Infineon Technologies Bipolar

34mm and 50mm Solder Bond Modules

Use and Installation Manual

Contents

1 Introduction

34mm and 50mm power semiconductor solder bond modules are electrical components.

The application conditions in which these components are used are an important aspect of a complete power electronics package design and so the mechanical design must be considered as part of the design process, along with electrical, thermal, and the resulting product lifetime requirements.

The advice and recommendations in this document cannot cover every application and operating condition. The installation and application instructions as part of the document 'Technical Information: Bipolar Semiconductor AN2012-01' are not a substitute for a detailed assessment and review for the intended application by your technical department. Therefore the application instructions do not form any contractual part of any warranty unless specifically stated in writing. The application notes are therefore under no point part of a contractual guarantee, unless the contract determines something different in writing.

2 Delivery quality

All thyristor and diode modules are tested before delivery in accordance with IEC60747-15. Therefore, an incoming inspection by the user is not necessary.

After an additional and final visual inspection, the devices are packaged in a shipping container transport container. Minor variations in the baseplate finish, in the micrometer range, are permitted within the relevant valid Infineon specification. These variations will have no impact on the thermal, electrical or reliability characteristics of the solder bond modules.

After removing the modules from the shipping container the user is directed to Section 9 of this document for further handling instructions and information.

3 Storage and shipping of 34 mm and 50mm solder bond modules

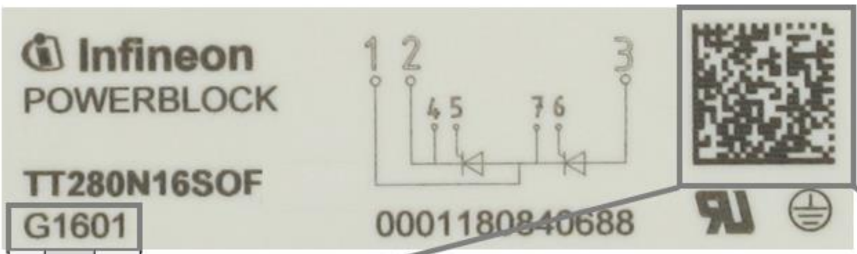
During shipping and storage of the modules, high forces caused by shock and / or vibration have to be avoided as well as extreme environmental conditions which are outside the recommended Infineon storage conditions see [1].

The storage time at the recommended storage conditions according to [1] should not be exceeded.

Pre-drying of the case prior to the assembly process, as is recommended for molded discrete components (e.g. microcontrollers, TO-cases etc.), is not necessary with 50mm solder bond modules as long as the modules have been stored as recommended.

4 Module identification, RoHS

Infineon’s 34mm and 50mm solder bond modules comply with the RoHS guidelines and are marked “G” as part of the module label. Detailed Information on the materials used is available on request from Infineon in the form of Material Data Sheets (MDS).



designation
RoHS conform
calender year e.g year 2016
calender week e.g. week 1 in …

content	digit quantity	position
type designation	18 alphanumeric digits	1 - 18
serial number	5 numeric digits	19 - 23
internal production order number	8 numeric digits	24 -31
material number	10 numeric digits	32 - 41
date code (YY/WW)	4 numeric digits	42 - 45
add on for date code	1 alphanumeric digit	46

5 Module selection

34mm and 50mm solder bond modules are available in various configurations, voltage and current classes. A complete product range overview as well as a selection and simulation tool (IPOSIM) are available at **www.infineon.com**.

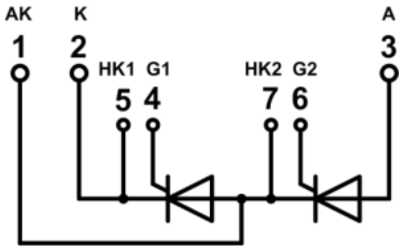
The maximum values shown in the product data sheets and application notes are definitely a limit and must not be exceeded – not even for a short time. Any exceedance of maximum values may pre-damage or destroy the components. Additional information can be found in the application notes [2].

When selecting the most appropriate device for a given application, there are a number of factors to be taken into account. The following overview is intended to give some initial assistance and a brief explanation.

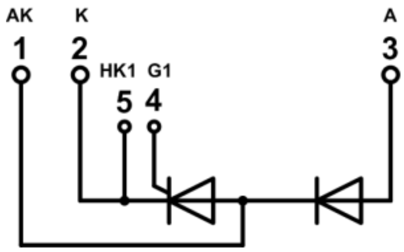
Module Configurations:

34mm modules

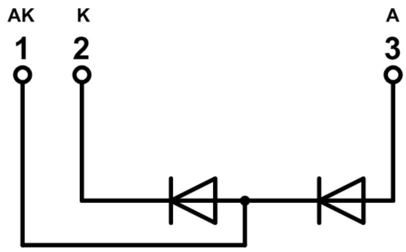
TT (Thyristor – Thyristor)



TD (Thyristor – Diode)

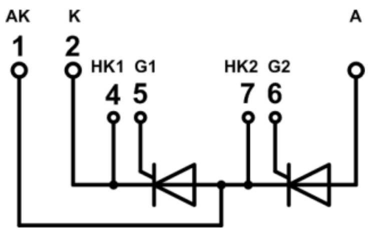


DD (Diode – Diode)

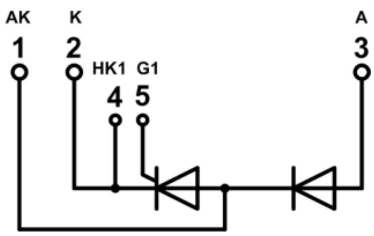


50mm modules

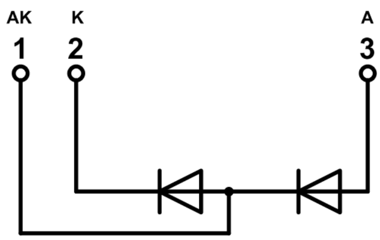
TT (Thyristor – Thyristor)

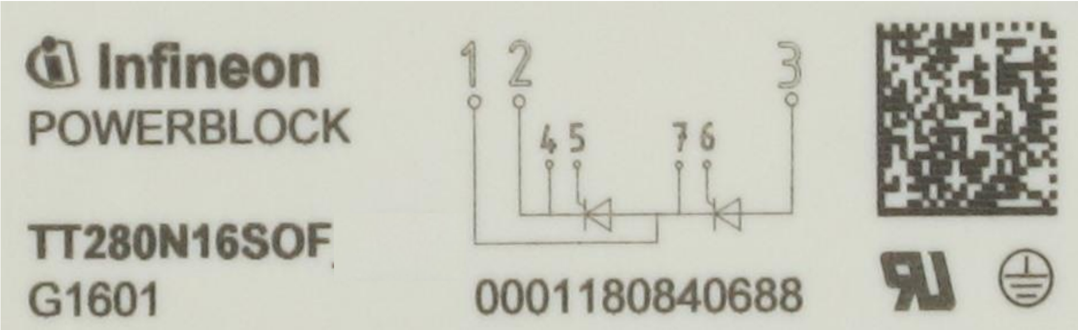


TD (Thyristor – Diode)



DD (Diode – Diode)





TT 280 N 16 S O F

	explanation
TT DD TD	with 2 thyristors with 2 diodes with 1 thyristor or 1 diode
280	average on-state current [A] at T_C = 85°C (thyristors) 100°C (diodes) (type current)
N	phase control device
16	repetitive peak off-state and reverse voltage in 100V
S	technology: solder contact
O	no guaranteed turn-off time (N - thyristors)
F	1000V/µs critical rate of rise of off-state voltage (du/dt)

6 Selecting module voltage class and operation of modules at high altitudes

See [2]

7 Climatic conditions in active, current conducting operation of 34mm and 50mm solder bond modules

34mm and 50mm solder bond modules are not hermetically sealed. The housing and the resin used for electrical insulation inside the housing are permeable to humidity and gases in both directions. Therefore any humidity differences between the external and internal environment will be equalized.

