User Guide **PRD-06983**

# BM Module Platform Mounting Guide

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This document provides guidance on how to install or mount the Wolfspeed® BM power modules to a cold plate and provides guidance on how to construct the mechanical system in which the module will be placed. This document does not describe how to operate the system once these steps are taken.

## Contents

**CAUTION**

Before operating the system, please carefully review the operating limits Wolfspeed's BM Half-Bridge Modules set forth in the datasheet located at www.wolfspeed.com or available upon request, and please ensure that appropriate safety procedures are followed when working with the system. There can be very high voltages present in the system when connected to an electrical source (and thereafter until applicable capacitors are fully discharged), and some components in the system can reach very high temperatures. Serious injury, including death by electrocution or serious injury by electrical shock or electrical burns, can occur if you do not operate the module within its operating limits or follow proper safety precautions.

# 1. Introduction

This document provides guidance on how to properly mount Wolfspeed® BM power modules and design a system that maximizes its performance and reliability. When mounted, the power module must be securely held in place, while not exceeding the baseplate mounting hole and power terminals force ratings. Similarly, the module's gate driver should be firmly attached to a rigid surface to ensure that it remains in place, while not placing excessive force on the signal pins of the power module it is attached to. Furthermore, the bussing attached to the power module must not induce excessive stress on the module's power terminals. Following the guidance described in this document is recommended to ensure proper mechanical mounting of the BM power module.

## 1.1 Scope

This document applies to the industry-standard 62 mm BM power module platform shown in Figure 1. BM power module products can be identified by the presence of 'BM' in the final 3-4 characters in the part number, such as the CAB530M12**BM**3.


*Figure 1: Example image of Wolfspeed 62 mm BM Modules*

## 2. ESD Protection

Wolfspeed power modules are electrostatic sensitive devices and thus are supplied with a connector across the gate and source terminals. Do not remove this connector until the gate driver is ready to be mounted. After the shorting connector is removed, industry standard electrostatic discharge (ESD) practices should be used to handle the module. Assembly must be carried out by appropriately trained staff, wearing conductive grounding bracelets at ESD-safe workstations.

## 3. Baseplate & Cold-Plate Specifications

Cold plates are necessary to remove heat from the die during operation and maximize the module's performance. Minimizing the thermal impedance between the module baseplate and the cold plate will further improve performance by allowing operation at higher power levels and reducing the die junction temperature.

The BM module should be adhered to a cold plate using a thermal interface material. Before applying the TIM, it is important to make certain that the contact surfaces—the cold plate mounting surface and module baseplate—are clean and free from any type of debris. This can be achieved by using an alcohol based cleaner and a lint free cloth. Another important parameter to consider when selecting a proper cold plate is the roughness of its surface. Any cold plate surface will have imperfections in the surface finish that will cause void regions to develop in the contact region between the module and the cold plate. Thermally conductive material should be used to fill these void regions. To ensure the filling of these voids and to minimize the thermal impedance, it is recommended to select a cold plate that meets the requirements listed below and in Figure 2. It is recommended to apply the TIM using a stencil with 0.006" thickness and stencil fixture, as described in the TIM material application user guide located at www.wolfspeed.com or available upon request. Following the application of the TIM, the module baseplate should be attached to the cold plate using the procedure described in section 3.1.

- Surface flatness ≤ 25.4 µm per 25.4 mm (DIN EN ISO 1101)
- Surface roughness $R_z$ ≤ 10 µm (DIN EN ISO 4287)
- No steps > 10 µm (DIN EN ISO 4287)

