

**Model M3500DB**  
**Dynamic Safety Brake for**  
**Servo Motors**

**Customer Reference Manual**

**Bonitron, Inc.**  
Nashville, TN



*An industry leader in providing solutions for AC drives.*

## **ABOUT BONITRON**

Bonitron designs and manufactures quality industrial electronics that improve the reliability of processes and variable frequency drives worldwide. With products in numerous industries, and an educated and experienced team of engineers, Bonitron has seen thousands of products engineered since 1962 and welcomes custom applications.

With engineering, production, and testing all in the same facility, Bonitron is able to ensure its products are of the utmost quality and ready to be applied to your application.

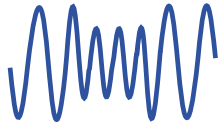
The Bonitron engineering team has the background and expertise necessary to design, develop, and manufacture the quality industrial electronic systems demanded in today's market. A strong academic background supported by continuing education is complemented by many years of hands-on field experience. A clear advantage Bonitron has over many competitors is combined on-site engineering labs and manufacturing facilities, which allows the engineering team to have immediate access to testing and manufacturing. This not only saves time during prototype development, but also is essential to providing only the highest quality products.

The sales and marketing teams work closely with engineering to provide up-to-date information and provide remarkable customer support to make sure you receive the best solution for your application. Thanks to this combination of quality products and superior customer support, Bonitron has products installed in critical applications worldwide.

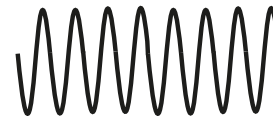
## AC DRIVE OPTIONS

In 1975, Bonitron began working with AC inverter drive specialists at synthetic fiber plants to develop speed control systems that could be interfaced with their plant process computers. Ever since, Bonitron has developed AC drive options that solve application issues associated with modern AC variable frequency drives and aid in reducing drive faults. Below is a sampling of Bonitron's current product offering.

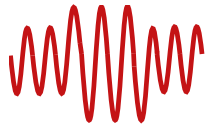
## WORLD CLASS PRODUCTS



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Braking Resistors  
Transistor/Resistor Combo  
Line Regeneration  
Dynamic Braking for Servo Drives



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3-Phase Power Supplies  
Common Bus Sharing Diodes  
Isolation Diodes  
Bus Filter Capacitance



**Green/Sustainable Solutions**  
Voltage Boosters  
(for Solar and Wind Applications)  
Line Regeneration  
Power Factor Correction



**Portable Maintenance Solutions**  
Capacitor Formers  
Battery Testers  
Capacitor Testers  
Capacitor Dischargers

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## 1. INTRODUCTION

### 1.1. WHO SHOULD USE

This manual is intended for use by anyone who is responsible for integrating, installing, maintaining, troubleshooting, or using this equipment with any Motion Control System.

Please keep this manual for future reference.

### 1.2. PURPOSE AND SCOPE

This manual is a user's guide for the Model M3500DB and M3500DB4 Dynamic Braking modules for E-Stop applications. It will provide you with the necessary information to successfully install, integrate, and use the M3500DB and M3500DB4 modules in any Motion Control System.

In the event of any conflict between this document and any publication and/or documentation related to the AC drive system, the latter shall have precedence.

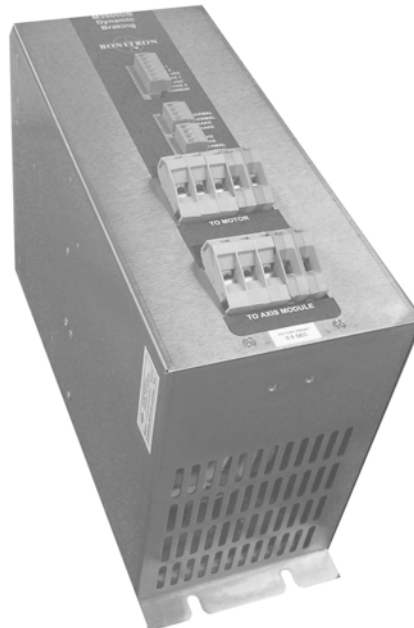
### 1.3. MANUAL VERSION AND CHANGE RECORD

Specifications were updated in Rev 13 of this manual.

Additional dimensions were added in Rev 13a.

Deceleration Time Calculation was added in Section 7 in Rev 13b.

**Figure 1-1: M3500DB-H01A-65**



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## 2. PRODUCT DESCRIPTION / FEATURES

The M3500DB Dynamic Braking Module is designed to provide resistive E-stop braking control for permanent magnet servo motion systems with safety requirement as per EN-954. The M3500 Brake Module incorporates positive guided contactors and can be used in conjunction with a control reliable safety relay to provide the desired level of system safety.

In order to achieve redundancy, as in EN-954, the drive is the primary brake, and must always attempt to stop the axis (controlled stop) upon E-stop or light curtain command. Regenerative braking may be needed in order to achieve a safe decel time. The M3500DB4 is the secondary brake, and will stop the motor in case of power or motion controller failure.

This document describes the Model M3500DB and M3500DB4 series of Dynamic Safety Brake Modules for E-Stop applications.

The M3500DB and M3500DB4 Dynamic Safety Brake modules are compatible with any Servo system and are designed for use in conjunction with regenerative braking for E-stop applications. These modules enhance system performance and safety by providing resistive braking control for emergency stop applications when regenerative braking fails.

The Dynamic Safety Brake will satisfy three basic functions as outlined below:

- The need to physically isolate one motor from its drive on a very frequent basis so that the Axis module is in a safe condition for an operator to intervene in a process. The System module and other Servo modules remain "live".
- To act as a back-up brake in E-stop situations where an operator has tripped a light curtain or other safety interlock device.
- To act as a back-up brake to slow a Servo in case of a power loss or a malfunction which prevents the use of regenerative braking in an emergency stop situation.

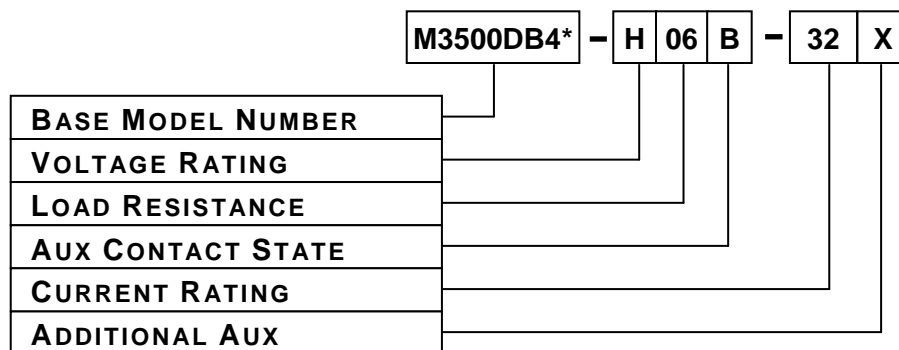
Both the M3500DB and M3500DB4 modules can be run right out of the box. However, these modules also provide the user a measure of control via selectable contactor brake delay time settings to allow custom integration into existing safety schemes.

All Model M3500DB and M3500DB4 Dynamic Safety Brake modules are designed for use in 380/460VAC rated systems using any available permanent magnet Servo-motors and are available with 1 $\Omega$ , 3 $\Omega$ , 6 $\Omega$ , 16 $\Omega$ , or 36 $\Omega$  internal load sizes. The modules utilize safety class-2, positive guided contactors to stop an Axis module on command. Refer to Appendix-A at the end of this manual for easy motor-to-module cross-referencing.

The standard M3500DB Dynamic Safety Brake module conforms to category II safety requirements per EN-954. The model M3500DB4 incorporates redundant, positive guided contactors to satisfy category IV safety requirements per EN-954.

## 2.1. PART NUMBER BREAKDOWN

**Figure 2-1: Example of Part Number Breakdown**



### **BASE MODEL NUMBER\***

The Base Model Number for the standard Dynamic Safety Brake is **M3500DB**. The standard module meets category II safety requirements per EN-954.

Model number **M3500DB4** should be used if redundant, positive-guided braking contactors are needed to satisfy category IV safety requirements in accordance with EN-954.

### **MAXIMUM VOLTAGE RATING**

The standard AC voltage rating for Model M3500DB and M3500DB4 Dynamic Safety Brake modules uses the letter **H**. These modules are intended for systems with a maximum of 460VAC input line voltage. Lower voltages can be used.

### **LOAD RESISTANCE**

The load resistance rating indicates the internal load resistance of the braking module. For instance, a number **06** in the part number would indicate that the module has a load resistance of 6Ω per leg in a wye configuration.

See Section 6 for available part numbers.

### **AUXILIARY CONTACT STATE**

32A, 43A, and 65A units in both M3500DB and M3500DB4 Dynamic Safety Brake modules are available with either a normally open (N.O.) or normally closed (N.C.) auxiliary contact output on each braking contactor for monitoring contactor status. The terms normally open and normally closed refer to the state of the auxiliary contact when the braking contactor is in a de-energized condition. This can occur with the loss of power or while in brake mode.

A letter **A** in this position of the part number indicates that the module is supplied with **Normally Closed** auxiliary contact outputs.

A letter **B** in this position of the part number indicates that the module is supplied with **Normally Open** auxiliary contact outputs.

The 150A units provide both auxiliary contacts (N.C. and N.O.) for each power contact, and therefore only use the **A** in this position.

### **CURRENT RATING**

The current rating indicates the maximum FLA rating of the braking module's internal braking contactor(s). The number **32** in the part number would indicate that the module's braking contactors are rated for 32 full load amps.

Both the M3500DB and M3500DB4 series of Dynamic Safety Brake modules are available with 32FLA, 43FLA, 65FLA, or 150FLA rated braking contactors.

See Section 6 for available part numbers.

### **ADDITIONAL AUXILIARY CONTACTS**

An x in this position indicates that the signal filtering option is exchanged for an extra set of auxiliary contacts on the contactors. For the DB4 module, each contactor has an independent set of contacts.

## **2.2. GENERAL SPECIFICATIONS**

**Table 2-1: General Specifications**

<b>PARAMETER</b>	<b>SPECIFICATION</b>
Max AC Voltage	480VAC @ rated current
Max FLA	32A 43A 65A 150A
Lifetime Cycles	1,000,000 @ no load
Operation Rate	3 Full Load Stops/Hour
Switching Delay	35-70 ms
Aux. Contact	250VAC, 2A
Storage Temp	-20°C to +65°C
Humidity	Below 90 % non-condensing
Atmosphere	Free of corrosive gas and conductive dust

### 2.3. GENERAL PRECAUTIONS AND SAFETY WARNINGS



**DANGER!**

- HIGH VOLTAGES MAY BE PRESENT!
- NEVER ATTEMPT TO OPERATE THIS PRODUCT WITH THE ENCLOSURE COVER REMOVED!
- NEVER ATTEMPT TO SERVICE THIS PRODUCT WITHOUT FIRST DISCONNECTING POWER TO AND FROM THE UNIT!
- ALWAYS ALLOW AMPLE TIME FOR RESIDUAL VOLTAGES TO DRAIN BEFORE REMOVING THE ENCLOSURE COVER.
- FAILURE TO HEED THESE WARNINGS MAY RESULT IN SERIOUS INJURY OR DEATH!



**CAUTION!**

- THIS PRODUCT WILL GENERATE HIGH TEMPERATURES DURING OPERATION.
- THIS PRODUCT SHOULD BE INSTALLED ACCORDINGLY ON NON-FLAMMABLE SURFACES WITH CLEARANCES OF AT LEAST FOUR INCHES IN ALL DIRECTIONS.
- ALWAYS ALLOW AMPLE TIME FOR THE UNIT TO COOL BEFORE ATTEMPTING SERVICE ON THIS PRODUCT.
- BEFORE ATTEMPTING INSTALLATION OR REMOVAL OF THIS PRODUCT, BE SURE TO REVIEW ALL DRIVE AND/OR RESISTIVE LOAD DOCUMENTATION FOR PERTINENT SAFETY PRECAUTIONS.
- INSTALLATION AND/OR REMOVAL OF THIS PRODUCT SHOULD ONLY BE ACCOMPLISHED BY A QUALIFIED ELECTRICIAN IN ACCORDANCE WITH NATIONAL ELECTRICAL CODE OR EQUIVALENT REGULATIONS.
- WHEN WORKING WITH SHIELDED CABLES, SPECIAL CARE SHOULD BE TAKEN TO NOT NICK OR CUT OTHER WIRES IN THE CABLE. ENSURE SHIELD DOES NOT HAVE STRAY STRANDS THAT CAN ACCIDENTLY COME IN CONTACT WITH ELECTRICAL EQUIPMENT.