In active current conducting operation, Infineon's 34mm and 50mm solder bond modules are specified in accordance with the climatic conditions in EN60721-3-3, and with the classification of environmental conditions for fixed intallations use according to class 3K3.

The effects of moisture on the modules, for example by condensation or a combination of condensation and climatic conditions, which exceed class 3K3 of EN60721-3-3, must be avoided in every application by additional protection if necessary.

Harmful gases during storage and operation should be avoided at all times.

8 Module creepage and clearance distances

When calculating the isolation requirements, all application-specific standards, particularly regarding clearance and creepage distances must be taken into consideration.

The module-specific drawings can be obtained from the data sheet or can be obtained in electronic form as 3D CAD files from your Infineon sales partner.

In particular, with the selection of the bolts and washers, clearance and creepage distances must be considered. Please consider the notes in [2].

The creepage and clearance distances stated in the data sheets specify the shortest creepage and clearance distances for a bare module without any external connections, for pollution degree 2 in accordance with IEC60664-1. The table below shows an overview of the various clearances and creepage distances.

Description	Values (mm)	Path
Creepage 1	31	AK-GND
Creepage 2	53	K-GND
Creepage 3	28	K-A
Creepage 4	16.5	A-Plug
Creepage 5	44	Plug-GND
Clearance distance 6	16.5	K-A
Clearance distance 7	21	M8 - GND

Table 1: Clearance and creepage distances – 50mm solder bond module

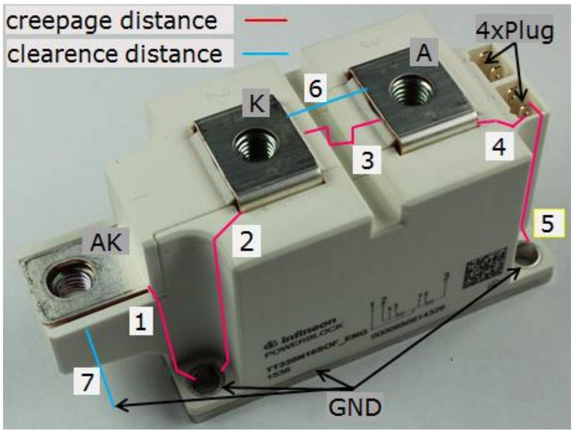


Figure 4.1: Shortest creepage and clearance distances for a bare 50mm solder bond module without any external connections.

In any case, creepage and clearance distances are to be checked and met according to the relevant application specific standards – if necessary, by adding additional isolation barriers.

Module creepage and clearance distances

Description	Values (mm)	Path
Creepage 1	25	AK-GND
Creepage 2	15	K-A, AK-K
Creepage 3	10,2	A-Plug
Clearance distance 4	10	K-A, AK-K

Table 2: Clearance and creepage distance – 34mm solder bond module

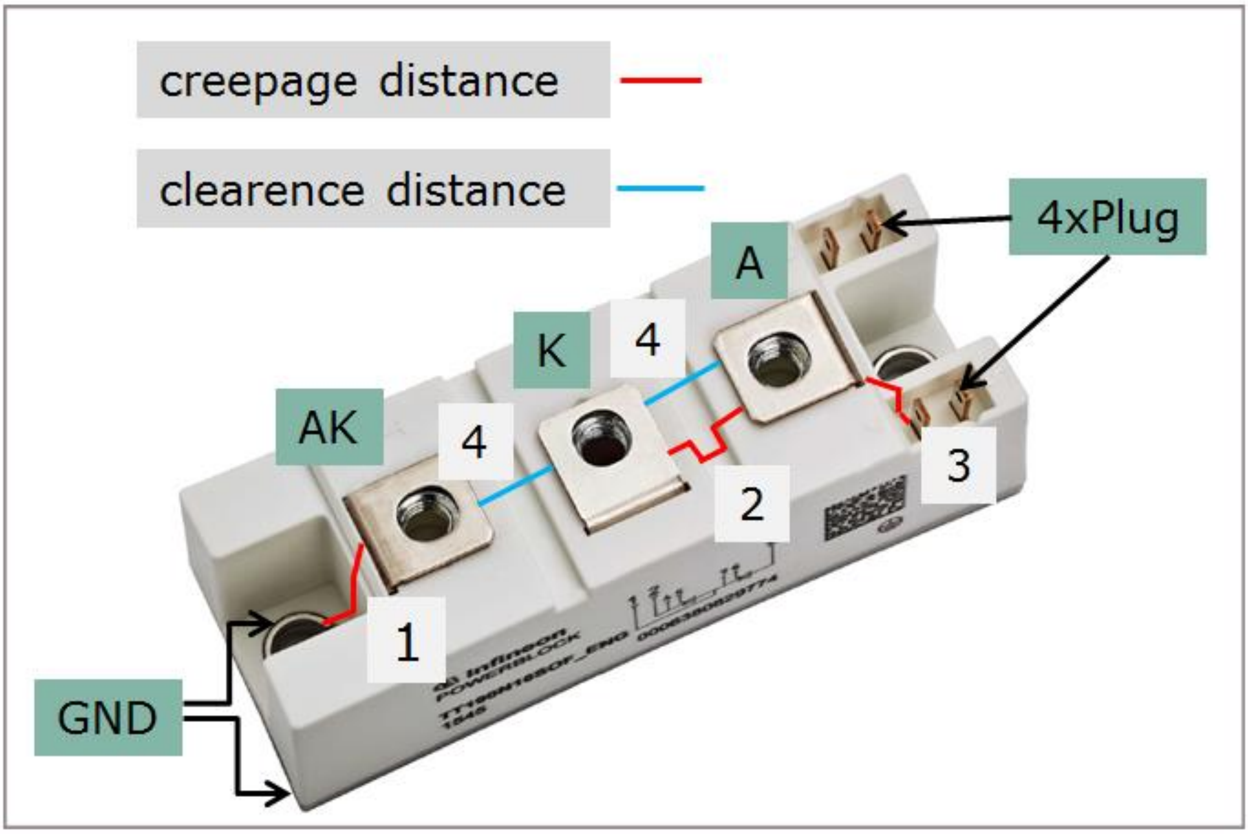


Figure 4.2: Shortest creepage and clearance distances for a bare 34mm solder bond module without any external connections.

9 Module assembly and mounting to a heatsink

9.1 Heatsink properties for module assembly

The heat generated in the module through power dissipation must be removed by a suitable heatsink, such that the junction temperature limit (T_{VJM}) specified in the datasheet is not exceeded during operation – see [2]. The conditon of the heatsink surface during module assembly is very important as this interface (between the heatsink and module) has a large impact on the thermal conductivity and distribution of the power loss.

The condition of the contact surface of the heatsink to each module must not exceed the following values otherwise uneven heat spreading and dissipation can lead to partial overheating of the semiconductors.

