
**a white paper from Bodine Electric Company**

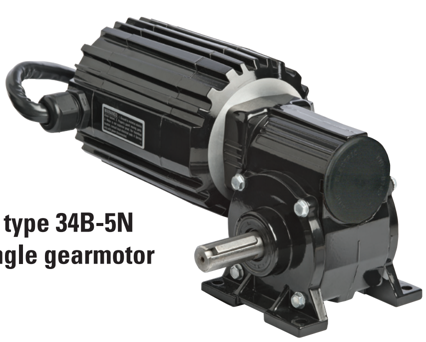
# Know Your Current, Know Your Load

## Load Testing a Drive Application with a Brushless DC Gearmotor and Control

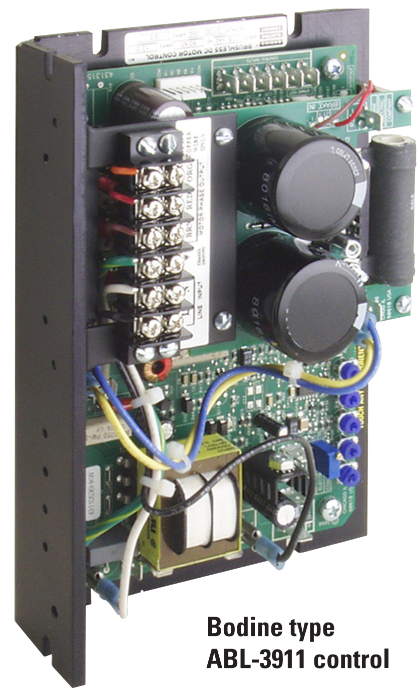
BY EMAN ELASHYE

When designing a new piece of equipment that uses motors or gearmotors, design engineers must calculate how much motor torque will be needed to drive their application load. If the gearmotor or motor is undersized and too small, the product will be underpowered and likely not meet all application requirements. If the gearmotor or motor delivers more power and torque than required, then it adds unnecessary cost, requires more space and can negatively affect the total weight of the equipment.

This tech note provides the design engineer with a procedure on how to check his or her calculations against real-world performance by load testing the application. A good way to determine how much the actual load is on a motor or gearmotor is to measure the amount of current it draws. Three-phase brushless DC (ECM) motors present a challenge to the engineer who wants to measure motor current. If the current is measured through the motor leads (i.e. the motor phases), the resulting current values will be useless and essentially make no sense.



Bodine type 34B-5N right angle gearmotor



**Bodine type ABL-3911 control**

**There is a simple way to accurately measure the current through the motor:** measure the current through the motor fuse on the brushless DC control.* The current measurement provides the DC bus current before it goes into the 3 phases of the motor, and therefore can be used to calculate the load (torque) at the motor/gearmotor shaft. This is possible because just as in PMDC motors or gearmotors, the measured current is directly proportional to the load (required torque). The measured DC bus current should be very close, if not equivalent, to the nameplate rated current, if the motor or gearmotor is loaded to the nameplate rated torque. Once the current measurement is obtained, the motor torque is calculated by multiplying the torque constant ($K_t$) for the motor/gearmotor by the current value measured. Gearmotor output torque can be calculated once the motor torque has been determined.

$$K_t \text{ (oz-in./A)} \times I(A) = T \text{ (oz-in.)}$$

***Eman Elashye** is an Application Support Specialist at Bodine Electric Company. She has a degree in Electrical Engineering and works in their customer support group in the Chicago area.*

* This will only work on non-PWM controls, such as Bodine Type ABL-3911 and ABL-3921. It will not work with a PWM control, such as Bodine's low voltage type ABL-3905 and ABL-3907 controls.

## Test Procedure:

This example uses a Bodine type ABL-3911 brushless DC control. This control accepts a 115VAC 50/60Hz input and delivers filtered 0-130VDC to a BLDC motor or gearmotor. Before performing any measurements, read the control instruction manual completely and carefully. Pay special attention to all warnings, cautions and safety rules. Failure to follow the instructions could produce safety hazards, which could injure personnel or damage the control, motor or other equipment. **Dangerous voltages are present in the electronic control and motor, which could cause serious injury or death.** Use extreme caution during handling, testing and adjusting. Only a properly trained technician or engineer should perform these measurements on a live board. Properly guard the electronic control and motor to prevent accidental contact by all persons. Finally, do not earth-ground any components of our control.