**ANY QUESTIONS AS TO APPLICATION, INSTALLATION, OR SERVICE SAFETY SHOULD BE DIRECTED TO THE EQUIPMENT SUPPLIER OR SPECIFYING ENGINEER.**

### **3. INSTALLATION INSTRUCTIONS**

This section provides all of the information needed to physically mount the Model M3500DB and M3500DB4 series of Dynamic Safety Brake modules.

#### **3.1. ENVIRONMENT**

When selecting the installation site for the Model M3500DB or M3500DB4 Braking module, be sure there is ample space to allow for a minimum of 4 inches of clearance above and below the module.

This is to allow for proper air flow through the module in order to dissipate any heat generated during the braking process.

#### **3.2. UNPACKING**

Upon receipt of this product, please verify that the product received matches the product that was ordered and that there is no obvious physical damage to the unit. If the wrong product was received or the product is damaged in any way, please contact the supplier from which the product was purchased.

#### **3.3. MOUNTING**

##### **3.3.1. BONDING**

Bonding is the practice of connecting or mounting the various modules, assemblies, panels, shields, and enclosures of a system in such a way as to reduce the effects of electromagnetic interference (EMI).

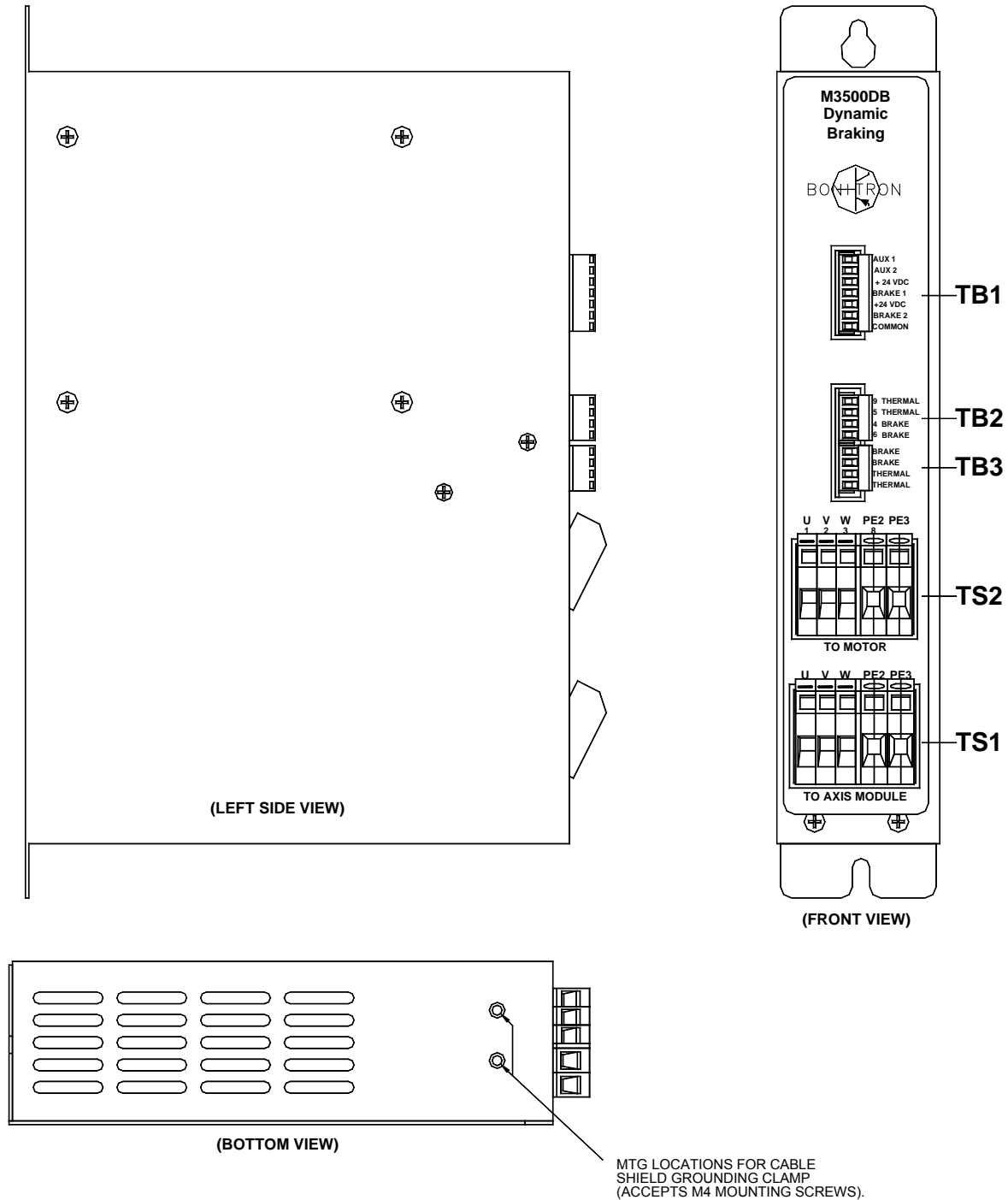
When done properly, bonding provides a low impedance path for high frequency energy to exit an enclosure or system. If not dealt with, excessive high frequency energy can damage or affect the operation of nearby electronic equipment.

Model M3500\*\* Accessory modules up to 65A are plated with zinc chromate. This provides the modules with an electrically conductive finish, allowing for excellent bonding. Be sure the module has good contact with earth ground to ensure proper shielding.

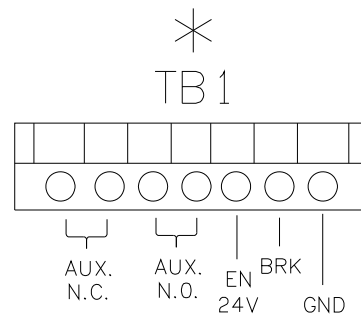
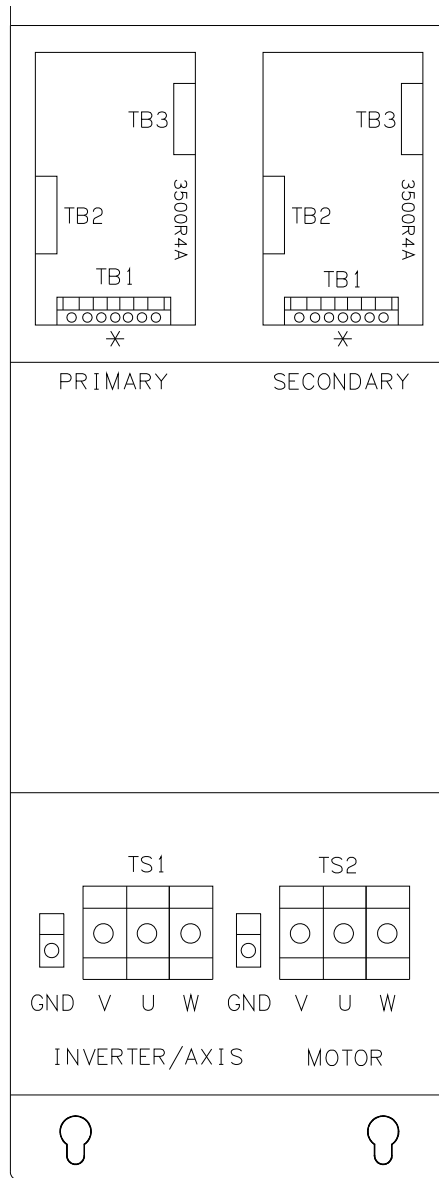
##### **3.3.2. MOUNTING THE M3500DB(4) DYNAMIC SAFETY BRAKE**

32A and 43A Modules are mounted using (2) M6 or ¼" mounting screws. 65A and 150A modules are mounted using (4) M6 or ¼" mounting screws. Refer to Figures 6-1 and 6-2 for mounting dimensions. Remember to allow for 4" of clearance above and below the module for adequate ventilation. Threaded ground terminals accepting M4 screws are available for cable shield grounding clamps. Motor ground wires should terminate at TS1 & TS2.

**Figure 3-1: Field Connections for M3500DB and M3500DB4 Modules up to 65A**



**Figure 3-2: Field Connections for 150 Amp M3500DB and M3500DB4 Modules**



### 3.4. WIRING AND CUSTOMER CONNECTIONS

#### 3.4.1. POWER WIRING

**Table 3-1: 32 & 43 Amp Power Terminations**

POWER SIGNALS	NAME	EXTERNAL CONNECTION	WIRING (MAX.)	TERMINAL TORQUE	LOCATION	USE
TS1-1	Servo Drive	U1	8 AWG		Lower SAK10 Terminals located near bottom of module front panel	3-phase PWM from drive
TS1-2		V1				
TS1-3		W1				
TS1-4	Ground	PE2	10 AWG			Ground
TS1-5		PE3				
TS2-1	Servo Motor	U1	8 AWG		Upper SAK 10 Terminals located in lower middle of module front panel	3-phase PWM to motor
TS2-2		V1				
TS2-3		W1				
TS1-4	Ground	PE2	10 AWG			Ground
TS1-5		PE3				

**Table 3-2: 65 Amp Power Terminations**

POWER SIGNALS	NAME	EXTERNAL CONNECTION	WIRING (MAX.)	TERMINAL TORQUE	LOCATION	USE
TS1-1	Servo Drive	U1	6 AWG		Lower SAK16 Terminals located near bottom of module front panel	3-phase PWM from drive
TS1-2		V1				
TS1-3		W1				
TS1-4	Ground	PE2	8 AWG			Ground
TS1-5		PE3				
TS2-1	Servo Motor	U1	6 AWG		Upper SAK 16 Terminals located in lower middle of module front panel	3-phase PWM to motor
TS2-2		V1				
TS2-3		W1				
TS1-4	Ground	PE2	8 AWG			Ground
TS1-5		PE3				

*Threaded inserts using M4 screws are available on underside of module for ground shield cable clamps.*

**Table 3-3: 150 Amp Power Terminations**

POWER SIGNALS		NAME	EXTERNAL CONNECTION	WIRING (MAX.)	TERMINAL TORQUE	LOCATION	USE
TS1-1	Servo Drive	U1	Servo Controller	2 / 0		Bottom of module on left side	3-phase PWM from drive
TS1-2		V1					
TS1-3		W1					
TS1-4	Ground	PE					Ground
TS2-1	Servo Motor	U1	Motor	2 / 0		Bottom of module on right side	3-phase PWM to motor
TS2-2		V1					
TS2-3		W1					
TS1-4	Ground	PE					Ground

### 3.4.2. CONTROL WIRING

When wiring the M3500DB and M3500DB4 Dynamic Safety Brake for control, it is important to be familiar with the control scheme of the entire system. Be sure to review all relevant system documentation before attempting to make these connections. Please note that in order to achieve a safety class 2 or 4 system, the M3500DB and M3500DB4 Braking modules must be used in conjunction with a safety relay.

**Table 3-4: 32, 43 and 65 Amp Control Terminations**

CONTROL SIGNALS		NAME	EXTERNAL CONNECTION	WIRING (MAX.)	TERMINAL TORQUE	LOCATION	USE
TB1-1	AUXILIARY Contact	AUX	Control circuits	14 AWG		Upper Plug located on module front panel	Brake Status Report
TB1-2		AUX					
TB1-3	+24V Enable1	EN1	24V power supply				Precharge
TB1-4	+24V Brake1	BR1	Control circuits				Brake
TB1-5	+24V Enable2 <sup>①</sup>	EN2	24V power supply				Precharge
TB1-6	+24V Brake 2 <sup>①</sup>	BR2	Control circuits				Brake
TB1-7	Common	COM	24V power supply				Common
TB2-1	Therm 1	K1	Servo Motor	14 AWG		Middle Plug located on module front panel	Temp Feedback
TB2-2		K2					
TB2-3	Brake 1	B1					Mechanical Brake Coil
TB2-4		B2					
TB3-1	Brake 2	B2	Servo Controller	14 AWG		Lower Plug located on module front panel	Mechanical Brake Coil
TB3-2		B1					
TB3-3	Therm 2	K2					Temp Feedback
TB3-4		K1					

① Not used on 65 Amp units

**Table 3-5: 150 Amp Control Terminations**

CONTROL SIGNALS		NAME	EXTERNAL CONNECTION	WIRING (MAX.)	TERMINAL TORQUE	LOCATION	USE
TB1-1	AUXILIARY N.C. Contact	AUX	Control circuits	12 AWG		Top half of unit on ASB 3500R4	Brake Status Report
TB1-2		N.C.					
TB1-3	AUXILIARY N.C. Contact	AUX	Control circuits				Brake Status Report
TB1-4		N.O.					
TB1-5	+24V Enable	EN	24V power supply				Precharge
TB1-6	+24V Brake	BR	Control circuits				Brake
TB1-7	Common	COM	24V power supply				Common