34mm solder bond module with baseplate 34mm x 94mm and
50mm solder bond module with baseplate 50mm x 92mm

- surface flatness ≤10µm over 100mm length
- surface roughness (R_Z) ≤10µm

The contact surfaces including the baseplate of the module and the surface of the heatsink must be free from damage and contamination which will reduce the thermal contact at the interface of the module and heatsink. Before module assembly, it is recommended to clean all the surfaces with a clean, lint-free, cloth.

For assembly and subsequent transport, the heatsink must be sufficiently stiff so as to exert no additional mechanical stress on the module baseplate. During the entire assembly process, the heatsink must be handled in such a way as to eliminate twisting or torsional forces, e.g. on a suitable carrier jig.

9.2 Thermal grease

Each module and heatsink will have slightly a different surface flatness and shape. Therefore, gaps between the two parts cannot be avoided. In order to ensure a good heat flow from the module to the heatsink a suitable heat conducting material, such as thermal grease, must be used to fill in the majority of the air gaps that exist between the two surfaces.

The thermally conductive material should be qualified by the user to be stable and to hold a consistent thermal resistance value over the life of the product under the real world application conditions. If the thermal properties of the material degrade over time there is a risk of overheating the semiconductors so reducing the module's lifetime. The grease should be applied in a manner around the mounting holes so as not to be transferred to the threads of the mounting screws as this can affect the mounting screw torque levels.

9.3 Thermal Interface Material (TIM) from Infineon

For long-term stability, Infineon has developed a phase change material (TIM) with excellent thermal properties for power semiconductor modules.
50mm solder bond modules from Infineon are available with TIM with a preapplied, optimized pattern - this can be ordered from your Infineon sales partner. These modules are marked with the type designation suffix 'TIM' – more information is available in [3].

Example of printed pattern on the module baseplate after application of TIM:

Figure 5: Module printed with TIM (Thermal Interface Material)

When using 50mm modules with TIM, please continue directly to section 9.6.

9.4 Application of standard thermal grease and the stencil printing process

When using 34mm and 50mm solder bond modules on which Infineon's TIM is NOT applied by the manufacturer, the thermal grease should be qualified by the user to be stable and to hold a consistent thermal resistance value over the life of the product under real world application conditions.

To achieve an optimal result, the module, the pattern of the applied thermal grease, the heatsink contact surface and the applied material should be considered as single heat transfer path.

Manual application of thermal paste with a layer thickness in the micrometer range can be challenging as a well-applied layer should fill all the voids and, at the same time, ensures a good metal to metal contact between the baseplate and heatsink surface. It is therefore recommended to apply the thermal grease with a stencil printing process. With this method it is possible to adjust the layer thickness and distribution to get a reproducible layer with a well defined thickness. It also matches the distribution of the thermal grease to the shape and geometry of the base plate assuring that grease is only placed where it is needed.

For further instructions on the use of screen printing stencils and the application of thermal paste please see the relevant application notes [4].

Module-specific drawings for the thermal paste stencil can be obtained from your Infineon sales partner.

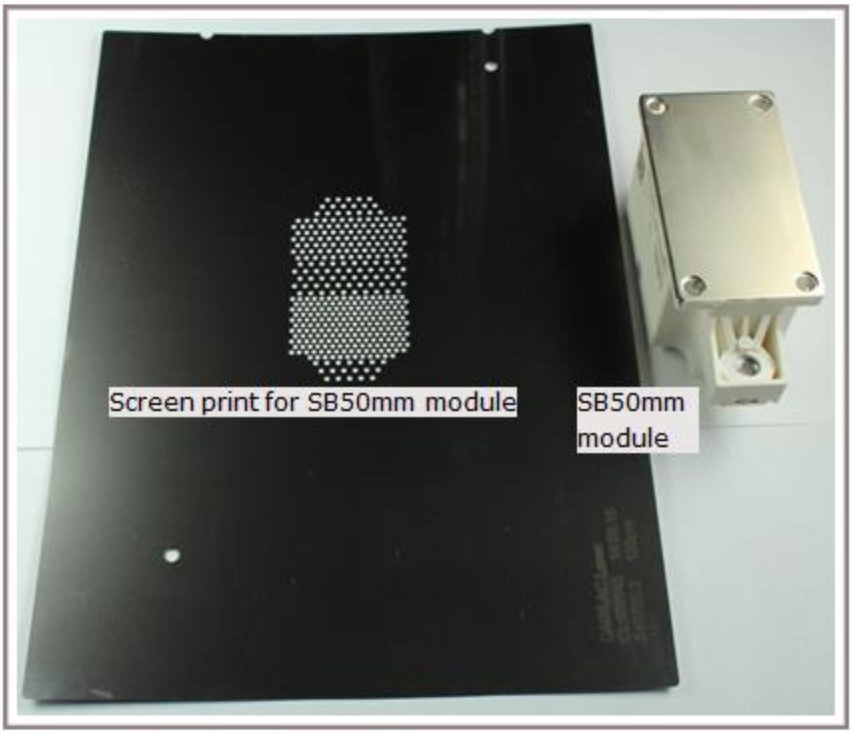


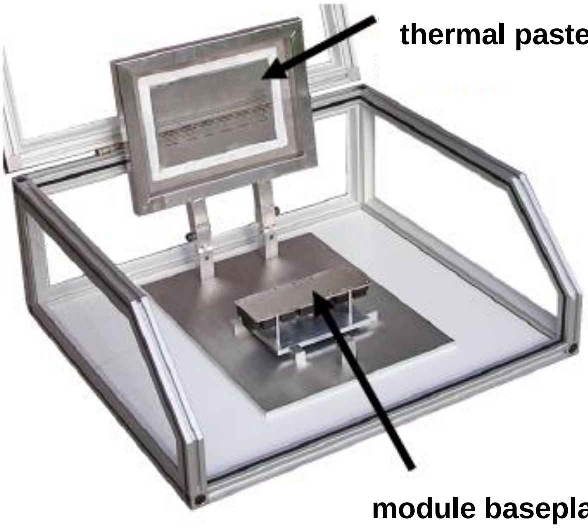
Figure 6: Template for 50mm solder bond module

Module assembly and mounting to a heatsink

The screen printing process has to be stable in order to deliver a reproducible thermal grease layer. One method to ensure this is to use an application fixture or jig as shown in Figure 7.

A. Thermal Paste Device

B. Application of the thermal paste



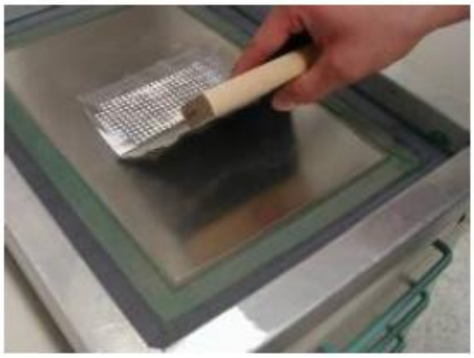


Figure 7A: Application fixture/jig to apply thermal paste in a screen printing process.
7B: Application of thermal grease using a stencil

Procedure for applying thermal paste:

1. Clean the stencil of any possible thermal grease residue. This step can be carried out with suitable solvents like isopropanol or ethyl alcohol. Observe the safety regulations when handling these materials.
2. Align stencil and module. Perhaps with a fixture/jig holding the module as shown in Figure .
3. Lower the stencil onto the module base plate.
4. Apply the thermal grease over the stencil. It is imperative that all stencil holes are filled properly.
5. Lift the stencil and remove the module.
6. Visual inspection after application of the thermal grease ensures that every point of the screen is filled. The application of the thermal grease using a screen, especially when performed manually, can be affected by a poor alignment of the stencil causing small variations in the amount of thermal grease, and thus increase the expected module temperature by a few degrees.
7. Therefore the measurement of the thickness of the deposited thermal grease is strongly recommended which will ensure that an adequate amount of thermal grease was applied.
8. When applying the thermal grease with the aid of a tool on the stencil, the possible wear of the stencil and the resulting reduction in the layer thickness needs to be periodically checked. Stencils are to be replaced if they no longer have the predetermined thickness.