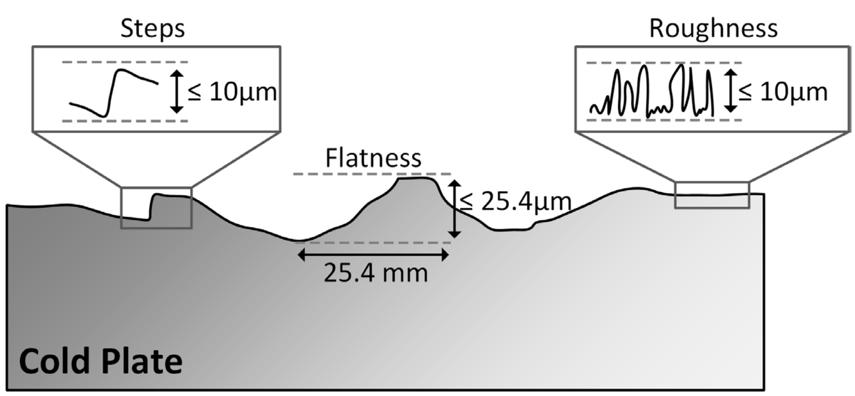


*Figure 2: Required cold plate surface tolerances*

## 3.1 Bolt Tightening Procedure

Carefully align the mounting holes and place the module onto the cold plate taking care not to slide the module around. Install the washers and thread in the M6 bolts until seated finger tight. Following Figure 3 and using a torque wrench, tighten the bolts in the sequence described below until the desired torque is reached. The recommended torque for the BM module is 5 N-m.

- Torque bolt number: 1 – 2 – 3– 4 to 1/3 final torque
- Torque bolt number: 3 – 4 – 2 – 1 to 2/3 final torque
- Torque bolt number: 2 – 1 – 3 – 4 to final torque

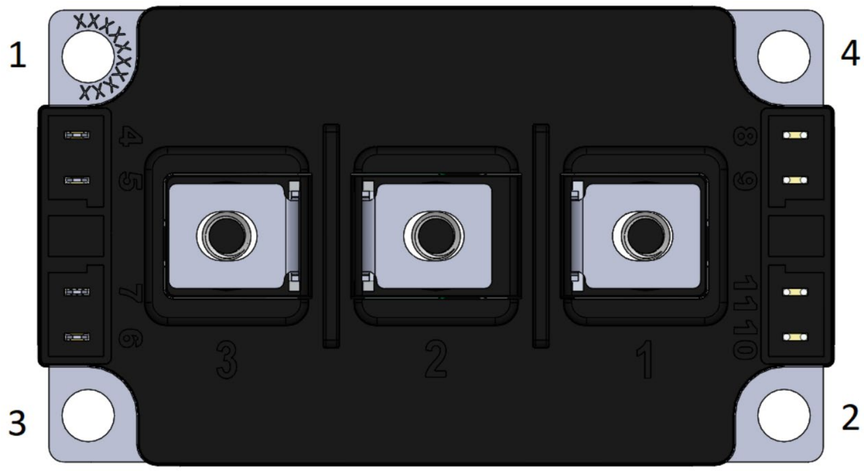


*Figure 3: BM Bolt Pattern Reference*

After heat cycling the module, it is recommended to check the torque of each mounting screw.

# 4. Power Terminal Mounting

The power terminals of the 62 mm modules are designed for DIN M6 bolts (class 6.8 minimum) tightened to 5 N-m. The engagement depth of the screw into the power terminals must **not** exceed the maximum penetration depth of 13.0 mm. Exceeding this value may result in significant damage to the power module.

It is imperative that the bussing connected to the power terminals of the module does not place excessive force on the power terminals. This condition must be maintained even under shock and vibration conditions. Consequently, the bussing **must** have proper mechanical stress relief, which will serve as a rigid mechanical connection between the module baseplate and bussing, minimizing the amount of force that may be placed on the power terminals because of an outside force being placed on the bussing.

The power terminals of the 62 mm module are threaded for M6 bolts. As such, the mounting holes in the bussing that is attached to the module should be as close to the standard M6 clearance hole of 6.6 mm as possible, given the tolerances in your system. Excessively exceeding the standard M6 clearance hole size may result in damage to the power terminals of the module.