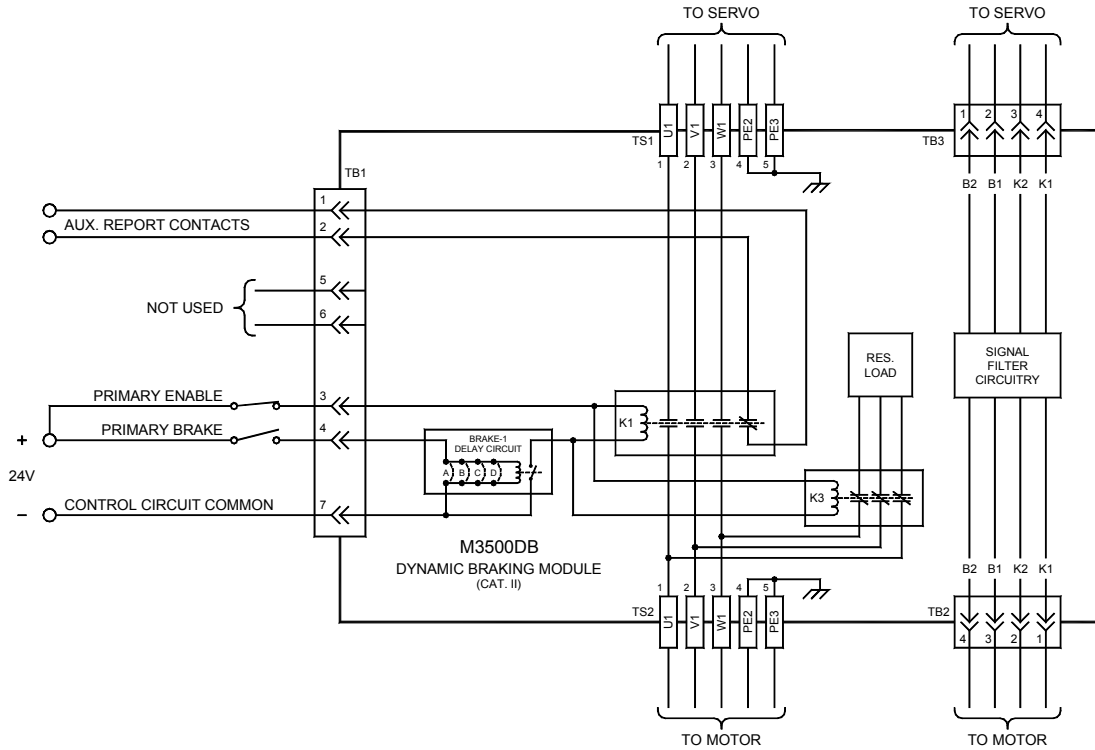
### 3.4.2.1. GROUNDING REQUIREMENTS

There are three ground connection points (motor input, motor output, and cable shield) all tied to chassis. The chassis is plated with zinc chromate to help keep EMI inside in the 65A and below.

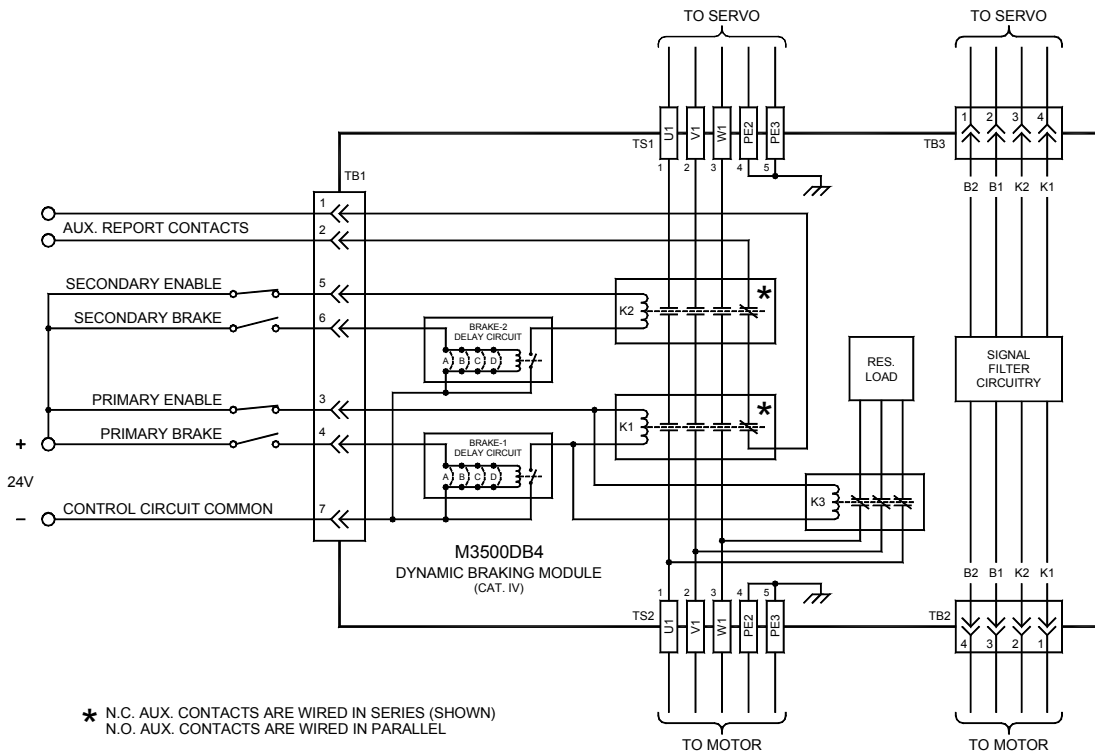
The chassis should be earth grounded at one of these connection points in accordance with local codes.

### 3.5. TYPICAL CONFIGURATIONS

**Figure 3-3: M3500DB Basic Control Circuit Interconnection Diagram**

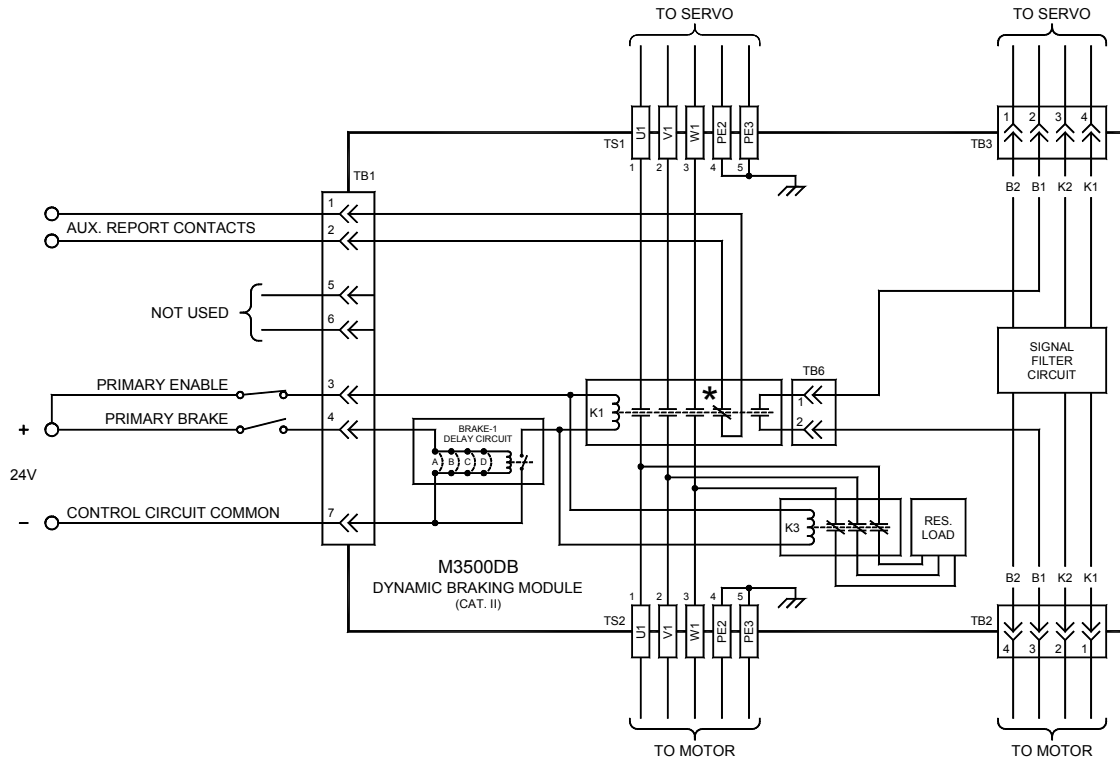


**Figure 3-4: M3500DB4 Basic Control Circuit Interconnection Diagram**

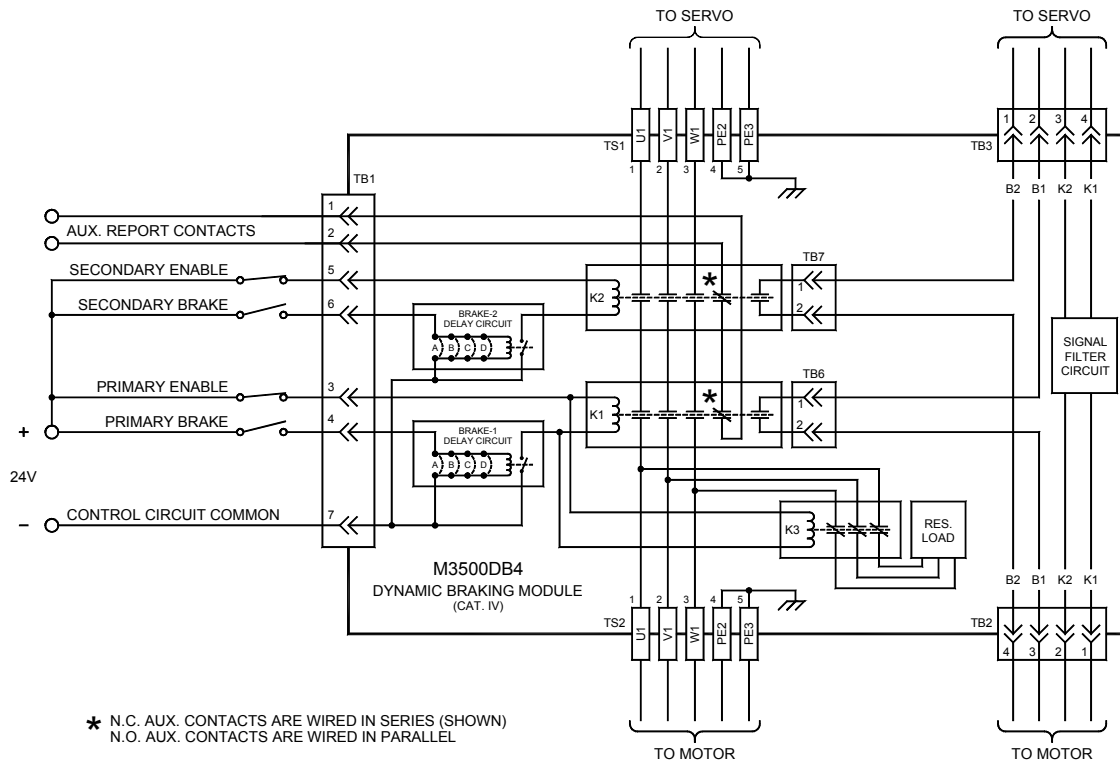


\* N.C. AUX. CONTACTS ARE WIRED IN SERIES (SHOWN)  
 N.O. AUX. CONTACTS ARE WIRED IN PARALLEL

**Figure 3-5: M3500DB Basic Control Circuit Interconnect ("X" option)**



**Figure 3-6: M3500DB4 Basic Control Circuit Interconnection ("X" option)**



## 4. OPERATION

### 4.1. FUNCTIONAL DESCRIPTION

The M3500DB Dynamic Braking Module was designed to be used as an integral part of a complete safety system, as per EN 954-1. The M3500DB module is designed to provide resistive e-stop braking control as a back up to the normal stopping process, so that inverter failure or power failure cannot result in the loss of safety. The system should be designed so that if power is removed, or if the servo drive doesn't decelerate in time, the DB Module will disconnect the servo drive and motor, then place resistance across the motor windings for emergency stopping.

The DB Module switches the servo drive output with a contactor. The contactor is controlled by a dry "brake" contact from the motor control system. When the "brake" command is received, a selectable time delay ranging from 0 to 2 seconds begins, allowing for controlled decelerate of the motor. When the time delay is over, the contactor disconnects the motor from the servo drive, and resistance is applied to the motor output.

The braking delay times are jumper selectable in half-second increments, and adjustable in between those increments. The module comes factory set for a 0.5 second delay.