9.5 Alternative procedures for the application of standard thermal grease

Alternatively, thermal paste can be applied manually - a homogenous layer of 50µm on the module baseplate is typically sufficient.

The manual application of such a thin layer by using rollers or toothed spatulas is problematic. Homogeneity and reproducibility of the thermal grease thickness is always questionable. A verification of the thermal grease layer thickness can be done by a wet film comb as shown in figure 8.

Place the comb perpendicular to the surface of the heat sink and scrape the comb slowly over it through the thermal grease layer. Wet film combs have teeth of various lengths on their sides. The paste thickness lies between the biggest value of the "coated" or "wet" tooth and the smallest value of the "uncoated" or "dry" tooth.

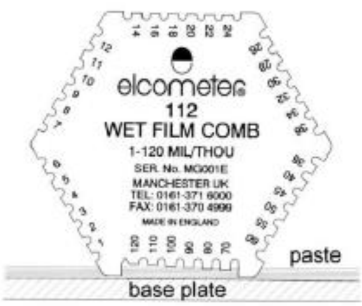


Figure 8: Using a wet film comb to measure the thickness of thermal grease

9.6 Mounting the module to the heatsink

The module assembly must comply with the tolerances specified in the module data sheets. The outline drawing of each module is shown in the data sheet or can be obtained electronically as a 3D CAD file from your Infineon module sales partner. The specified torques and processing instructions listed here are applicable to modules with either pre-applied TIM or user applied thermal grease.

Attaching the module to the heatsink using screws has to be done so that forces on all the components are within specified limits so as not to exceed the mechanical yield point. The use of lock washers will increase the elasticity of the screw connection and thus compensate for any effects of relaxation and temperature cycling. This will ensure that the pre-tension force will be retained, and prevent the loosening of screws over time.
The tightening torque must be selected so that the preload force applied leads to a purely frictional connection between the components. To accurately determine the preload force and the tightening torque, one must know the friction constant. The friction depends on many factors such as material combination, surfaces, lubrication, temperature etc. A typical interface of an aluminum heatsink with a galvanized M5 steel screw results in a friction coefficient of about 0.14. Any changes of the friction coefficient within the mechanical design will require an adjustment of the tightening torque.

As a target value, the screws should be tightened near to the recommended maximum torque M_{MAX}. However, this maximum torque must not be exceeded.

Description	Values	Comments
Mounting Screw	M5 (50mm), M6 (34mm)	**1.)**
Maximum recommended tightening torque	M_{max}= 5Nm +/-15%	**2.)**
Recommended strength class of the screw	8.8	**3.)**
Minimum screw depth into the heatsink	1.6 x d = 8.0mm (50mm) 1.6 x d = 9.6mm (34mm)	**4.)**

Comments:

1.) According to ISO4762, DIN6912, DIN7984 in combination with a suitable washer e.g. compliant with DIN433 or DIN125 and a lock washer as screw retention or alternatively a complete combination screw compliant to DIN6900 with a lock washer as screw retention is recommended for mounting the module.

