of the device. The inaccuracy of torque wrench tightening method can range up to ±10%. This must be considered to prevent over−tightening the fastener. Glue added screw is recommended to prevent the loosening of the screws.

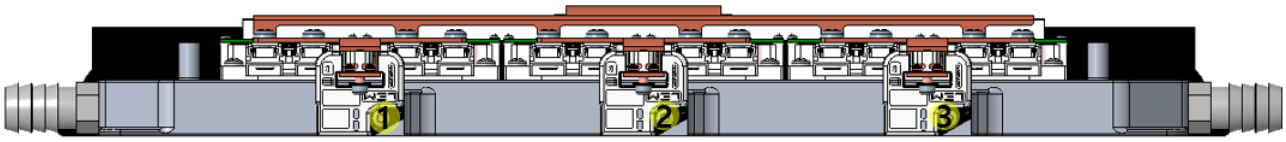


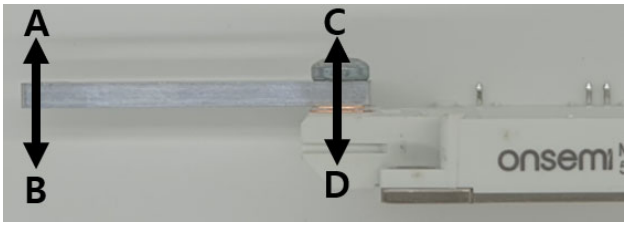
Figure 19. Sequence of M4 Screw Fixing_Current Sensor

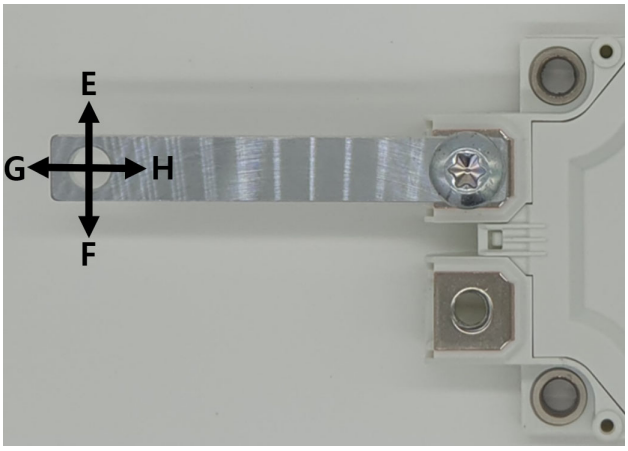
Connection of Busbar and Power Terminal

The force in below table is the maximum allowable force which can be applied to busbar. The force applied to the end of the busbar is much greater at the module main terminal because the moment of force is proportional to the length of busbar. Therefore, please do not apply more force than the values in the table. Also, you can tighten the screw after align the main terminal and busbar.

Table 2. MAXIMUM ALLOWABLE FORCE BETWEEN BUSBAR AND MAIN TERMINAL

Direction of Force	Maximum Allowable Force
A	5 Nm
B	5 Nm
C	200 Nm
D	800 Nm
E	5 Nm
F	5 Nm
G	200 Nm
H	200 Nm





Heatsink Specification

The following surface qualities are required for the heatsink to achieve a good thermal conductivity, according to DIN 4768−1. Roughness (Rz) should be 10 μm or less and flatness, based on a length of 100 mm, should be 50 μm or less. The heatsink should have no contamination, unevenness, and burrs on the surface contacting the module.

The interface surface of the heatsink must be free of particles and contamination(Surface tension min. 32 mN/m, verification with ink test). Avoid handling the heatsink surface with bare hands or contacting any foreign materials. If it is necessary to remove contamination from heatsink, cleaning can be accomplished using dry cloth soaked with solvent, such as isopropyl or ethylene alcohol.

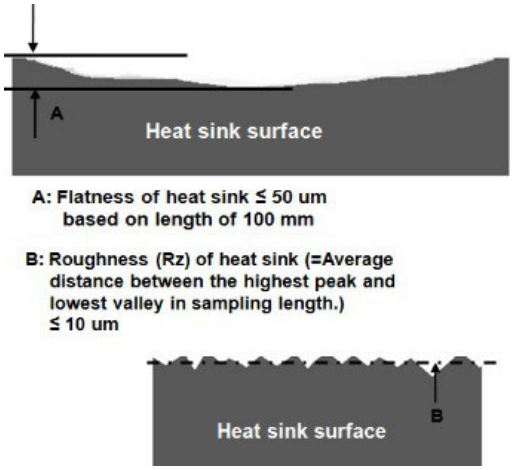


Figure 20. Heatsink Surface Specification

Thermal Interface Material

Thermal Grease

Thermal grease can be applied to the heatsink or the module substrate using a rubber roller or spatula or by screen printing. Alternatively, apply thermal paste by screen printing, for example using a honeycomb pattern. Recommended thermal paste thickness is 80−180 μm. Typical thickness of the TIM layer is 120 μm and its thermal conductivity is 2.8 W/mK. Thickness of the TIM layer more than this recommendation will unnecessarily increase thermal resistance. DOWSIL TC−5121C LV thermal conductive compound has been tested with the product.

