Model M3452

Heavy Duty Braking Transistor

K6, K9, K10, M14, T10 Chassis
R7, R7E Options

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.

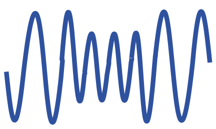
The Bonitron engineering team has the background and expertise necessary to design, develop, and manufacture the quality industrial electronic systems demanded in today’s market. A strong academic background supported by continuing education is complemented by many years of hands-on field experience. 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

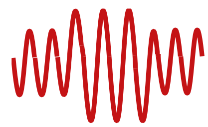
In 1975, Bonitron began working with AC inverter drive specialists at synthetic fiber plants to develop speed control systems that could be interfaced with their plant process computers. Ever since, Bonitron has developed AC drive options that solve application issues associated with modern AC variable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

World Class Products



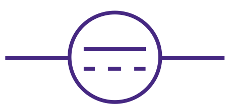
Undervoltage Solutions

Uninterruptible Power for Drives
(DC Bus Ride-Thru)
Voltage Regulators
Chargers and Dischargers
Energy Storage



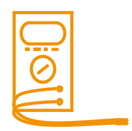
Overvoltage Solutions

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



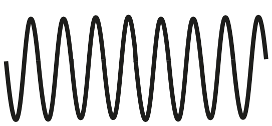
Common Bus Solutions

Single Phase Power Supplies
3-Phase Power Supplies
Common Bus Diodes



Portable Maintenance Solutions

Capacitor Formers
Capacitor Testers



Power Quality Solutions

12 and 18 Pulse Kits

Green Solutions

Line Regeneration

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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 AC Drive System.

Please keep this manual for future reference.

1.2. PURPOSE AND SCOPE

This manual is a user's guide for the Model M3452 Dynamic Braking Transistor Module. It will provide the user with the necessary information to successfully install, integrate, and use the M3452 Dynamic Braking Transistor Module in a variable frequency AC drive 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

The "D" Control Voltage and "L" Braking Current Ratings were added in Rev 03.

DC bus information was expanded in Rev 03a.

Dimensional Outlines were updated in Rev 03b.

Connection drawings were updated in Rev 03c.

Certification information and link length limits were updated in Rev 03d.

The T10 Chassis was added in Rev 03e.

The text was rotated in Figure 3-5 in Rev 03f.

Manual template was updated in Rev 03g.

Figure 6-5 was updated in Rev 03h.

Update covers minor edits in Rev 03i.

Added Altitude to table 2-6 in Rev 03j.

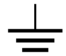
Updated table 3-1 & fixed headers & footers in Rev 03k.

Figure 1-1: Typical M3452 - R7

K9 CHASSIS

M14 CHASSIS

1.4. SYMBOL CONVENTIONS USED IN THIS MANUAL AND ON EQUIPMENT

	Earth Ground or Protective Earth
	AC Voltage
	DC Voltage
 DANGER!	DANGER: Electrical hazard - Identifies a statement that indicates a shock or electrocution hazard that must be avoided.
 DANGER!	DANGER: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss.
 CAUTION!	CAUTION: Identifies information about practices or circumstances that can lead to property damage, or economic loss. Attentions help you identify a potential hazard, avoid a hazard, and recognize the consequences.
 CAUTION!	CAUTION: Heat or burn hazard - Identifies a statement regarding heat production or a burn hazard that should be avoided.

2. PRODUCT DESCRIPTION

Bonitron M3452 Heavy Duty Braking Transistors are used with AC drives to allow full power braking and eliminate overvoltage faults. This permits controlled braking and dramatically shortens motor stopping time.

The M3452 works with variable frequency drives (with DC bus connections) to monitor the DC bus. If overvoltage occurs, the M3452 shunts the excess energy through an external braking resistor to prevent overvoltage faults.

The need for regenerated voltage control occurs in applications where the frequency of an AC motor at times exceeds that of its variable frequency drive. In this case, the motor acts as a generator. The energy generated by the motor must be dissipated as heat or returned to the power line. If this energy is not controlled, the motor may run with high peak voltages, the energy may be dissipated as heat in the motor, or the drive may trip on an over-voltage condition.