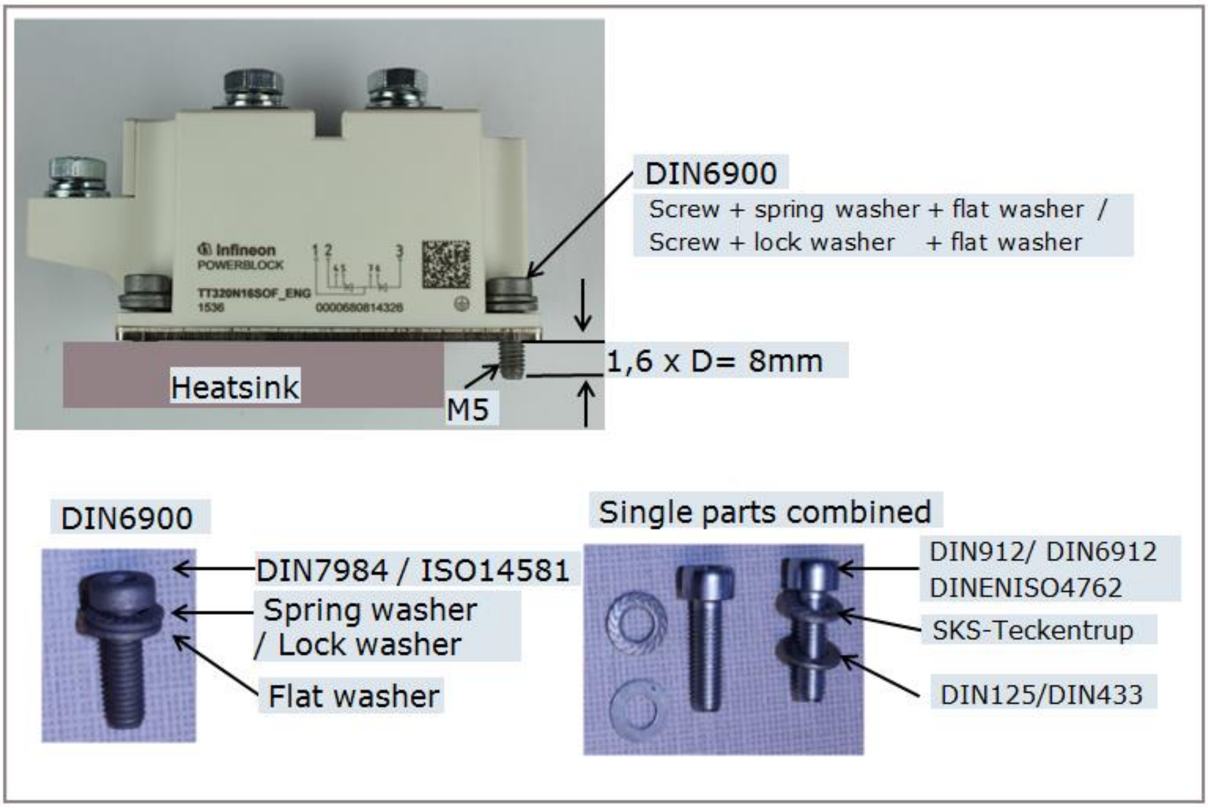


Figure 9.1 for comment 1.) Module installation and screw 50mm solder bond module

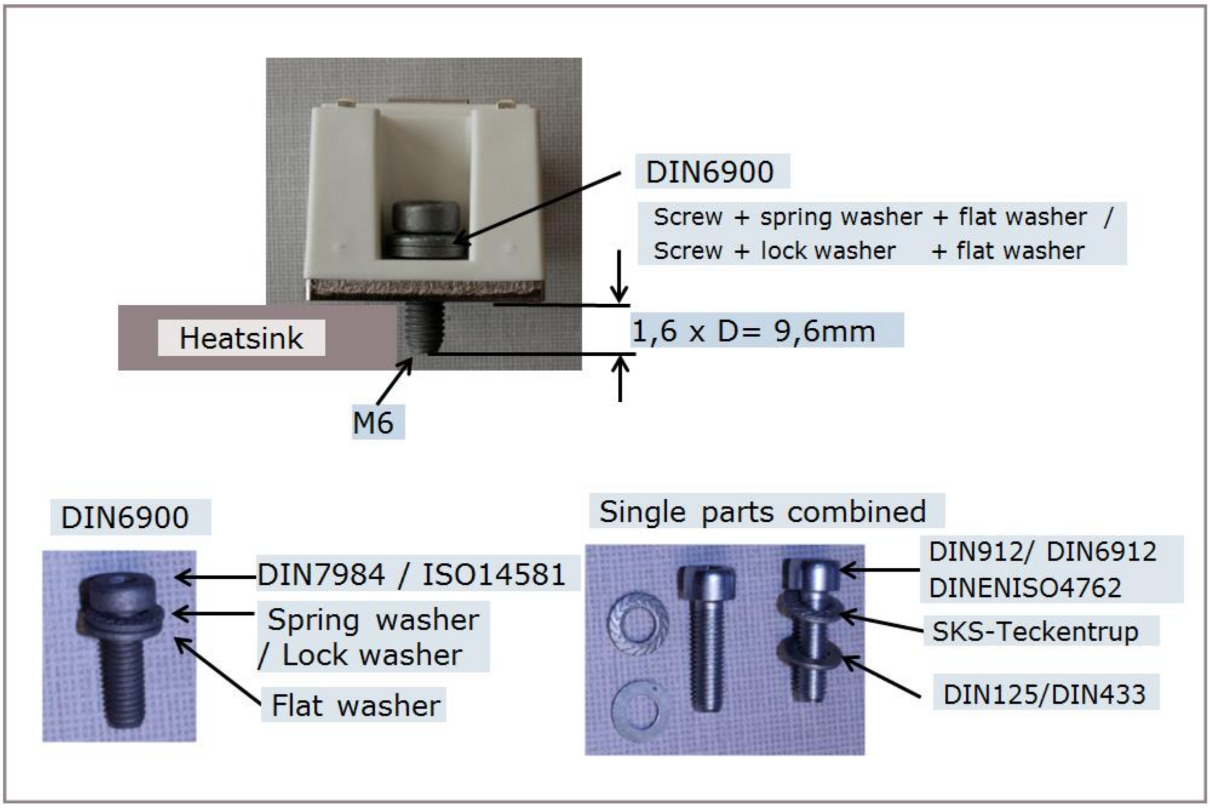


Figure 9.2 for comment 1.) Module installation and screw 34mm solder bond module

2.) Determined for a friction coefficient of 0.14 (screw clean and dry, aluminum heatsink, screw to ISO14581, galvanised, thread rolled). The torque used should be based on the maximum torque.

3.) Minimum of 6.8

4.) In aluminum, according to literature

Other combinations of screw and/or heatsink material may require an adjustment of the mechanical values and an evaluation of the potential for corrosion between the two mating materials.

The module mounting screws should be uniformly tightened crosswise with a torque within the specified limits. For optimal thermal contact of the module with the heatsink the following procedure for tightening the screws is recommended.

1. Place the module with the thermal grease on the clean heatsink and loosely fix it with two screws down to approx. half their thread length.

2. Insert the remaining screws down to approx. half their thread length
3. Tighten all screws to approx. 0.5 Nm in the sequence shown in Figure 10.

   If the module has TIM on the baseplate, skip to step 4.

   a. Tighten all screws to approx 1 Nm in the same sequence 1 – 2 – 3 – 4. The waiting time before step 4 depends on the viscosity of the thermal grease and can be determined and set by the user. As a guideline a waiting time of 10-20 minutes is normal.

4. Tighten the screws with 5Nm +/-15% torque in the same sequence 1 – 2 – 3 – 4.

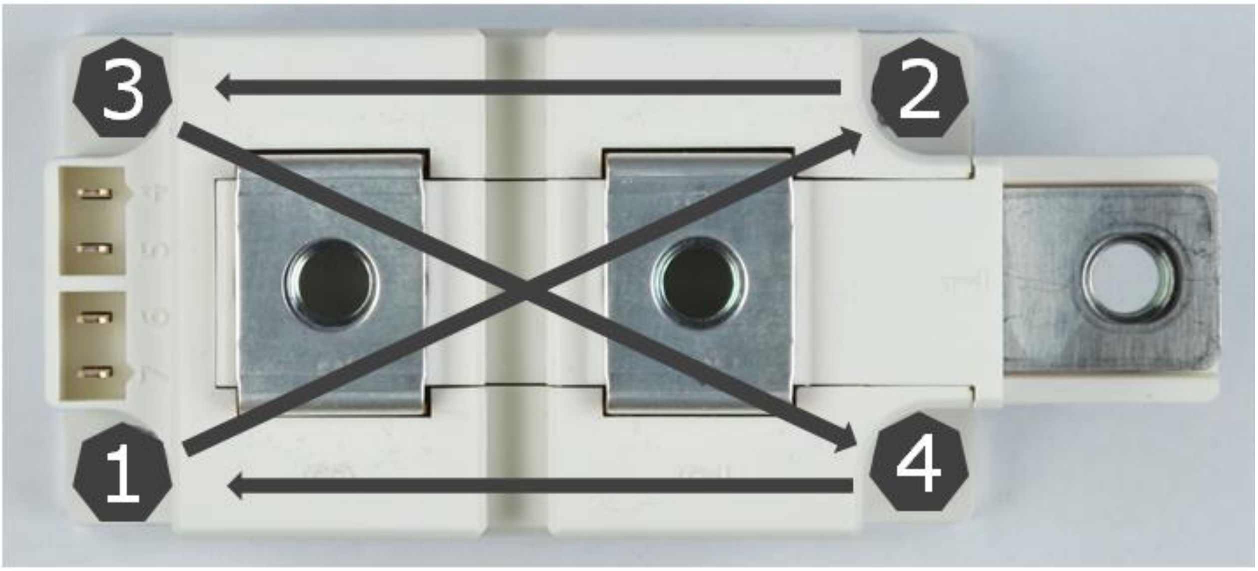


Figure 10: Tightening sequence for the module assembly

When using thermal grease, depending on the type of grease, it may be required to check the tightening torques of the screws after a heat run, so that they are correct. When using phase change films this additional check is recommended. The use of silicone sheets/film is not recommended.

For the qualification and verification of the assembly process and an appropriate thermal design it is strongly recommended that the user conducts experiments and takes measurements. The maximum junction temperature should be checked under operational conditions with thermal measurements to ensure that the maximum junction temperature does not exceed the maximum junction temperature stated in the data sheets (T_{VJM}).

For a thermal measurement as close to the chip as possible, it is necessary to place the temperature sensing probe below the chip to be measured as shown in Fig 11. Knowledge of the exact chip positions is therefore indispensable. The module-specific chip positions can be obtained from the Infineon modules sales partner.