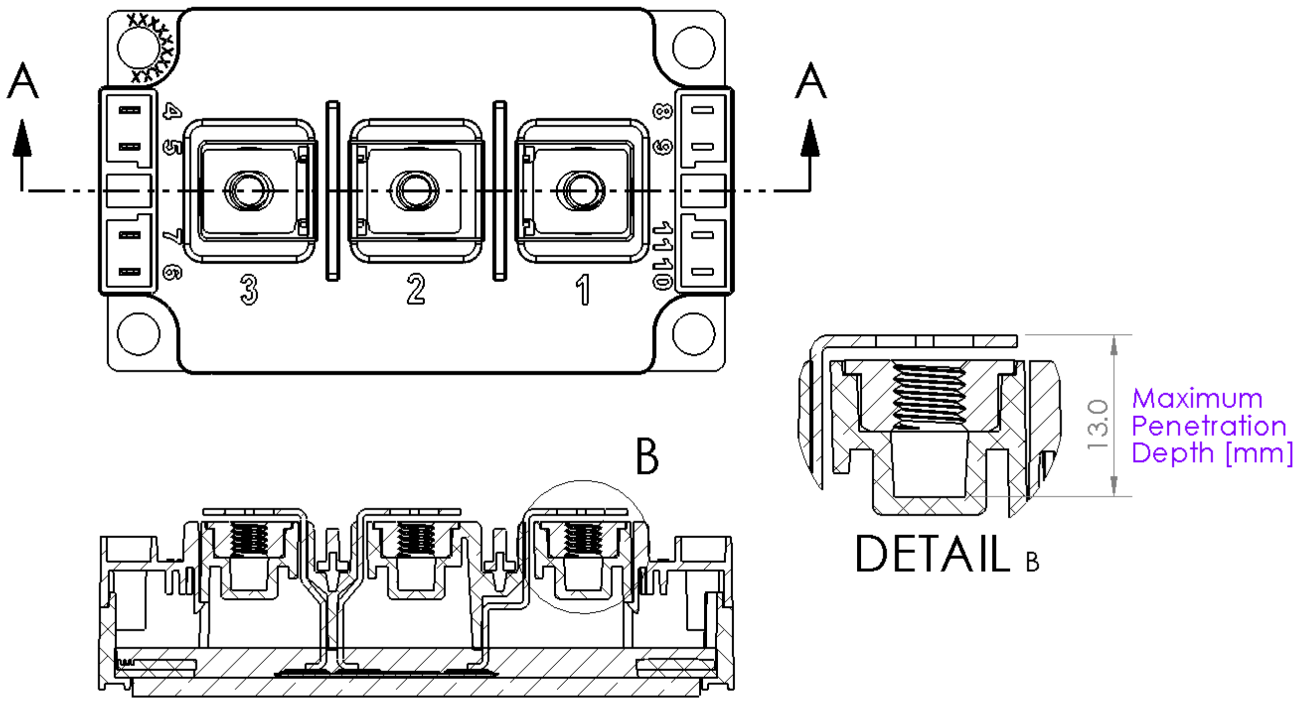


*Figure 4:  Power Terminal Maximum Penetration Depth*

# 5. Provisions for Vibrations

Vibrations over time have the potential to cause a failure in any inverter. For applications where vibrations are expected, it is important to minimize the amount of force that vibrations will induce at the interfaces. The module itself is a stiff object and is subject to vibrations as part of the qualification process. However, in applications, the entire system will be subject to vibrations. This will include not only the module, but also the interfaces between the module and the system. Thus, it is crucial to understand how the vibration environment will affect the module and all its interfaces. The following sections provide guidance to maximize device lifetime in environments where vibrations are a concern.

When mounting the BM power module into an application, the mechanical structure of the system should be scrutinized to ensure that the bussing connecting to the power terminals 1) does not place excessive shear force on the power terminals and 2) limits the possibility of forces pulling the terminals away from the module. This is particularly important for systems that may be subject to shock and vibration conditions.

## 5.1 Cold Plate Vibrations

A core point is that the power terminal and cold plate interfaces depend on bolted elements. Bolts are, in effect, stiff springs; the torque on the bolt induces a force on the threads to create friction that keeps the part fixed, as shown in Figure 5 below. A key design element is ensuring that vibration does not induce a counter force in the interface that will overcome the torque induced force, which can cause the bolt to loosen. Under all circumstances, this bolted interface must be under tension. While solutions such as lock washers, fixing compounds or bolts with inserts can be used to assist the frictional resistance, they should not be used in lieu of the above recommendation.