In some models, filtering is also provided for mechanical brake and thermal signals to and from the motors.

### 4.2. FEATURES

#### 4.2.1. INPUTS

##### 4.2.1.1. PRIMARY ENABLE INPUT (M3500DB AND M3500DB4)

The PRIMARY ENABLE input supplies the coil voltage for primary contactor K1. This signal must be present for the servo drive to power the motor.

Losing or removing this signal will cause contactor K1 and K3 to drop out (immediately for 32A and 43A units, after a 2 second delay for 65A and 150A units), the motor will be disengaged, and the resistive braking load will be applied.

##### 4.2.1.2. PRIMARY BRAKE INPUT (M3500DB AND M3500DB4)

The PRIMARY BRAKE input supplies the coil voltage for the primary contactor brake relay. This signal must be present for the primary contactor to be energized.

Losing or removing this signal will initiate the brake time delay. Once the time delay has expired, contactor **K1** and **K3** will drop out, the motor will be disengaged, and the braking load will be applied. For more details on the brake delay circuit, see Section 4.4.1 of this manual.

##### 4.2.1.3. SECONDARY ENABLE INPUT (M3500DB4 ONLY)

The SECONDARY ENABLE input supplies the coil voltage for secondary contactor **K2**. This signal must be present for the Axis to power the Servo-motor. Losing or removing this signal will cause contactor **K2** to drop out (immediately for 32A and 43A units, after a 2 second delay for 65A and 150A units), and the motor will be disengaged without applying the braking load.

#### 4.2.1.4. **SECONDARY BRAKE INPUT (M3500DB4 ONLY)**

The SECONDARY BRAKE input supplies the coil voltage for the secondary contactor brake relay. This signal must be present for the secondary contactor to be energized.

Losing or removing this signal will initiate the brake time delay. Once the time delay has expired, contactor K2 will drop out and the motor will be disengaged without applying the braking load. For more details on the brake delay circuit, see Section 4.4.1 of this manual.

#### 4.2.2. **OUTPUTS**

##### 4.2.2.1. **AUX. REPORT CONTACT (M3500DB AND M3500DB4)**

The AUX. REPORT CONTACT output is used to monitor the status of the primary and/or secondary contactors. The de-energized state of this contact is determined by the Braking module part number. A letter **A** after the load resistance value in the part number indicates that the module is supplied with **Normally Closed** (N.C.) Aux. contact outputs while a letter **B** indicates that the module is supplied with **Normally Open** (N.O.) Aux. contact outputs.

For all M3500DB4 modules 65A and below, which have dual contactors, normally closed auxiliary contact outputs are wired in a series configuration while normally open auxiliary contact outputs are wired in a parallel configuration.

The 150A module supplies both the N.O. and N.C. contacts at TB1.

These contacts are factory hard-wired based on the part number. However, if necessary, the contacts can be reconfigured. Figure 4-1 in the “Brake Delay Settings” section (Section 4.4.1) of this manual shows the locations of the internal contact terminations.

##### **AUXILIARY CONTACT NOTES**

- The Truth Tables (Table 4-1 and Table 4-2) represent all possible combinations of control circuit inputs and the resulting auxiliary contact states of both the normally open and normally closed contacts for M3500DB and M3500DB4 Dynamic Safety Brake modules.
- All control circuits require a regulated +24V DC input or a closed +24V DC circuit for proper operation.
- The terms Normally Open (N.O.) and Normally Closed (N.C.) refer to a contact’s state while the contactor’s coil is de-energized.
- For the Model M3500DB4, N.O. contacts are wired in parallel and N.C. contacts are wired in series. The 150A module supplies both the N.O. and N.C. contacts at TB1.
- For the Model M3500DB4, combinations 13, 14, and 15 in Table 4-2 will allow the possibility of “Open” or disconnected motor outputs at TS2 of the Braking module without the module’s internal braking load connecting to the motor.

##### 4.2.2.2. **ADDITIONAL AUX CONTACTS**

When the Additional Auxiliary Contact option (X) is built, the B1 and B2 brake signal path is interrupted by a second AUX contact on each main

motor contactor. B1 is interrupted by the primary contactor on DB and DB4 units, while B2 is interrupted by the secondary contactor. This option is factory hard wired based on the part number. Figures 3-6 and 3-7 show the basic schematic with this option installed.

The truth table for M3500DB modules can be found in Table 4-1, and for M3500DB4 modules in Table 4-2.

## 4.2.3. TRUTH TABLES

**Table 4-1: M3500DB Auxiliary Contact Status and Control Logic Truths**

COMBINATIONS	CONTROL CIRCUITS (+24V DC)				MOTOR STATUS		(A) CONTACT STATUS		(B) CONTACT STATUS	
	Primary Enable-1	Primary Brake-1	Secondary Enable-2	Secondary Brake-2	U1,V1,W1 Output To Motor	Braking Resistors Engaged	AUX Contact N.C.	B1 Contact N.O.	AUX Contact N.O.	B1 Contact N.C.
1	Open	Open	Not Used	Not Used	No	Yes	Closed	Open	Open	Closed
2	Open	Closed	Not Used	Not Used	No	Yes	Closed	Open	Open	Closed
3	Closed	Open	Not Used	Not Used	No	Yes	Closed	Open	Open	Closed
4	Closed	Closed	Not Used	Not Used	Yes	No	Open	Open	Closed	Closed

**Table 4-2: M3500DB4 Auxiliary Contact Status and Control Logic Truths**

COMBINATIONS	CONTROL CIRCUITS (+24V DC)				MOTOR STATUS		(A) CONTACT STATUS			(B) CONTACT STATUS		
	Primary Enable-1	Primary Brake-1	Secondary Enable-2	Secondary Brake-2	U1,V1,W1 Output To Motor	Braking Resistors Engaged	AUX Contact N.C.	B1 Contact N.O.	B2 Contact N.O.	AUX Contact N.O.	B1 Contact N.C.	B2 Contact N.C.
1	Open	Open	Open	Open	No	Yes	Closed	Open	Open	Open	Closed	Closed
2	Open	Open	Open	Closed	No	Yes	Closed	Open	Open	Open	Closed	Closed
3	Open	Open	Closed	Open	No	Yes	Closed	Open	Open	Open	Closed	Closed
4	Open	Open	Closed	Closed	No	Yes	Open	Open	Closed	Closed	Closed	Open
5	Open	Closed	Open	Open	No	Yes	Closed	Open	Open	Open	Closed	Closed
6	Open	Closed	Open	Closed	No	Yes	Closed	Open	Open	Open	Closed	Closed
7	Open	Closed	Closed	Open	No	Yes	Closed	Open	Open	Open	Closed	Closed
8	Open	Closed	Closed	Closed	No	Yes	Open	Open	Closed	Closed	Closed	Open
9	Closed	Open	Open	Open	No	Yes	Closed	Open	Open	Open	Closed	Closed
10	Closed	Open	Open	Closed	No	Yes	Closed	Open	Open	Open	Closed	Closed
11	Closed	Open	Closed	Open	No	Yes	Closed	Open	Open	Open	Closed	Closed
12	Closed	Open	Closed	Closed	No	Yes	Open	Open	Closed	Closed	Closed	Open
13	Closed	Closed	Open	Open	No	No	Open	Closed	Open	Closed	Open	Closed
14	Closed	Closed	Open	Closed	No	No	Open	Closed	Open	Closed	Open	Closed
15	Closed	Closed	Closed	Open	No	No	Open	Closed	Open	Closed	Open	Closed
16	Closed	Closed	Closed	Closed	Yes	No	Open	Closed	Closed	Closed	Open	Open

## 4.3. STARTUP

### 4.3.1. PRE-POWER CHECKS

1. Confirm that proper DB module is used. See motor charts in Section 7 of this manual. (Note that not all motors are listed.)
2. Ensure that M3500DB module is properly installed as per instructions in Section 3 of this manual.

### 4.3.2. STARTUP PROCEDURE AND CHECKS

Model 3500DB is designed as a disconnect and brake for servo motor applications. It is to be controlled by a special safety relay and becomes part of an overall motor control safety system. This start -up procedure describes what to expect from the M3500DB unit, and does not consider other aspects of the connected system.

1. Apply 24VDC power to the Enable input of each contactor to be controlled.
  - DB models use only the PRIMARY enable.
  - DB4 models use the PRIMARY and SECONDARY enables.
  - For 65A and 150A models allow 10 seconds to precharge the surge capacitor before applying the brake signal in step 2.
    - a) Aux report contact should not change states.
2. After a 10 second precharge time, apply the 24VDC PRIMARY brake signal(s) to each contactor to be controlled.
  - DB models use only the PRIMARY brake.
  - DB4 models use the PRIMARY and SECONDARY brake.
    - a) PRIMARY contactor will pull in immediately when primary brake signal is applied.
    - b) SECONDARY Contactor will pull in immediately when secondary brake signal is applied.
    - c) Aux report contact should change states once all contactors are pulled in.
3. Remove the PRIMARY brake signal.
  - a) Primary contactor will drop out after programmed time delay.
    - i. Time delay can be defeated or changed by internal jumpers.
  - b) Aux report contact changes when contactor drops out (after delay).
4. Remove the SECONDARY brake signal.
  - a) Secondary contactor will drop out after programmed time delay.
    - i. Time delay can be defeated or changed by internal jumpers.
5. Reapply brake signals.
  - a) Contactors will pull in when brake signal is applied.
  - b) Aux report contact changes once all brake signals are applied and contactors are pulled in.

## 4.4. OPERATIONAL ADJUSTMENTS

### 4.4.1. BRAKE DELAY SETTINGS

The Model M3500DB and M3500DB4 Dynamic Safety Brakes are provided with contactor brake delay timing on the **PRIMARY BRAKE** and **SECONDARY BRAKE** input signals to ensure proper shutdown sequencing. The brake delay initiates upon loss of the **BRAKE** input signal. Once the delay has timed out, the brake relay will deactivate causing the corresponding contactor to drop out.

**All modules are factory preset with a brake delay time of 0.5-second.**

It is important to note that the **PRIMARY ENABLE** and **SECONDARY ENABLE** inputs **do not** have a delay on 32 and 43 amp models. Loss of an **ENABLE** signal will cause the corresponding contactor to drop out immediately. 65 amp models have a 2 second delay after **ENABLE** is removed.

65 amp models have a separate delay that matches internal relay drop out times. IF K3 dumps the load resistor on the motor BEFORE the path from the drive is opened, drive IOC faults may occur. This internal drop out delay is factory set for 20ms and should not be adjusted unless IOC faults occur.

## 4.5. CALIBRATION

Brake delay times are calibrated based on a 24.0VDC Brake signal input. These times are accurate to within  $\pm 5\%$  for the required 20-28VDC input voltage range.

Brake delay times can be adjusted by approximately 250 milliseconds up or down from the jumper settings. Adjusting the pot in a clockwise direction will increase the brake delay setting while a counter-clockwise adjustment decreases the delay. Each turn of the adjustment screw will give approximately 50 milliseconds.

To make adjustments to the delay setting you must first remove the cover panel from the right side of the braking module (for 65A units) or the front cover (for 150A units). Once this is done, the delay jumpers and adjustment pots are accessible. Next, set the delay jumpers to the setting that comes closest to the desired delay time. Now calculate the difference between the desired delay time and the jumper setting to determine the amount of adjustment needed.

For example, suppose that a brake delay of 1.6 seconds is desired. You would first set the delay jumpers for 1.5 seconds. Then, we calculate the difference between the desired delay time and the jumper setting. In this case, it is 0.1 seconds or a 100 millisecond increase. Two turns of the pot will be needed (approx. 50 milliseconds/turn) for a 100 millisecond adjustment. For an increase, the adjustment must be made in a clockwise direction.

Please note that the 50 millisecond/turn specification given above is only an approximation to aid in the calibration of the brake delay setting. Repeated adjustments may be required in order to fine tune the brake delay setting.

Refer to the illustration in Figures 4-1 and 4-2 for jumper and pot locations as well as jumper settings.