The R7 option allows for Master/Slave operation to be changed on the fly in multiple module systems to allow for fault redundancy in the control sections for critical applications.

The R7E option includes all the functions of the R7 option, while adding extended status I/O as well as the bus discharge feature. This can be used to drain a capacitor bank for quicker servicing at power down. This can be an issue with drive systems that have large capacitor banks or use oversized capacitor banks for power dip immunity. Under normal circumstances, these banks can take excessive amounts of time to reach safe working levels. The bus discharge feature allows the braking system to be used as the bleeder resistor, and brings the bus voltage down much quicker.

2.1. RELATED DOCS

The M3452 series is one of several overvoltage solutions offered by Bonitron. Below are a few related products, including braking resistors that are used in conjunction with the M3452 series.

BRAKING TRANSISTORS

- Like the M3452 heavy duty braking transistors, Bonitron M3575T and M3675T standard duty braking transistors work with variable frequency drives (with DC bus connections) to monitor the DC bus. If overvoltage occurs, the M3575T or M3675T shunts the excess energy through an external braking resistor to prevent overvoltage faults. The M3575T series is rated up to 600A peak / 20% duty, while the M3675T series is rated up to 10A peak / 20% duty.

BRAKING RESISTORS

- Bonitron offers resistor solutions to complement its braking transistor selection. The M3575R series is rated up to 32A peak / 20% duty, while the M3775R series is rated up to 1600A / 100% duty. Custom resistors are also available.

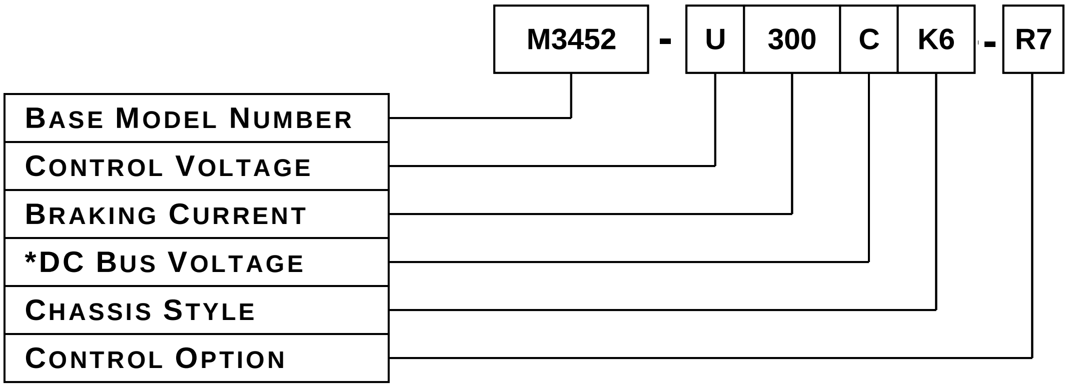
LINE REGENERATION

- Bonitron is famous for its industry-leading line regeneration solutions. The Bonitron M3645 line regen returns regenerative energy back onto the AC line instead of dissipating the energy as heat in a resistor, and is ideal for applications with high duty cycles, frequent deceleration, or where heat from a resistor may be an issue. The M3645 line regen features an interactive digital display with event logging.

Please contact your AC drive distributor or visit our website at www.bonitron.com for more information on these additional products.

2.2. PART NUMBER BREAKDOWN

Figure 2-1: M3452 Part Number Breakdown



BASE MODEL NUMBER

The Base Model Number for all dynamic braking transistor modules is **M3452**.

CONTROL VOLTAGE RATING

The Control Voltage Rating indicates the voltage level to be used to supply control power to the unit. Most units utilize the AC line voltage supplied to the drive system. However, this is not required. Other AC voltage sources can be used if desired. Refer to the unit specifications to determine the voltage source. The control voltage is indicated by a code letter.

Table 2-1: Control Voltage Rating

CONTROL VOLTAGE RATING CODE	VOLTAGES
U	115-120 VAC
L	230-240 VAC
E	380-415 VAC
H	460-480 VAC
C	575-600 VAC
D	24 VDC

BRAKING CURRENT RATING

The Braking Current Rating indicates the maximum current level that can safely be handled by the M3452 dynamic braking transistor module.