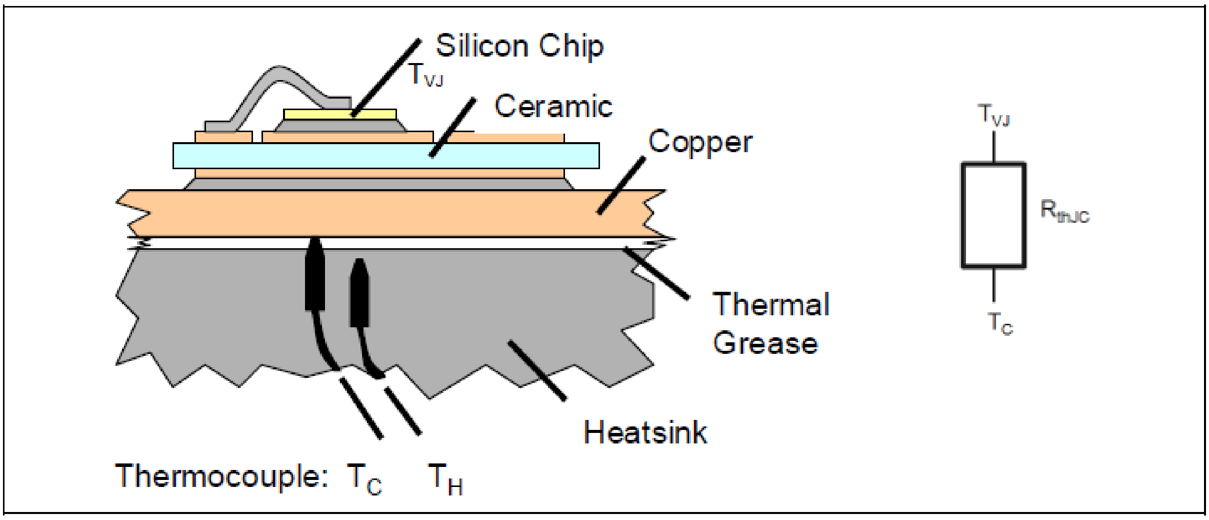


Figure 11: Example of the placement of the temperature sensor in a thermal measurement

The junction temperature (T_{VJ}) can be calculated as a function of the total power dissipation (P_V) and the baseplate temperature (T_C) as follows:

$$P_V = \frac{T_{VJ} - T_C}{R_{thJC}}$$

T_{VJ}: junction temperature (virtual)
T_C: baseplate temperature
P_V: total power loss
R_{thJC}: thermal resistance, junction to case

9.7 Connection and installation of the load current busbar

The module must be connected within the permissible module tolerances specified in the outline drawings in the module data sheet. The position and tolerance of adjacent components such as PCBs, DC-bus, mounting screws or cables have to be designed in such a manner that after the connections have been made there are no static and / or dynamic tensile forces applied to the terminals.

For connecting the load current terminals of the 34mm and 50mm solder bond modules screws compliant with ISO4762, DIN7984 or DIN 7985~~,~~ which meet a minimum strength class of 6.8, in combination with a suitable washer and lock washer (or a complete combination screw compliant with DIN6900) should be used. It is recommended to use a torque close to the maximum permissable torque.

However the maximum torques specified in Table 3 must not be exceeded. The tightening torque must be selected so that the preload force results in a pure frictional engagement of the components. To accurately determine the preload force and tightening torques the friction coefficient must be known. The friction depends on many factors such as material combination, surfaces, lubrication, temperature etc. The torque indicated in the table below is specified for an interface with a galvanized, metric steel screw. Any divergences between the coefficient of friction within the construction will accordingly lead to a need for adjustment of the tightening torque.

	ModuleType	**Connection**	**Screw**	**Max Torque M_{MAX} / Nm**
1	SB50mm	Load terminals	M8	9 +/-15%
2	SB34mm	Load terminals	M6	5 +/-15%

Table 3: Maximum torques on load terminal screws

The selection of screw length depends on the maximum specified screw-in depth of the module. The effective screw length of the screws inside the module load connection must not exceed the maximum specified screw-in depth of 14.5mm (SB50) and 9.0mm (SB34). Other combinations of screw and/or connection materials may require an adjustment of the mechanical parameters and an evaluation of the potential for corrosion between the two mating materials.

The design of the screw connections for the load terminals must be selected such that the sum of all possible loads does not exceed the yield strength of the assembled parts. The use of lock washers will increase the elasticity of the screw connection and thus compensate for any effects of relaxation and temperature cycling. This will ensure that the pre-tension force will be retained, and prevent the loosening of screws over time.

Maximum allowable push and pull forces (during assembly process @ Ta=25°C)

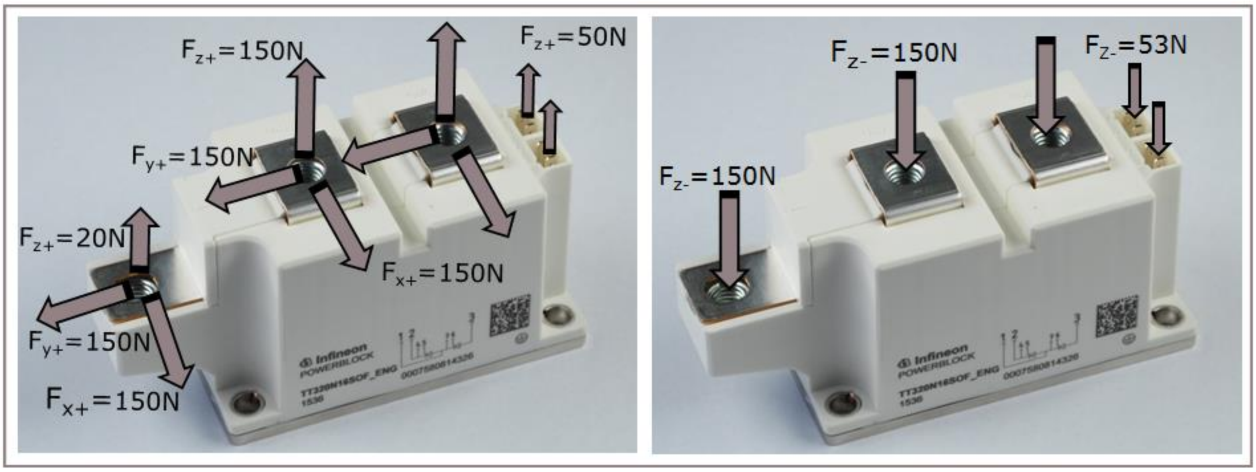


Figure 12.1: Maximum permissable forces during assembly (SB50)

Maximum allowable push and pull forces (during assembly process @ Ta=25°C)

Figure 12.2: Maximum permissable forces during assembly (SB34)

After assembly of the load and control terminals, forces acting on the module should be avoided over the entire operating temperature range. After installation and connection of the module it is recommended that the direction of any force applied to the terminals always keeps the terminals in compression or acts in the direction of the base plate. This must be assessed and evaluated by the user. Static forces in directions other than towards the baseplate, as well as any vibration, must be avoided.