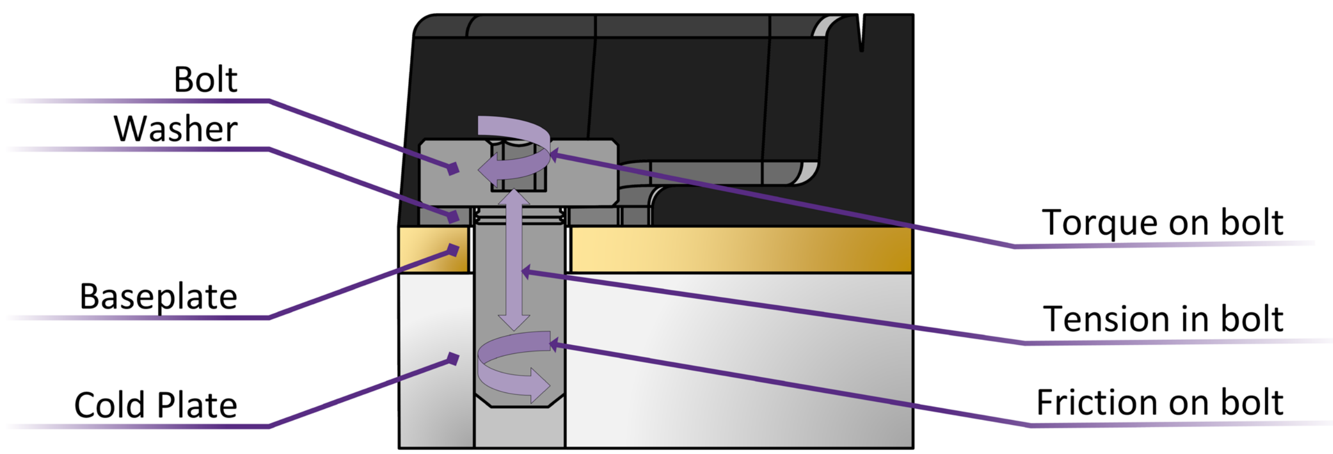


*Figure 5: Side cutaway of a baseplate bolt interface.*

## 5.2 Power Terminal Vibrations

The power terminals are made of a copper conductor with a bolted interface. The module terminal is bent down to trap a threaded nut that allows the bus to be bolted firmly to the terminal. This external power connection can be a lug on the end of a cable but in most cases will be some form of laminated copper sheets or even thick copper printed wiring board. This trapped nut and the bolt form a bolted interface requiring sufficient torque to prevent an induced vibration from causing the interface to come apart.

When the bussing is bolted to the terminal, it should not impart tension on the module terminal part that connects into the module. Instead, it should impart some compression, as shown in Figure 6, and be designed so that vibration in the system does not ever impart tension on the interface. Vibrations that cause the interface between the bussing and the module terminals to oscillate between compression and tension and is likely to lead to fatigue failure. The power interface structure needs to be analyzed across the vibration environment to ensure that they will not overcome the compressive force on the terminal.

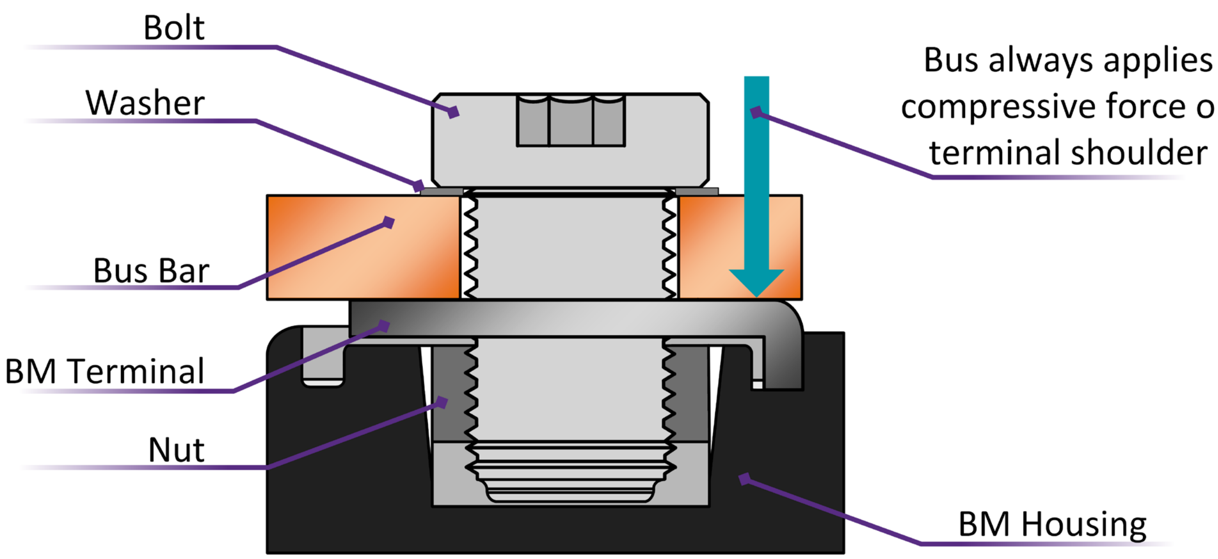


*Figure 6: Side cutaway of the bolted interface between the power terminal and bus*