The Braking Current Rating is indicated by a 3 or 4-digit number. For example, **300** would indicate a Braking Current Rating of 300 Amps maximum.

Table 2-2: Available Braking Current Ratings

AVAILABLE CURRENT RATINGS (ADC)
200, 300, 600, 800, 1200, 1600

*DC BUS VOLTAGE

*This code is used **only** if different from the Control Voltage Rating.*

Omit this position if control voltage is the same as nominal AC line voltage.

The DC bus voltage indicates the voltage regulation level of the DC bus if the control voltage input does not correspond to the actual drive bus being controlled.

The DC bus voltage uses the codes L, E, H, C, and Y for the control voltage ratings.

Table 2-3: DC Bus Voltage Rating

VOLTAGE RATING CODE	VOLTAGES (Nominal AC Line / DC Bus Trigger Level)
L	230 - 240VAC Line / 375VDC
E	380 - 415VAC Line / 620VDC
H	460 - 480VAC Line / 750VDC
C	575 - 600VAC Line / 940VDC
Y	690VAC Line / 1090VDC
Nxxxx	Special (xxxxVDC)

Nxxxx is used only for custom trigger levels. Contact Bonitron before specifying Nxxxx.

CHASSIS STYLE

The Chassis Style code represents the chassis type and size of the dynamic braking transistor module.

Table 2-4: Chassis Codes

CHASSIS CODE	CURRENT (AMPS)	TYPE	DIMENSIONS (H" X W" X D")
K6	200-600	Open Chassis	20.00 x 7.12 x 10.50
K9	800	Open Chassis	20.00 x 9.05 x 10.25
K10	1200	Open Chassis	20.00 x 10.00 x 10.50
M14	1600	Open Chassis	28.00 x 13.90 x 14.60
T10	1600	Open Chassis	30.60 x 10.12 x 19.20

CONTROL OPTIONS

A code following a dash in this position denotes that the indicated option is installed within the dynamic braking transistor module. See Table 2-5 below for a list of available options. Please contact Bonitron if you have any other special requirements.

Table 2-5: Control Option Codes

CONTROL OPTION CODE	DESCRIPTION
R7	R7 Control Board
R7E	R7 Control Board with Extended I/O

2.3. General Specifications

Table 2-6: General Specifications

Parameter	Specification		
DC Bus Voltage	325 - 1090VDC		
DC Braking Current	200 - 1600ADC		
Control Voltage	Single Phase, 115, 230, 380, 460, 575VAC ±10% 50/60Hz 70VA 24VDC ±10%		
Indicators	DC Bus Control Power Active Braking		
Logic I/O		Inputs – dry contact	Outputs – Max 140VAC/200VDC @ 100mA
	R7	Enable Master/Slave Select Fault Reset	Control Ready Master/Slave Status Power Stage Ready Instantaneous Overcurrent
	R7E	DC Bus Discharge	Logic Power OK Not IGBT Shorted Not Overtemp Not Blown Fuse
Control I/O	R7 R7E	Sharing Control Signal	
Operating Temp	0° to 40°C		
Storage Temp	-20° to 65°C		
Humidity	Below 90%, non-condensing		
Atmosphere	Free of corrosive gas or conductive dust		
Altitude	Up to 1000 Meters (3000 feet) above sea level*		

*Units must be derated by 2% for every 300 meters (1000 feet) above 1000 meters (3000 feet) sea level.

GENERAL PRECAUTIONS AND SAFETY WARNINGS

DANGER!

- HIGH VOLTAGES MAY BE PRESENT!
- NEVER ATTEMPT TO SERVICE THIS PRODUCT WITHOUT FIRST DISCONNECTING FROM THE INCOMING AC POWER AND DC BUS.
- ALWAYS ALLOW ADEQUATE TIME FOR RESIDUAL VOLTAGES TO DRAIN BEFORE ATTEMPTING SERVICE.
- BEFORE ATTEMPTING INSTALLATION OR REMOVAL OF THIS PRODUCT, BE SURE TO REVIEW ALL AC DRIVE DOCUMENTATION FOR PERTINENT SAFETY PRECAUTIONS.
- INSTALLATION AND/OR REMOVAL OF THIS PRODUCT SHOULD ONLY BE DONE BY A QUALIFIED ELECTRICIAN IN ACCORDANCE WITH NATIONAL ELECTRICAL CODE OR EQUIVALENT REGULATIONS.
- **FAILURE TO HEED THESE WARNINGS MAY RESULT IN SERIOUS BODILY INJURY OR DEATH.**

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CAUTION!