Module assembly and mounting to a heatsink

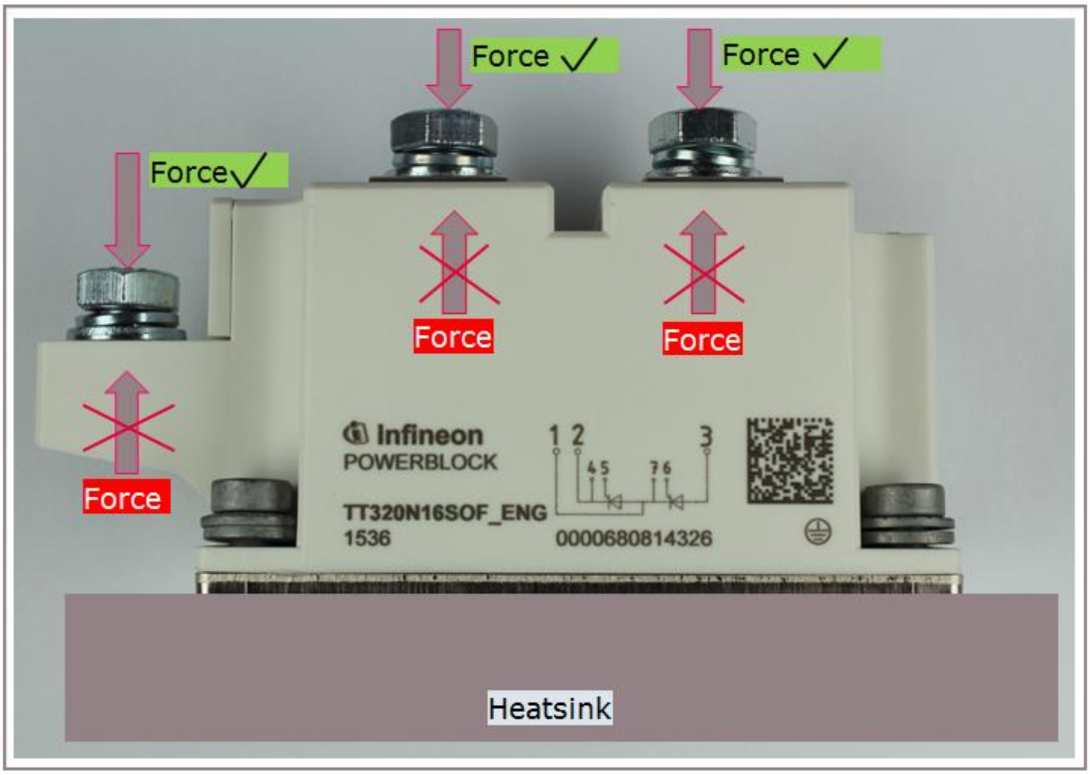


Figure 13.1: Module assembly SB50mm with pre-tensioning directions

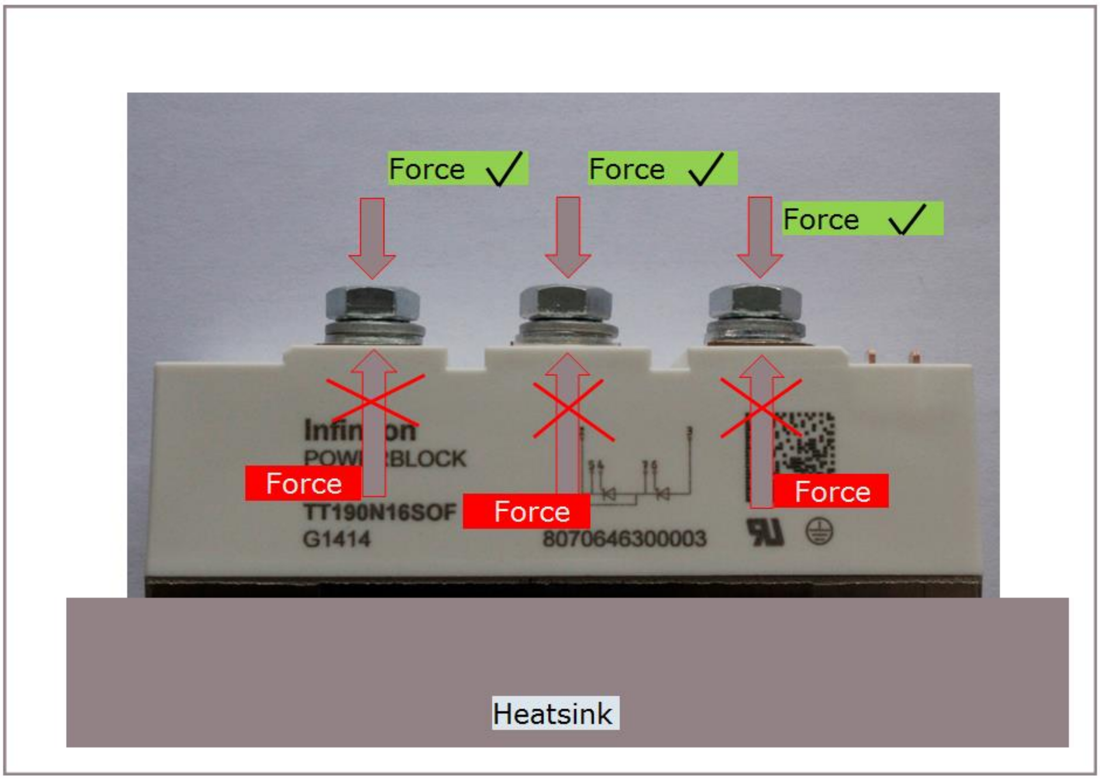


Figure 13.2: Module assembly SB34mm with pre-tensioning directions

For the design of the load terminal busbar the current capability and any additional power loss of the module connections must be considered.

9.8 Example 1: Connecting the gate and auxiliary cathode of 34mm and 50mm solder bond modules

To connect the control contacts (gate and auxiliary cathode), an insulated plug for a double socket and prefabricated cable available from Infineon (i. e. Gatelead L=500 PB34-60) can be used. With this, a gap of 0.5mm-1.0mm remains between the plastic housing of the plug and the bottom of the socket. The double socket plugs have a mechanical key to protect against transposition.

The suitability and reliability of the intended control contact should be checked and evaluated by the user.