### 4.5.1. CALIBRATION FOR UNITS 65A AND BELOW

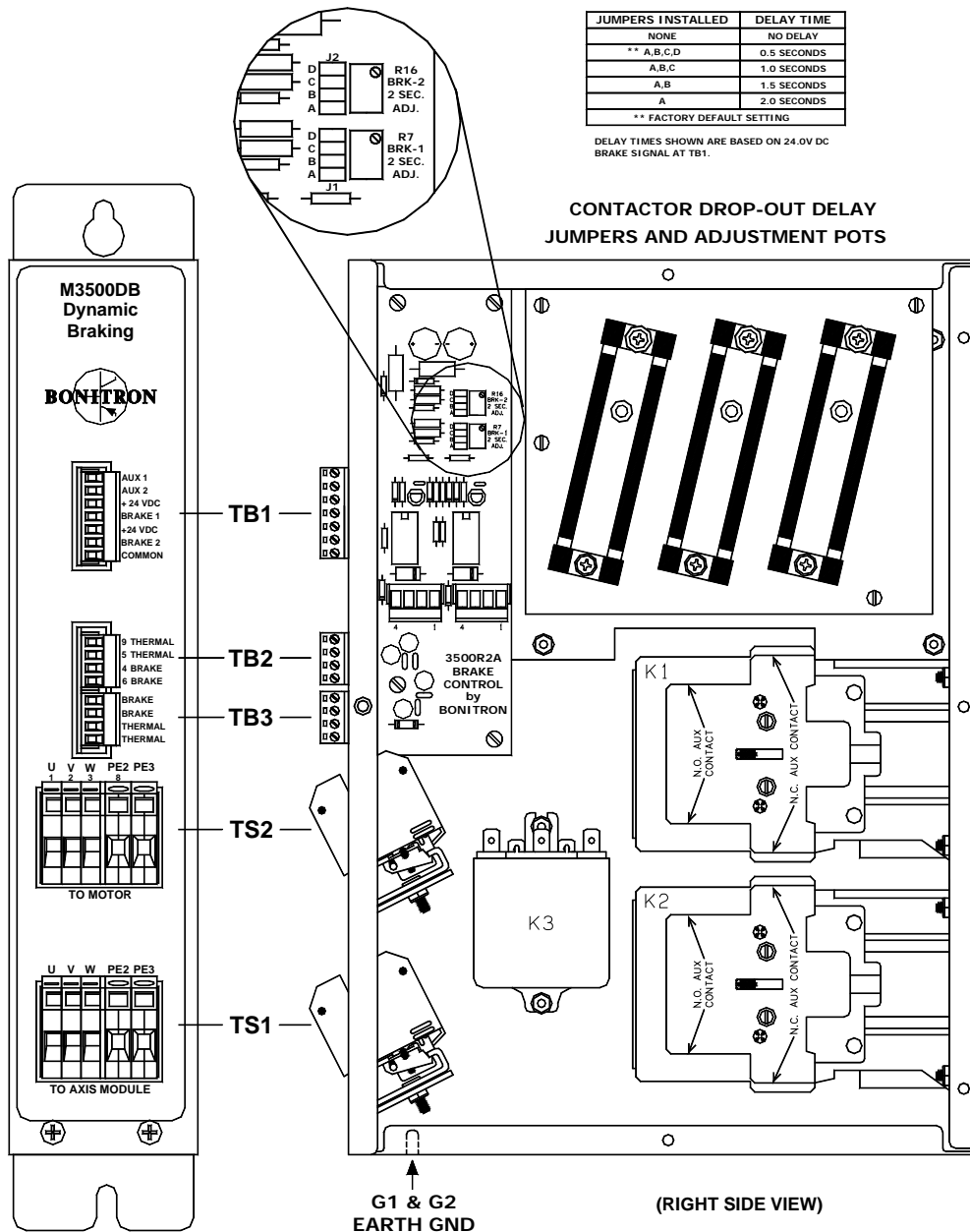
- For safety class II modules (M3500DB), which have a single braking contactor, only the J1 jumpers and R7 adjustment pot will be used.

# M3500DB

- For safety class IV modules (M3500DB4), which have redundant braking contactors, J1 and R7 will be used to set the delay for the BRAKE-1 input while the J2 jumpers and R16 adjustment pot will be used to set the delay for the BRAKE-2 input.

Since a change to the brake delay time does require that the side panel of the braking module be removed, brake delay adjustments should be made prior to installation whenever possible.

**Figure 4-1: M3500DB(4) Brake Delay Jumpers & Adj. Pot Locations for Units up to 65A**

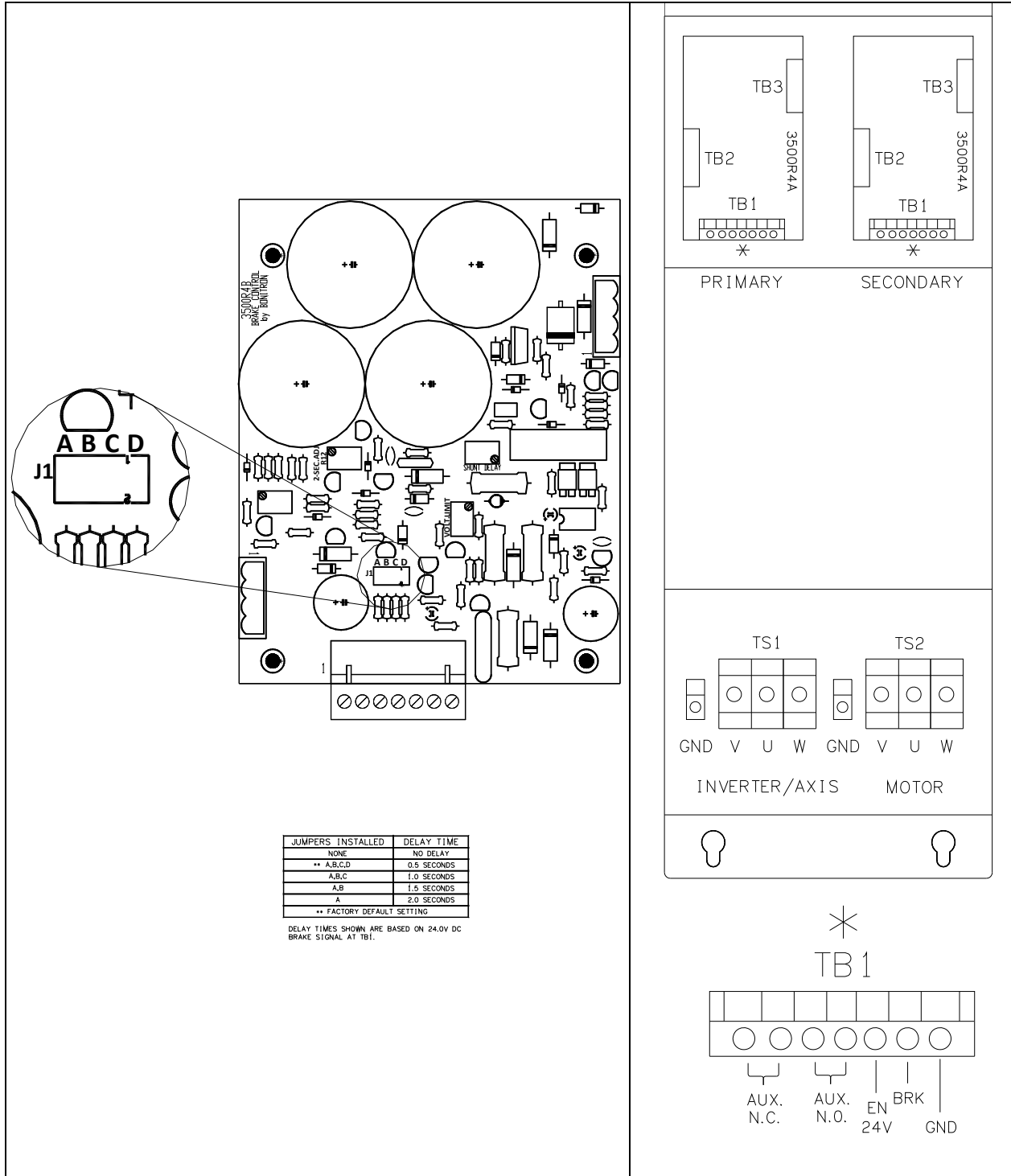


**Note:** The module depicted above is the Model M3500DB4 Safety Class IV module. Jumper and adjustment pot locations are the same for the Model M3500DB Safety Class II module.

### 4.5.2. CALIBRATION FOR 150A UNITS

- Jumper J1 and R12 on the ASB 3500R4 board are used to adjust the delay for the applicable BRAKE in the 150A units.

**Figure 4-2: M3500DB(4) Brake Delay Jumpers & Adj. Pot Locations for 150A Units**



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## **5. MAINTENANCE AND TROUBLESHOOTING**

Repairs or modifications to this equipment are to be performed by Bonitron approved personnel only. Any repair or modification to this equipment by personnel not approved by Bonitron will void any warranty remaining on this unit.

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## 6. ENGINEERING DATA

### 6.1. RATINGS CHARTS

**Table 6-1: Available 32FLA Dynamic Safety Brake Modules**

MODEL NUMBERS		FLA	LOAD	PARAMETERS	
EN-954 SAFETY CATEGORY II	EN-954 SAFETY CATEGORY IV			AUX. REPORT CONTACT STATE	BRAKE SIGNAL I/O HANDLING
M3500DB-H01A-32	M3500DB4-H01A-32	32A	1Ω	Normally Closed	Pass-through filtering and TVS
M3500DB-H01B-32	M3500DB4-H01B-32			Normally Open	
M3500DB-H01A-32X	M3500DB4-H01A-32X			Normally Closed	Switching via aux. contact
M3500DB-H01B-32X	M3500DB4-H01B-32X			Normally Open	
M3500DB-H03A-32	M3500DB4-H03A-32		3Ω	Normally Closed	Pass-through filtering and TVS
M3500DB-H03B-32	M3500DB4-H03B-32			Normally Open	
M3500DB-H03A-32X	M3500DB4-H03A-32X			Normally Closed	Switching via aux. contact
M3500DB-H03B-32X	M3500DB4-H03B-32X			Normally Open	
M3500DB-H06A-32	M3500DB4-H06A-32		6Ω	Normally Closed	Pass-through filtering and TVS
M3500DB-H06B-32	M3500DB4-H06B-32			Normally Open	
M3500DB-H06A-32X	M3500DB4-H06A-32X			Normally Closed	Switching via aux. contact
M3500DB-H06B-32X	M3500DB4-H06B-32X			Normally Open	
M3500DB-H16A-32	M3500DB4-H16A-32		16Ω	Normally Closed	Pass-through filtering and TVS
M3500DB-H16B-32	M3500DB4-H16B-32			Normally Open	
M3500DB-H16A-32X	M3500DB4-H16A-32X			Normally Closed	Switching via aux. contact
M3500DB-H16B-32X	M3500DB4-H16B-32X			Normally Open	
M3500DB-H36A-32	M3500DB4-H36A-32		36Ω	Normally Closed	Pass-through filtering and TVS
M3500DB-H36B-32	M3500DB4-H36B-32			Normally Open	
M3500DB-H36A-32X	M3500DB4-H36A-32X			Normally Closed	Switching via aux. contact
M3500DB-H36B-32X	M3500DB4-H36B-32X			Normally Open	

**Table 6-2: Available 43FLA Dynamic Safety Brake Modules**

MODEL NUMBERS		PARAMETERS			
EN-954 SAFETY CATEGORY II	EN-954 SAFETY CATEGORY IV	FLA	LOAD	AUX. REPORT CONTACT STATE	BRAKE SIGNAL I/O HANDLING
M3500DB-H01A-43	M3500DB4-H01A-43	43A	1Ω	Normally Closed	Pass-through filtering and TVS
M3500DB-H01B-43	M3500DB4-H01B-43			Normally Open	
M3500DB-H03A-43	M3500DB4-H03A-43		3Ω	Normally Closed	Pass-through filtering and TVS
M3500DB-H03B-43	M3500DB4-H03B-43			Normally Open	

**Table 6-3: Available 65FLA Dynamic Safety Brake Modules**

EN-954 SAFETY CATEGORY II	PARAMETERS			
	FLA	LOAD	AUX. REPORT CONTACT STATE	BRAKE SIGNAL I/O HANDLING
M3500DB-H0.5A-65	65A	0.5Ω	Normally Closed	Not Available
M3500DB-H0.5B-65			Normally Open	
M3500DB-H1.5A-65		1.5Ω	Normally Closed	
M3500DB-H1.5B-65			Normally Open	
M3500DB-H03A-65		3.0Ω	Normally Closed	
M3500DB-H03B-65			Normally Open	

**Table 6-4: Available 150FLA Dynamic Safety Brake Modules**

MODEL NUMBERS		PARAMETERS			
EN-954 SAFETY CATEGORY II	EN-954 SAFETY CATEGORY IV	FLA	LOAD	AUX. REPORT CONTACT STATE	BRAKE SIGNAL I/O HANDLING
M3500DB-H0.25A-150	M3500DB4-H0.25A-150	150A	0.25Ω	Normally Closed	Not Available
M3500DB-H0.25B-150	M3500DB4-H0.25B-150			Normally Open	
M3500DB-H0.75A-150	M3500DB4-H0.75A-150		0.75Ω	Normally Closed	
M3500DB-H0.75B-150	M3500DB4-H0.75B-150			Normally Open	
M3500DB-H1.5A-150	M3500DB4-H1.5A-150		1.5Ω	Normally Closed	
M3500DB-H1.5B-150	M3500DB4-H1.5B-150			Normally Open	

## 6.2. ELECTRICAL SPECIFICATIONS

**Table 6-5: Control Signal Specifications for 32 and 43 Amp Units**

CONTROL SIGNALS (20-28VDC)	INRUSH CURRENT @ 24VDC	HOLDING CURRENT @ 24VDC	IMPEDANCE	OFF TIME DELAY
Enable-1	0.5 Amp	0.5 Amp	50Ω	None
Brake-1	0.25 Amp	0.05 Amp	500Ω	0 – 2 sec.
Enable-2	0.37 Amp	0.37 Amp	65Ω	None
Brake-2	0.25 Amp	0.05 Amp	500Ω	0 – 2 sec.