- THIS PRODUCT WILL GENERATE HEAT DURING OPERATION.
- THIS PRODUCT SHOULD BE INSTALLED ACCORDINGLY ON NON-FLAMMABLE SURFACES WITH CLEARANCES OF AT LEAST TWO INCHES IN ALL DIRECTIONS.
- ALWAYS ALLOW AMPLE TIME FOR THE UNIT TO COOL BEFORE ATTEMPTING SERVICE ON THIS PRODUCT.
- ALWAYS BE SURE THE BRAKING CAPACITY OF THE CHOPPER AND LOAD BANK DOES NOT EXCEED THE CAPACITY OF THE CONNECTED DRIVE!
- REVIEW THE APPLICATION NOTE IN SECTION 7 OF THIS MANUAL FOR INFORMATION ABUT COMMON DC BUS SYSTEMS.

Important Notice about Drives with DC Link Chokes!

- DURING BRAKING SITUATIONS, ENERGY STORED IN A DRIVE'S DC LINK CHOKES CAN CREATE EXTREME OVER-VOLTAGE CONDITIONS FOR DYNAMIC BRAKING CONTROL MODULES. TO AVOID THESE CONDITIONS, DC CONNECTIONS FROM RESISTIVE BRAKING CONTROL MODULES TO THE DRIVE SYSTEM MUST ALWAYS BE MADE DIRECTLY IN PARALLEL WITH THE DRIVE'S FILTER CAPACITORS. THESE MODULES SHOULD NEVER BE CONNECTED IN SERIES WITH A DRIVE'S DC LINK CHOKES.
- BE SURE TO REVIEW THE PERTINENT AC DRIVE DOCUMENTATION TO ENSURE THAT THE PROPER CONNECTIONS ARE USED.
- CONTACT THE DRIVE MANUFACTURER OR EQUIPMENT SUPPLIER FOR ASSISTANCE WITH DRIVE CONNECTIONS.

ANY QUESTIONS RELATING TO APPLICATION, INSTALLATION, OR SERVICE SAFETY SHOULD BE DIRECTED TO THE EQUIPMENT SUPPLIER.

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3. INSTALLATION INSTRUCTIONS

DANGER!

Installation and/or removal of this product should only be performed by a qualified electrician in accordance with National Electrical Code or local codes and regulations.

Proper installation of the model M3452 resistive brake module should be accomplished following the steps outlined below. Be sure to refer to all other pertinent system documentation as these steps are performed. Please direct all installation inquiries that may arise during the installation and startup of this product to the equipment supplier or system integrator.

3.1. PRODUCT INSPECTION

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.

3.2. SITE SELECTION

The installation site for the module should be chosen with several considerations in mind:

- All units require adequate protection from the elements.
- Adequate clearance should be allowed for easy access to terminals and adjustments. This will facilitate inspection and maintenance.
- Sufficient circulation of clean, dry air should be provided. Ambient temperatures should not exceed +40°C (+104°F) nor be less than 0°C (+32°F) and non-condensing. Ambient air should not be contaminated with harmful chemical vapors or excessive dust, dirt, or moisture.
- The unit will require a minimum clearance of six (6) inches above and below it to allow for proper airflow for cooling. Avoid mounting the unit with its air intake near heat sources.

3.3. MOUNTING

Once the installation site has been selected as outlined above, and the mounting holes drilled and mounting studs or anchors installed, the resistive brake module is ready to be hung in position. Be sure all mounting hardware is tightened securely.

Refer to Section 6.6 of this manual to determine the correct mounting dimensions and provisions for the unit.

3.4. WIRING AND CUSTOMER CONNECTIONS

3.4.1. POWER WIRING

DANGER!

Only qualified electricians should perform and maintain the interconnection wiring of this product. All wiring should be done in accordance with local codes.

Wire size should be selected in accordance with local codes, according to the current rating of the braking transistor. Use copper conductors rated 75°C. In general, the wire type should be selected by the nominal system AC voltage and the current rating of the module.