When applying thermal grease, the material must be applied uniformly on the whole surface which is in contact to the module substrate surface. If the module is re−mounted, surfaces should be cleaned, and TIM needs be applied again.

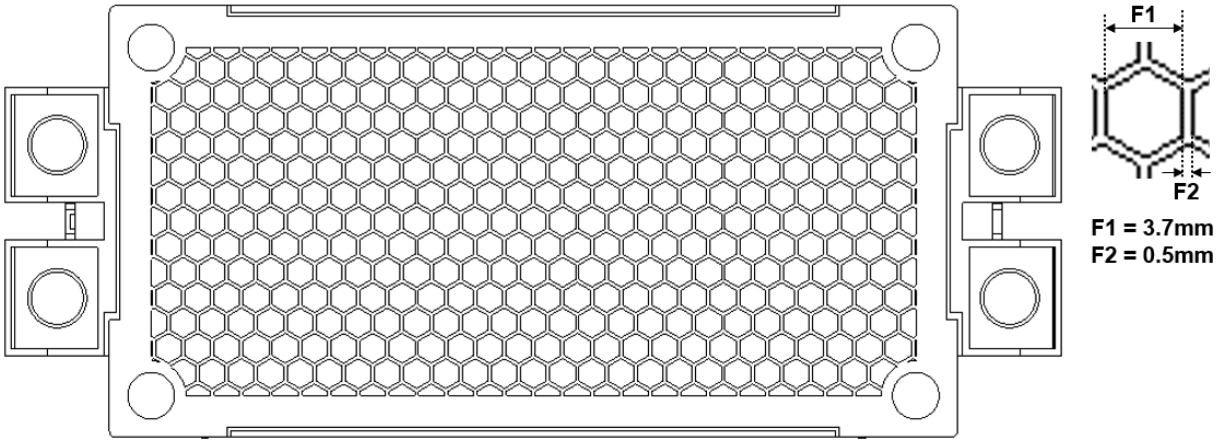


Figure 21. Screen Printing Honeycomb Pattern Example

Soldering Process

Requirement on PCB

The recommended final PCB hole diameter for solder pins is 1.95 mm by considering max lead diameter and pin position tolerance. The PCB pad diameter is determined by the minimum annular ring size, the production alignment tolerance (level A, B or C) and the drilling tolerance as detailed in IPC−2222. The effect of the pad size in reducing the creepage and clearance between pins should always be considered in minimum permissible spacing calculations. The pad diameter for level B manufacturing is 2.55 mm (1.95(hole size) + 0.1 (annular ring 0.05x2) + 0.5 (level B of IPC−2221)).

PCB holes with fully plated through−holes will enable 100% wetting and fillets between pin and both sides of PCB.

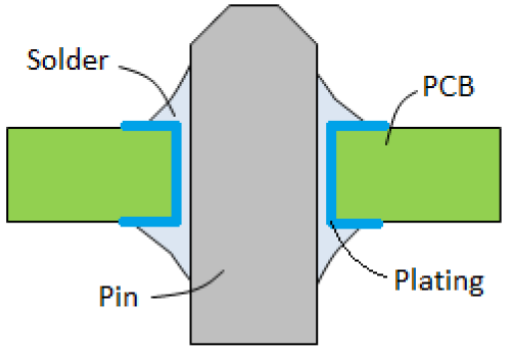


Figure 22. Solder Wetting of PCB Through Hole

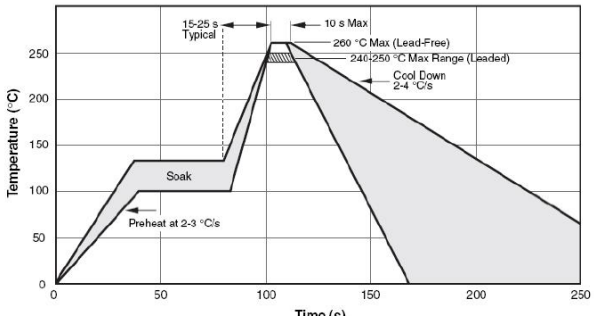


Figure 23. Wave Solder Profile

Storage and Shipping

During a transport and storage of the modules extreme thermal and mechanical shock should be avoided. The tray is designed to prevent direct contact to the module. It is recommended to open the cover carefully side−by−side to prevent mechanical damage.

Table 3 shows recommended storage conditions.

Table 3. RECOMMENDED STORAGE CONDITIONS

Storage temperatures	10 – 40 °C
Humidity condition	10 < RH < 55 %
Storage duration	Max 12 months

ADDITIONAL INFORMATION

TECHNICAL PUBLICATIONS:
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