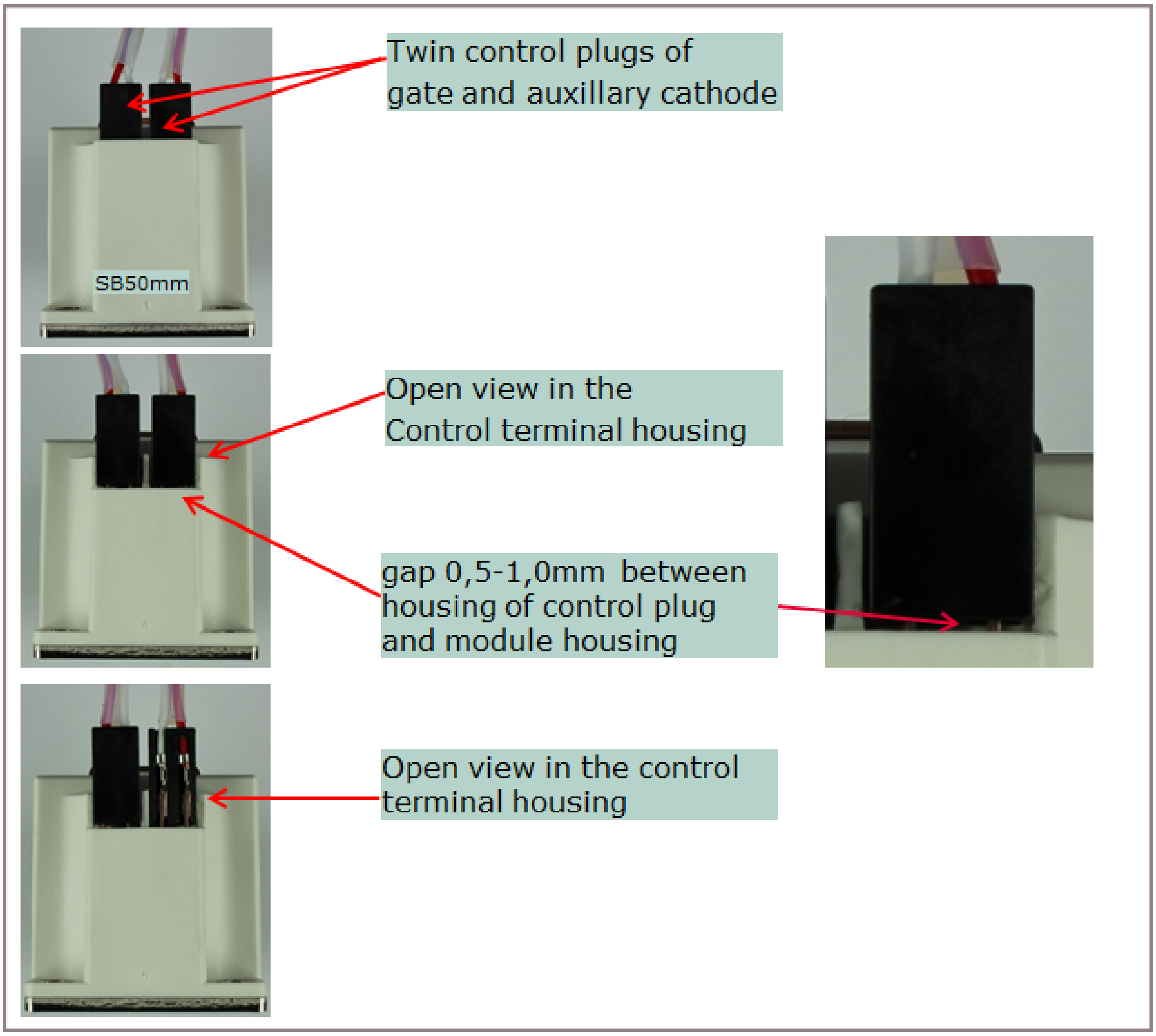


Figure 14: Connection example for SB 50mm thyristor module gate and auxiliary cathode control terminals

9.9 Example 2: Connecting the gate and auxiliary cathode of the 34mm and 50mm solder bond modules

The control contacts of the 34mm and 50mm modules are compliant with DIN 46244 – A2.8-0.8-Bz with a minimum length of L1 = 8.5mm.

Standard contact sleeves which conform to DIN46245 or equivalent blade receptables have a typical slide-on length of L2 = 6.3mm - see Figure 15.

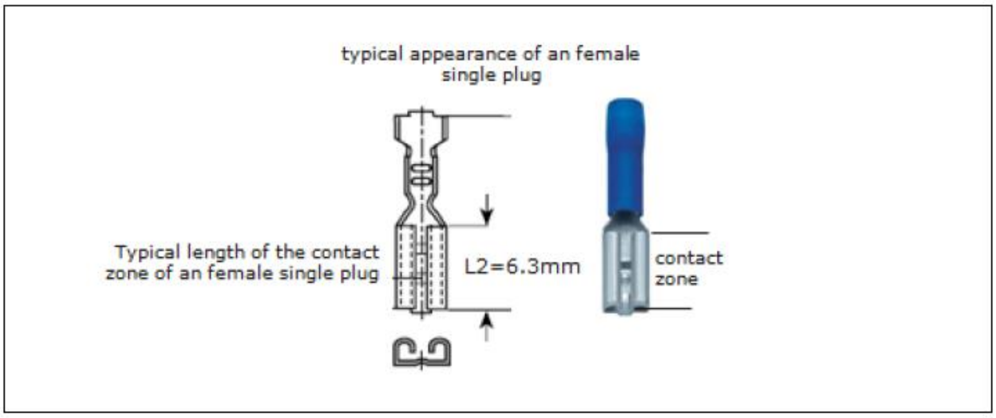


Figure 15: Typical slide-on connector

The suitability and reliability of the target control connector should be checked and evaluated by the user. If a standard slide-on connector (as described above) is used and the sleeve is put on completely and correctly, it will not touch the case bottom of the module.

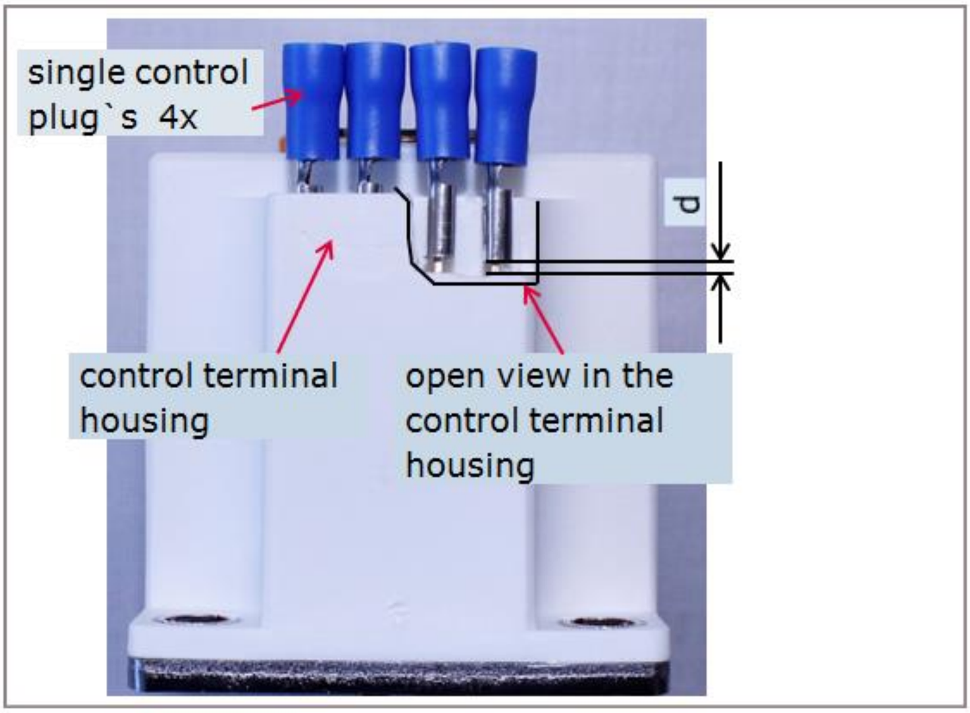


Figure 16: Control connection example 2 with standard slide-on connector

The maximum insertion and extraction forces must be checked and be compliant with the module specification (see Figure 12).

10 Use under vibration and shock conditions

The maximum values given in these assembly instructions for tensile and compressive loads on the mechanical and electrical connections are only permitted for one-time, short-term exposure during the mounting process.

The effects of mechanical stress such as vibration and shock depend on the mechanical structure and the mechanical load profile of the application and must be considered separately by the user.

11 References

[1] TR14 Storage of Products supplied by Infineon Technologies
[2] AN2012-01 Technical Information for Bipolar Semiconductors
[3] AN2016-07 Module with applied Thermal Interface Material
[4] AN2006-02 Application of silk screen

Revision History

Major changes since the last revision

Page or Reference	Description of change

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