## 5.3 Signal Terminal Mounting

The gate driver can be mounted to the BM power module as shown in Figure 7. Just as the power terminals must be protected from excessive force, the signal terminals of the power module must also be protected. This criterion must be balanced with the requirement that the gate driver signal connectors remain electrically connected to the signal pins of the power module. The best way to protect the power module signal terminals from excessive force while maintaining a reliable electrical connection is by mounting the gate driver with mechanical supports in place to provide mechanical stress relief. Just as with the bussing mechanical relief, the gate driver mechanical relief should lock the position of the gate driver relative to the power module and prevent outside forces on the gate driver from stressing the signals pins of the power module.

When removing the gate driver from the power module, special care must be given to apply even pressure across all four pins to prevent damage to the pins. Excessive force or uneven pressure applied to the pins may result in permanent damage manifesting itself as the tearing of a signal pin out of the module.

For the DESAT connection, a flying lead connector can be used to connect the spade connector on the gate driver to the V+ terminal of the BM module, as shown in Figure 7.

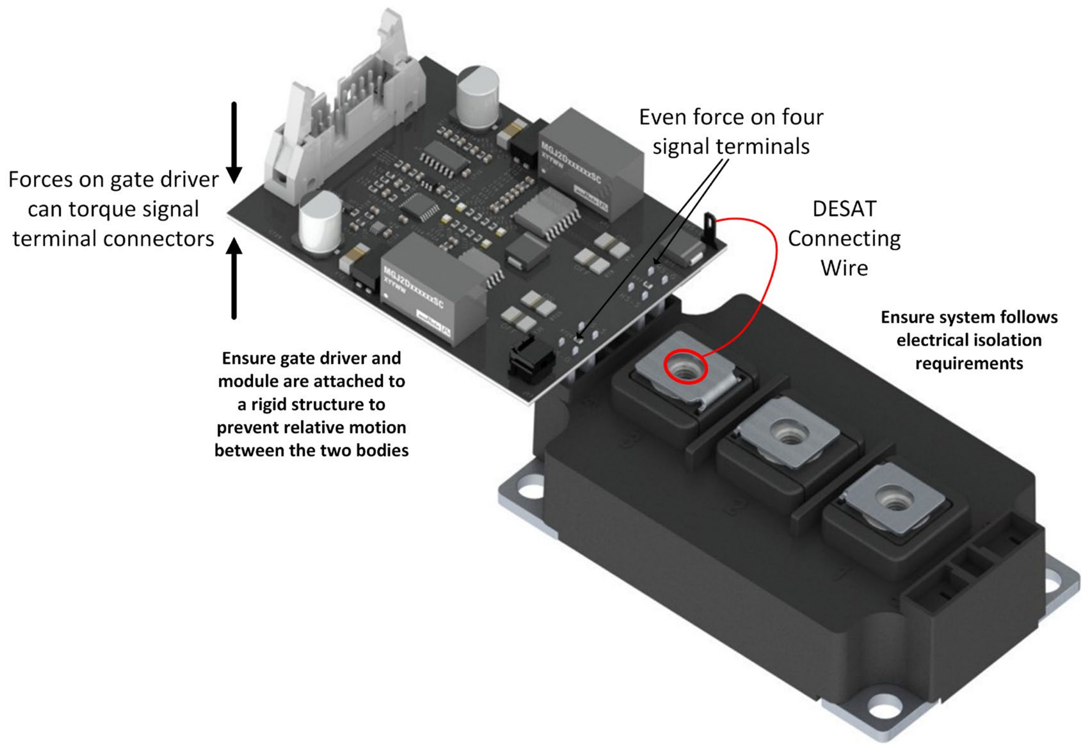


*Figure 7: BM gate driver mounting considerations*

## Revision History

| Date | Revision | Changes |
|---|---|---|
| **April 2020** | 1 | Initial Release |
| **December 2023** | 2 | Added provisions for vibrations |