**Table 6-6: Control Signal Specifications for 65 Amp Units**

CONTROL SIGNALS (20-28VDC)	INRUSH CURRENT @ 24VDC	HOLDING CURRENT @ 24VDC	IMPEDANCE	OFF TIME DELAY
Enable	2.5 Amp	500mA	50Ω	2 sec
Brake	100mA	50mA	500Ω	0 – 2 sec.

**Table 6-7: Control Signal Specifications for 150 Amp Units**

CONTROL SIGNALS (20-28VDC)	INRUSH CURRENT @ 24VDC	HOLDING CURRENT @ 24VDC	IMPEDANCE	OFF TIME DELAY
Enable	3 Amp	1A	50Ω	2 sec
Brake	100mA	50mA	500Ω	0 – 2 sec.

**Table 6-8: Auxiliary Contacts**

PARAMETER	SPECIFICATION
Continuous Thermal Current	A600 - 10A Q600 - 2.5A
Max VA/Amps Making	A600 - 7200 VA / 60A Q600 - 69 VA
Max VA/Amps Breaking	A600 - 720 VA / 6A Q600 - 69 VA
Max Operating Voltage	A600 - 600VAC Q600 - 600VDC

**Note:** For DC ratings at 600V or less, the make and break ratings shall be obtained by dividing the volt-ampere rating by the application voltage but shall not exceed the continuous carrying current.

**Table 6-9: Braking Loads (ENABLE-1, BRAKE-1)**

PARAMETER	SPECIFICATION
Duty Cycle:	No more than 3 full load E-Stop conditions per minute per hour
Resistance:	Rated load +/- 10% per leg, WYE configuration

**Table 6-10: Motor Brake/Thermal Signal Conditioning (B1, B2, K1, K2)①**

PARAMETER	SPECIFICATION
LC Filtering::	47μH, 1μF each signal
Transient suppression:	30V TVS between B1,B2
Max Ratings:	28V DC @ 2 amps

① Not included in 150A

**Table 6-11: Control Inputs - Max Operations**

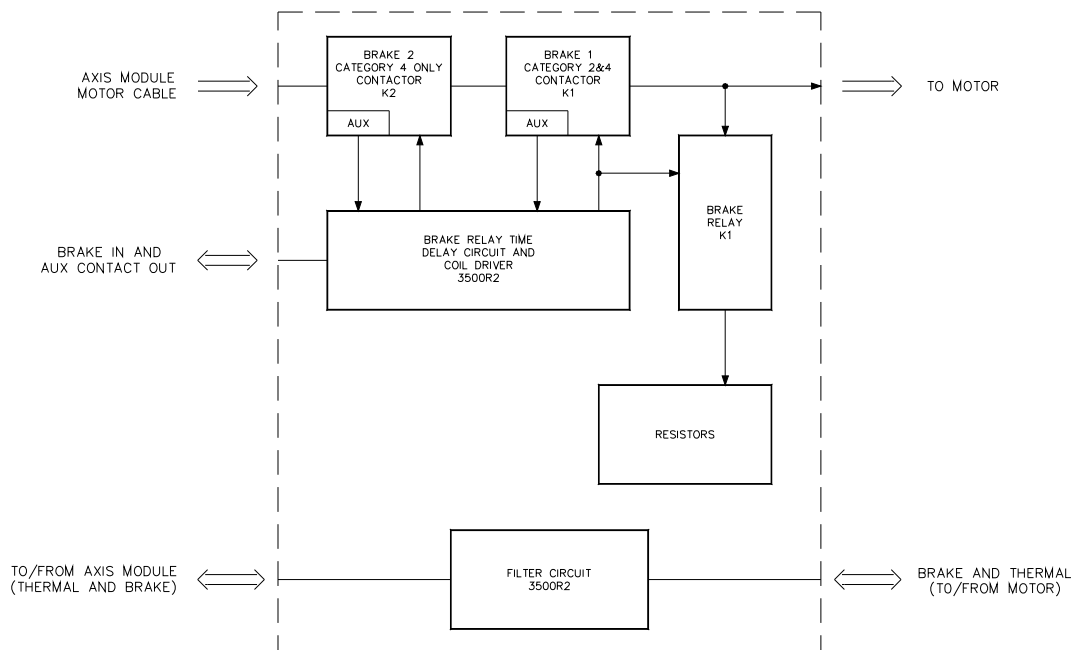
PARAMETER	SPECIFICATION
Primary Circuit (ENABLE-1/BRAKE-1)	
Full Load	No more than 3 full load E-Stop conditions per minute per hour
No Load	1200 operations per hour
Secondary Circuit (ENABLE-2/BRAKE-2)	
Full Load	1200 operations per hour
No Load	1200 operations per hour

### 6.3. THERMAL AND HEAT DISSIPATION

For most applications, heat will only be generated during emergency stop situations and the maximum heat generated by these braking modules is 10 kJoules per hour.

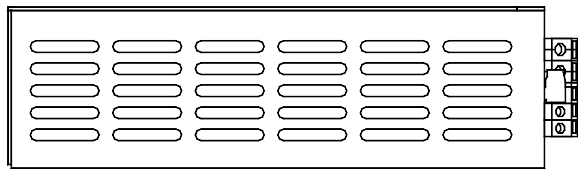
### 6.4. BLOCK DIAGRAM

**Figure 6-1: M3500DB Basic Block Diagram**

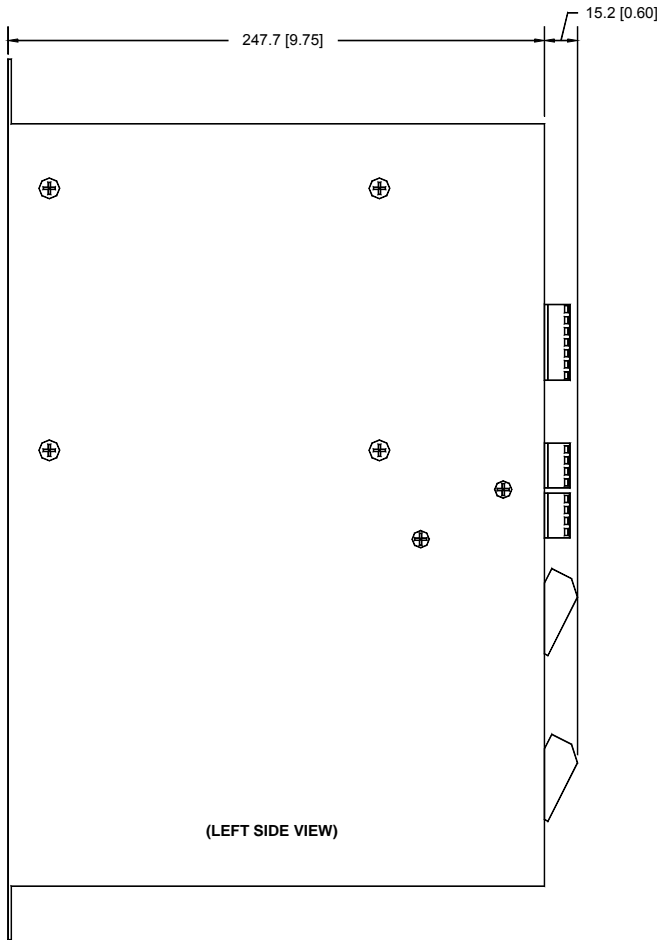


### 6.5. DIMENSIONS AND MECHANICAL DRAWINGS

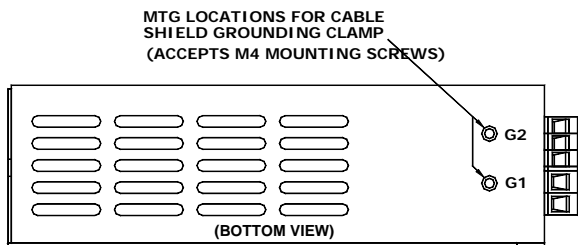
**Figure 6-2: Dimensional Outline for the 32FLA and 43FLA M3500DB and M3500DB4**



(TOP VIEW)



(LEFT SIDE VIEW)

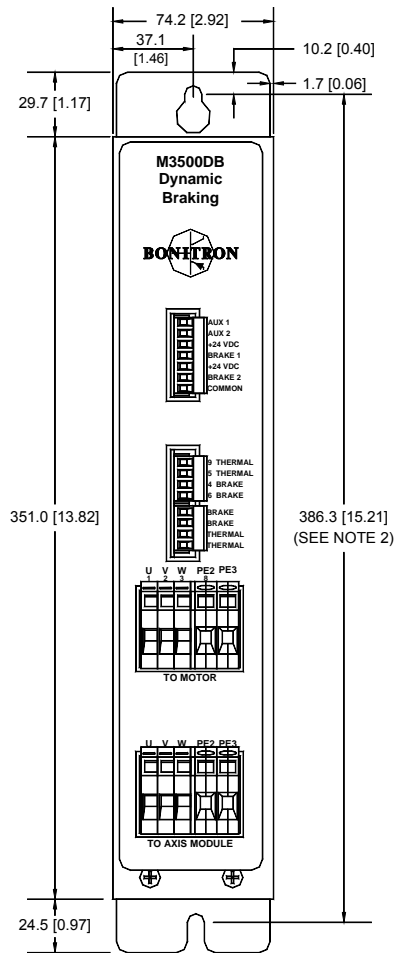


MTG LOCATIONS FOR CABLE SHIELD GROUNDING CLAMP (ACCEPTS M4 MOUNTING SCREWS)

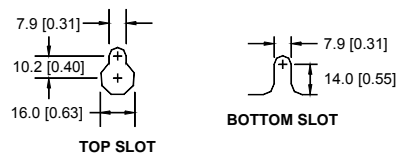
(BOTTOM VIEW)

**NOTES:**

- 1) DIMENSIONS ARE IN MILLIMETERS [INCHES]
- 2) DIMENSION SHOWN IS FOR MOUNTING HARDWARE LOCATION AND DOES NOT REFLECT THE LOCATION OF THE BOTTOM SLOT RADIUS.