As shown in Figure 3, measure the current by using the quick connect tabs on the board labeled M+ and MF3.

1. Remove the motor fuse from the on-board fuse holder.
2. Connect floating wires to M+ and MF3.
3. Place the motor fuse into an external fuse holder.
4. Connect the fuse holder and the ammeter in series with M+ and MF3 as shown in figure 3.
5. Measure the DC current using an ammeter.

**FIGURE 1.** Motor fuse location on a Bodine type ABL-3911 control

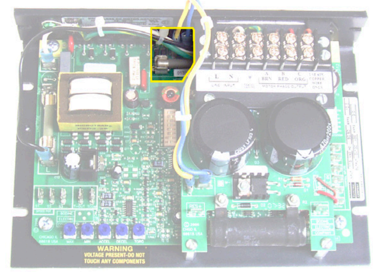


**FIGURE 2.** Location of motor fuse and quick connect tabs M+ and MF3.

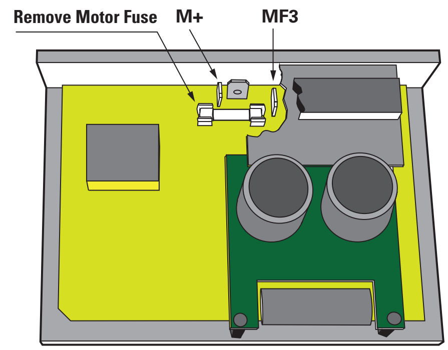
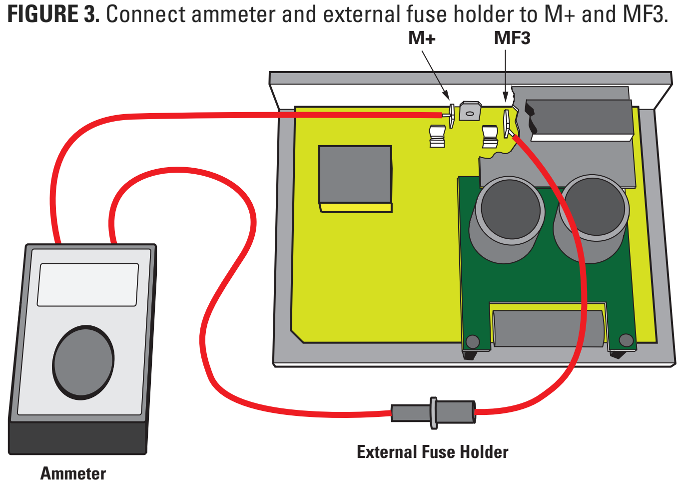
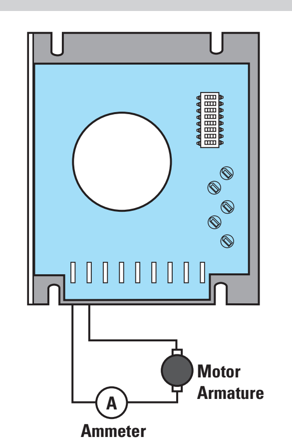



**FIGURE 3.** Connect ammeter and external fuse holder to M+ and MF3.




### Load Testing With A Permanent Magnet DC Motor And Control System

To load test a PMDC motor application, measure the current through the motor leads. Place the ammeter in series with one of the motor leads and the control. Measure the DC current through the motor.

This current measurement can then be used to calculate a torque value.

**T(oz-in.) = Kt(oz-in./A) x I(A)**

where
**T(oz-in.):** Calculated Motor Torque
**Kt(oz-in./A):** Motor's Torque Constant
**I(A):** Measured DC Current

*Note: This applies only to our filtered PMDC controls (type WPM or type FPM).*