(FRONT VIEW)

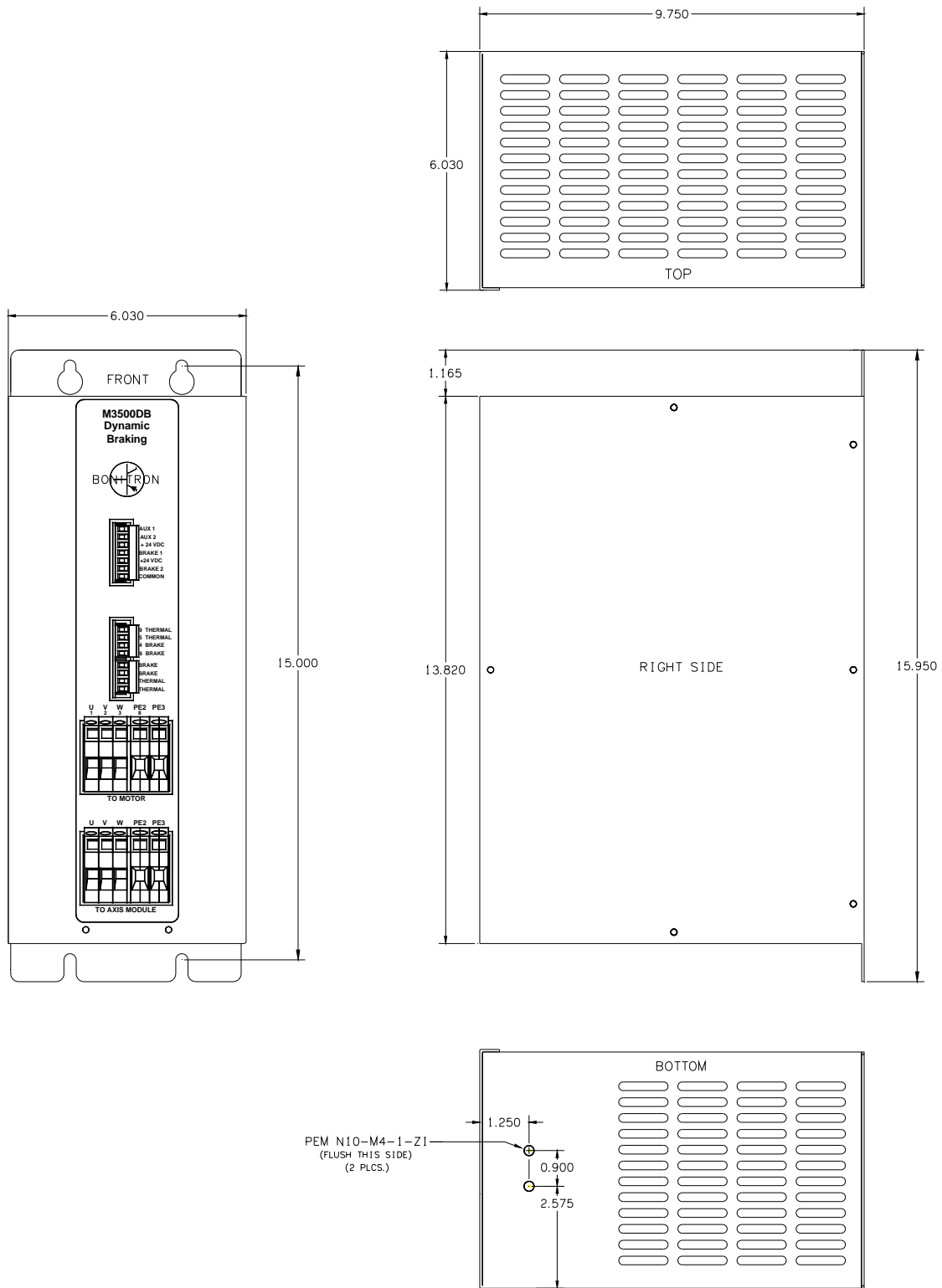


TOP SLOT

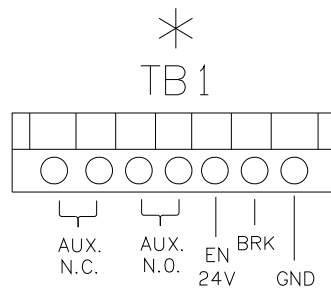
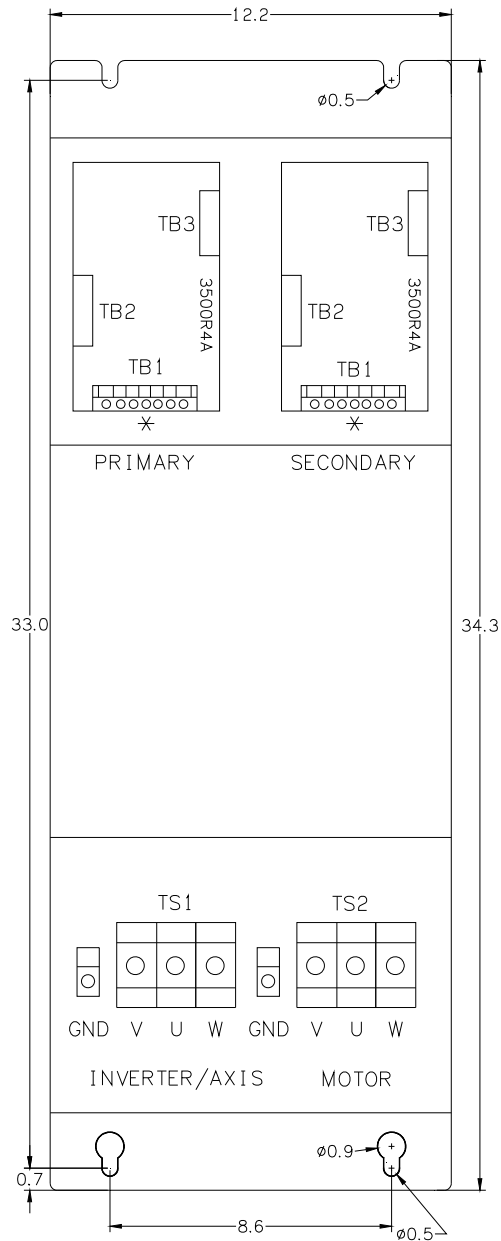
BOTTOM SLOT

SLOTS ACCEPT M6 OR 1/4-20 MOUNTING SCREWS

**Figure 6-3: Dimensional Outline for the 65FLA M3500DB and M3500DB4**



**Figure 6-4: Dimensional Outline for the 150FLA M3500DB and M3500DB4**



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## 7. APPENDICES

### 7.1. APPLICATION NOTES

It is very important to properly size the module to the application. The two main pieces of data are the full load current of the motor during normal operation and the resistance. The full load current of the motor will determine the size contactors required. The M3500DB modules are rated for maximum full load current. If the motor exceeds the rating of the module, use the next larger M3500DB module.

The resistance of the module determines the stopping time of the system. It must also be compatible with the winding impedance of the motor.

The stopping time and torque can be calculated from this resistance.

The best, and usually only, source of information for this resistance is the motor manufacturer and/or motion control simulation software provided by the drive manufacturers. Bonitron provides some selection criteria for the motors in Tables 7-1 thru 7-8, but this data should be checked during the engineering and specification of the system with the drive and motor manufacturers for compatibility and application. For motors not listed, contact your motor or drive manufacturer for assistance.

### 7.2. MOTOR-TO-BRAKING MODULE CROSS REFERENCE TABLES

**Table 7-1: 1326AB Series Motor To M3500DB(4) Cross Reference Table**

1326AB SERIES MOTOR DATA		BONITRON DB MODULE		
MOTOR TYPE	OPTIMUM BRAKING RESISTANCE (OHMS PER LEG)	PART NUMBER		DB MODULE BRAKING RESISTANCE (OHMS PER LEG)
		EN-954 CLASS 2	EN-954 CLASS 4	
1326AB-B410G	18Ω	M3500DB-H16*	M3500DB4-H16*	16Ω
1326AB-B410J	12Ω	M3500DB-H16*	M3500DB4-H16*	16Ω
1326AB-B420E	6Ω	M3500DB-H06*	M3500DB4-H06*	6Ω
1326AB-B420H	6Ω	M3500DB-H06*	M3500DB4-H06*	6Ω
1326AB-B430E	4Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
1326AB-B430G	4Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
1326AB-B515E	3Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
1326AB-B515G	2.5Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
1326AB-B520E	3Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
1326AB-B520F	3Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
1326AB-B530E	2Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
1326AB-B720E	1.5Ω	M3500DB-H01*	M3500DB4-H01*	1Ω
1326AB-B720F	.8Ω	M3500DB-H01*	M3500DB4-H01*	1Ω
1326AB-B730E	1.0Ω	M3500DB-H01*	M3500DB4-H01*	1Ω
1326AB-B740C	1.0Ω	M3500DB-H01*	M3500DB4-H01*	1Ω
1326AB-B740E	1.0Ω	M3500DB-H01*	M3500DB4-H01*	1Ω
1326AB-C3E	1.0Ω	M3500DB-H01*-43	M3500DB4-H01*-43	1Ω

\* A letter **A** in this position of the part number indicates that the module is supplied with **Normally Closed** auxiliary contact outputs. A letter **B** in this position of the part number indicates that the module is supplied with **Normally Open** auxiliary contact outputs.

**Table 7-2: 1326AS Series Motor To M3500DB(4) Cross Reference Table**

1326AS SERIES MOTOR DATA		BONITRON DB MODULE		
MOTOR TYPE	OPTIMUM BRAKING RESISTANCE (OHMS PER LEG)	PART NUMBER		DB MODULE BRAKING RESISTANCE (OHMS PER LEG)
		EN-954 CLASS 2	EN-954 CLASS 4	
1326AS-B310H	36Ω	M3500DB-H36*	M3500DB4-H36*	36Ω
1326AS-B330H	23Ω	M3500DB-H36*	M3500DB4-H36*	36Ω
1326AS-B420G	16Ω	M3500DB-H16*	M3500DB4-H16*	16Ω
1326AS-B440G	10Ω	M3500DB-H16*	M3500DB4-H16*	16Ω
1326AS-B460F	9Ω	M3500DB-H16*	M3500DB4-H16*	16Ω
1326AS-B630F	11Ω	M3500DB-H16*	M3500DB4-H16*	16Ω
1326AS-B660E	6Ω	M3500DB-H06*	M3500DB4-H06*	6Ω
1326AS-B690E	4.5Ω	M3500DB-H06*	M3500DB4-H06*	6Ω
1326AS-B840E	4Ω	M3500DB-H06*	M3500DB4-H06*	6Ω
1326AS-B860C	3Ω	M3500DB-H03*	M3500DB4-H03*	3Ω

- \* A letter **A** in this position of the part number indicates that the module is supplied with **Normally Closed** auxiliary contact outputs.
- \* A letter **B** in this position of the part number indicates that the module is supplied with **Normally Open** auxiliary contact outputs.

**Table 7-3: F Series Motor To M3500DB(4) Cross Reference Table**

F SERIES MOTOR DATA		BONITRON DB MODULE		
MOTOR TYPE	OPTIMUM BRAKING RESISTANCE (OHMS PER LEG)	PART NUMBER		DB MODULE BRAKING RESISTANCE (OHMS PER LEG)
		EN-954 CLASS 2	EN-954 CLASS 4	
F-4030-Q	2.25Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
F-4050-Q	1.25Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
F-4075-R	3.25Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
F-6100-R	0.75Ω	M3500DB-H01*	M3500DB4-H01*	1Ω
F-6200-R	0.80Ω	M3500DB-H01*	M3500DB4-H01*	1Ω
F-6300-R	0.25Ω	M3500DB-H01*	M3500DB4-H01*	1Ω

- \* A letter **A** in this position of the part number indicates that the module is supplied with **Normally Closed** auxiliary contact outputs.
- \* A letter **B** in this position of the part number indicates that the module is supplied with **Normally Open** auxiliary contact outputs.

**Table 7-4: H Series Motor To M3500DB(4) Cross Reference Table**

H SERIES MOTOR DATA		BONITRON DB MODULE		
MOTOR TYPE	OPTIMUM BRAKING RESISTANCE (OHMS PER LEG)	PART NUMBER		DB MODULE BRAKING RESISTANCE (OHMS PER LEG)
		EN-954 CLASS 2	EN-954 CLASS 4	
H-2005-K	0.50Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
H-3007-N	0.50Ω	M3500DB-H01*	M3500DB4-H01*	1Ω
H-3016-N	1.75Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
H-4030-M	0.75Ω	M3500DB-H01*	M3500DB4-H01*	1Ω
H-4030-P	2.0Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
H-4050-P	1.75Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
H-4075-R	1.50Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
H-6100-Q	1.0Ω	M3500DB-H01*	M3500DB4-H01*	1Ω
H-6200-Q	0.50Ω	M3500DB-H01*	M3500DB4-H01*	1Ω
H-6300-Q	0.25Ω	M3500DB-H01*	M3500DB4-H01*	1Ω
H-8350-S	0.50Ω	M3500DB-H01*	M3500DB4-H01*	1Ω
H-8500-S	0.50Ω	M3500DB-H01*	M3500DB4-H01*	1Ω

- \* A letter **A** in this position of the part number indicates that the module is supplied with **Normally Closed** auxiliary contact outputs.
- \* A letter **B** in this position of the part number indicates that the module is supplied with **Normally Open** auxiliary contact outputs.

**Table 7-5: MPL-A Series Motor To M3500DB(4) Cross Reference Table**

MPL-A SERIES MOTOR DATA		BONITRON DB MODULE		
MOTOR TYPE	OPTIMUM BRAKING RESISTANCE (OHMS PER LEG)	PART NUMBER		DB MODULE BRAKING RESISTANCE (OHMS PER LEG)
		EN-954 CLASS 2	EN-954 CLASS 4	
MPL-A310F	13.25Ω	M3500DB-H16*	M3500DB4-H16*	16Ω
MPL-A310P	11Ω	M3500DB-H16*	M3500DB4-H16*	16Ω
MPL-A320H	6.5Ω	M3500DB-H06*	M3500DB4-H06*	6Ω
MPL-A320P	5.75Ω	M3500DB-H06*	M3500DB4-H06*	6Ω
MPL-A330P	3.75Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
MPL-A420P	2.75Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
MPL-A430H	2.25Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
MPL-A430P	1.5Ω	M3500DB-H01*	M3500DB4-H01*	1Ω
MPL-A4520K	3.25Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
MPL-A4520P	2.5Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
MPL-A4530F	3.25Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
MPL-A4530K	1.75Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
MPL-A4540C	3Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
MPL-A4540F	2Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
MPL-A520K	2.5Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
MPL-A540K	1.5Ω	M3500DB-H01*-43	M3500DB4-H01*-43	1Ω
MPL-A560K	1.25Ω	M3500DB-H01*-43	M3500DB4-H01*-43	1Ω

- \* A letter **A** in this position of the part number indicates that the module is supplied with **Normally Closed** auxiliary contact outputs.
- \* A letter **B** in this position of the part number indicates that the module is supplied with **Normally Open** auxiliary contact outputs.

**Table 7-6: MPL-B Series Motor To M3500DB(4) Cross Reference Table**

MPL-B SERIES MOTOR DATA		BONTRON DB MODULE		
MOTOR TYPE	OPTIMUM BRAKING RESISTANCE (OHMS PER LEG)	PART NUMBER		DB MODULE BRAKING RESISTANCE (OHMS PER LEG)
		EN-954 CLASS 2	EN-954 CLASS 4	
MPL-B310P	50Ω	M3500DB-H36*	M3500DB4-H36*	36Ω
MPL-B320P	20.25Ω	M3500DB-H36*	M3500DB4-H36*	36Ω
MPL-B330P	13.5Ω	M3500DB-H16*	M3500DB4-H16*	16Ω
MPL-B420P	10Ω	M3500DB-H16*	M3500DB4-H16*	16Ω
MPL-B430P	6.5Ω	M3500DB-H06*	M3500DB4-H06*	6Ω
MPL-B4520P	10Ω	M3500DB-H16*	M3500DB4-H16*	16Ω
MPL-B4530F	11.25Ω	M3500DB-H16*	M3500DB4-H06*	16Ω
MPL-B4530K	7.25Ω	M3500DB-H06*	M3500DB4-H06*	6Ω
MPL-B4540F	8.25Ω	M3500DB-H06*	M3500DB4-H06*	6Ω
MPL-B4540K	9Ω	M3500DB-H06*	M3500DB4-H06*	6Ω
MPL-B520K	11.25Ω	M3500DB-H16*	M3500DB4-H16*	16Ω
MPL-B540K	5.75Ω	M3500DB-H06*	M3500DB4-H06*	6Ω
MPL-B560F	4.5Ω	M3500DB-H06*	M3500DB4-H06*	6Ω
MPL-B580J	3Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
MPL-B640F	3.5Ω	M3500DB-H03*-43	M3500DB4-H03*-43	3Ω
MPL-B660F	2.25Ω	M3500DB-H03*-43	M3500DB4-H03*-43	3Ω
MPL-B680D	2.5Ω	M3500DB-H03*-43	M3500DB4-H03*-43	3Ω
MPL-B680F	1.75Ω	M3500DB-H03*-65	M3500DB4-H03*-65	3Ω
MPL-B860D	2.25Ω	M3500DB-H03*-65	M3500DB4-H03*-65	3Ω
MPL-B880C	2Ω	M3500DB-H03*-65	M3500DB4-H03*-65	3Ω
MPL-B960B	4.25Ω	M3500DB-H06*-65	M3500DB4-H06*-65	6Ω
MPL-B960C	2.5Ω	M3500DB-H03*-65	M3500DB4-H03*-65	3Ω
MPL-B960D	2.75Ω	M3500DB-H03*-65	M3500DB4-H03*-65	3Ω
MPL-B980B	3.75Ω	M3500DB-H03*-65	M3500DB4-H03*-65	3Ω
MPL-B980C	2.25Ω	M3500DB-H03*-65	M3500DB4-H03*-65	3Ω
MPL-B980D	2.25Ω	M3500DB-H03*-65	M3500DB4-H03*-65	3Ω

- \* A letter **A** in this position of the part number indicates that the module is supplied with **Normally Closed** auxiliary contact outputs.
- \* A letter **B** in this position of the part number indicates that the module is supplied with **Normally Open** auxiliary contact outputs.

**Table 7-7: N Series Motor To M3500DB(4) Cross Reference Table**

N SERIES MOTOR DATA		BONITRON DB MODULE		
MOTOR TYPE	OPTIMUM BRAKING RESISTANCE (OHMS PER LEG)	PART NUMBER		DB MODULE BRAKING RESISTANCE (OHMS PER LEG)
		EN-954 Class 2	EN-954 Class 4	
N-2302-1	2.0Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
N-2304-1	4.0Ω	M3500DB-H06*	M3500DB4-H06*	6Ω
N-3406-2	1.8Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
N-3412-2	5.0Ω	M3500DB-H06*	M3500DB4-H06*	6Ω
N-4214-2	2.9Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
N-4220-2	2.0Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
N-5630-2	2.25Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
N-5637-2	2.75Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
N-5647-2	3.0Ω	M3500DB-H03*	M3500DB4-H03*	3Ω

- \* A letter **A** in this position of the part number indicates that the module is supplied with **Normally Closed** auxiliary contact outputs.
- \* A letter **B** in this position of the part number indicates that the module is supplied with **Normally Open** auxiliary contact outputs.

**Table 7-8: Y Series Motor To M3500DB(4) Cross Reference Table**

Y SERIES MOTOR DATA		BONITRON DB MODULE		
MOTOR TYPE	OPTIMUM BRAKING RESISTANCE (OHMS PER LEG)	PART NUMBER		DB MODULE BRAKING RESISTANCE (OHMS PER LEG)
		EN-954 CLASS 2	EN-954 CLASS 4	
Y-1002-1	0.50Ω	M3500DB-H01*	M3500DB4-H01*	1Ω
Y-1002-2	1.25Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
Y-1003-1	0.25Ω	M3500DB-H01*	M3500DB4-H01	1Ω
Y-1003-2	1.50Ω	M3500DB-H01*	M3500DB4-H01*	1Ω
Y-2006-1	1.0Ω	M3500DB-H01*	M3500DB4-H01*	1Ω
Y-2006-2	1.25Ω	M3500DB-H03*	M3500DB4-H03*	3Ω
Y-2012-1	1.50Ω	M3500DB-H01*	M3500DB4-H01*	1Ω
Y-2012-2	5.0Ω	M3500DB-H06*	M3500DB4-H06*	6Ω
Y-3023-2	2.5Ω	M3500DB-H03*	M3500DB4-H03*	3Ω

- \* A letter **A** in this position of the part number indicates that the module is supplied with **Normally Closed** auxiliary contact outputs.
- \* A letter **B** in this position of the part number indicates that the module is supplied with **Normally Open** auxiliary contact outputs.

### 7.3. DECELERATION TIME CALCULATION FOR SERVO MOTORS

The deceleration time can be calculated given certain properties of the motor and braking unit. The time can be calculated through the equation (1):

$$t = -\ln\left(\frac{\omega_f}{\omega_\theta}\right) * \frac{104.7 * R * J}{k_e * k_t}$$

Where:

- $t$  is the elapsed time (seconds).
- $\omega_f$  is the final velocity of the motor
- $\omega_\theta$  is the initial angular velocity of the motor

Ex: For time required to slow initial rotational velocity to 5% of operation speed,  $\frac{\omega_f}{\omega_\theta} = 0.05$

- 104.7 is the conversion factor to convert  $k_e$  from KRPM to radians/second.
- $k_e$  is the motor voltage constant (Volts/KRPM).
- $k_t$  is the motor torque constant (lb\*in/Amp).
- $J$  is the total system inertia (motor inertia + reflected load inertia).
- $R$  is the total dynamic braking resistance (motor armature + cables + resistors)

$R$  is calculated by summing the equivalent resistance of the braking resistors with the cables and the armature resistance as in the following equation (2):

$$R = (2 * R_{db}) + R_{ma} + R_{mc}$$

Where:

- $R$  is the total dynamic braking resistance.
- $R_{db}$  is the resistance in a leg of the braking resistor.
- $R_{ma}$  is the motor armature resistance .
- $R_{mc}$  is the motor cable resistance .

For example:

- $R_{db} = 0.845$  Ohms
- $R_{ma} = 0.23$  Ohms
- $R_{mc} = 0.25$  Ohms

$$R = (2 * R_{db}) + R_{ma} + R_{mc}$$

$$R = (2 * 0.845) + 0.23 + 0.25 = 2.17 \text{ Ohms}$$

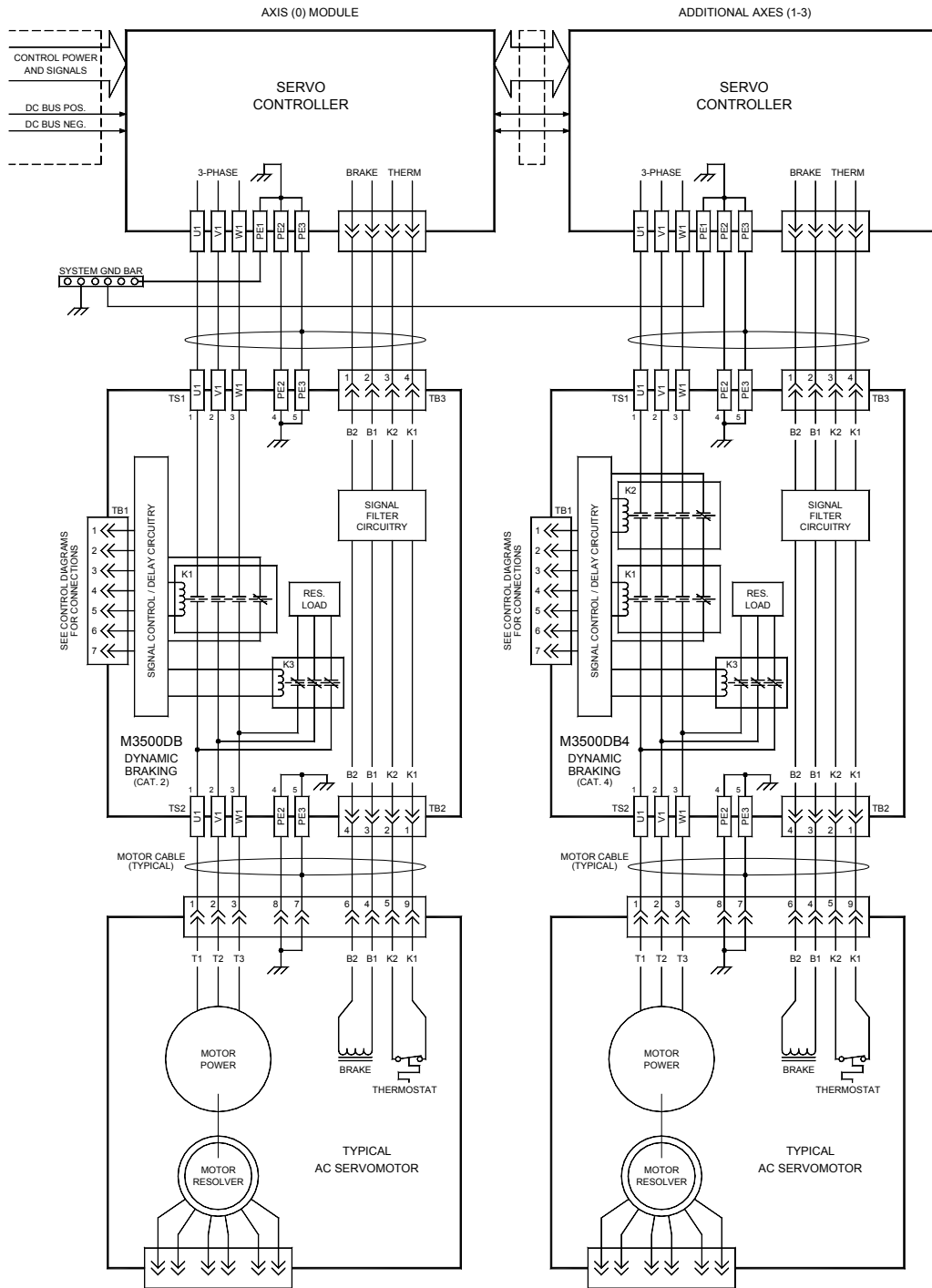
Given the values:

- $\frac{\omega_f}{\omega_\theta} = 0.05$
- $k_e = 136.2$  V/KRPM
- $k_t = 19.9$  lb\*in/Amp
- $J = 0.5044$  lb\*in/sec<sup>2</sup>
- $R = 2.17$  Ohms

We plug these into equation (1) to get:

$$t = -\ln(.05) * \frac{104.7 * 2.17 * 0.544}{136.2 * 19.9} = 0.127 \text{ s}$$

## Figure 7-1: M3500DB and M3500DB4 Dynamic Safety Brake Field Interconnection





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