Table 3-1: Power Wiring Specifications

CHASSIS	TERMINAL	CONNECTION	TORQUE
K6	DC+, DC-, RES+, RES-	3/8" stud	192 lb-in
K9	DC+, DC-, RES+, RES-	1/2" stud	300 lb-in
K10	DC+, DC-, RES+, RES-	1/2" stud	300 lb-in
M14	DC+, DC-, RES+, RES-	Bus Bar	N/A
T10	DC+, DC-, RES+, RES-	Bus Bar	N/A

3.4.1.1. DC BUS CONNECTION

As a general rule of thumb, 30 feet (10m) is the maximum total buswork or cable that the chopper should be mounted from the drive. This means that the actual installation distance should be 15 feet (5m), as the cable must go out and back. If you must connect the choppers farther away, see the information below.

The braking transistor must be connected directly to the DC bus filter capacitors of the drive.

Figure 3-8 is an example of the terminals that may be available in your installation. Not all of the terminals may be on your drive. Refer to the drive manufacturer's manual or technical documents to locate the proper terminals. Your drive will have different terminal markings depending on manufacturer and drive series.

Ensure that the polarity of the connection is correct. Incorrect polarity will effectively short the DC bus of the drive, and can cause severe damage to the drive, load resistor, and the Bonitron braking transistor.

The proper terminals to attach the braking transistor are marked + and - on Figure 3-8. The terminals marked BR+ and BR– are intended for the internal braking transistor. If the Bonitron external braking transistor is hooked to the terminals, the braking transistor will not operate properly. In some cases, it may cause drive failure.

The terminals marked X and Y are intended for connection of a DC link choke. If the Bonitron braking transistor is connected to the terminals marked "X" and "-" in Figure 3-8, switching resonances caused by the DC link choke will destroy the braking transistor. If the Bonitron braking transistor is connected between X and Y, the drive will not operate.

If the braking transistor is connected to the terminals marked "A" and "B" in Figure 3-8, switching resonances caused by the lack of filter capacitance during precharge will destroy the braking transistor.

3.4.1.2. RESISTOR CONNECTION

The polarity of the resistor connections is not critical; however, it is critical that the resistor be connected to the proper terminals. Improper hookup can lead to the resistor being connected directly across the DC bus, which will cause severe overheating and drive stress.

3.4.1.3. GROUNDING REQUIREMENTS

All units come equipped with either a ground terminal or ground stud that is connected to the module chassis. Ground the chassis in accordance with local codes. Typically, the wire gauge will be the same as is used to ground the attached drive.

3.4.2. I/O WIRING

Table 3-2: I/O Terminal Block Specifications: R7 Control Board

TERMINAL	FUNCTION	ELECTRICAL SPECIFICATIONS	MIN WIRE AWG	MAX WIRE AWG	TORQUE
TB1-1	Control Voltage L1 24V (+)	24V – 3A * 24V – 8A * 120V – 0.6A 230V – 0.3A 460V – 0.16A 575V – 0.15A	16	10	4.5 lb-in
TB1-2	Control Voltage L2 24V (-)	24V – 3A * 24V – 8A * 120V – 0.6A 230V – 0.3A 460V – 0.16A 575V – 0.15A	16	10	4.5 lb-in
TB2-1&2	Control Ready Output	140VAC / 200VDC @ 100mA max.	18	12	4.5 lb-in
TB2-3&4	Enable Input	Dry Contact (24V, 100mA)	18	12	4.5 lb-in
TB2-5&6	Power Stage Ready Output	140VAC / 200VDC @ 100mA max.	18	12	4.5 lb-in
TB2-7&8	Master/Slave Select Input	Dry Contact (24V, 100mA)	18	12	4.5 lb-in
TB2-9&10	Master/Slave Status Output	140VAC / 200VDC @ 100mA max.	18	12	4.5 lb-in
TB2-11&12	Control Signal I/O	Analog	18	12	4.5 lb-in
TB2-13&14	IOC Output	140VAC / 200VDC @ 100mA max.	18	12	4.5 lb-in
TB2-15&16	Fault Reset Input	Dry Contact (24V, 100mA)	18	12	4.5 lb-in

* 24V – 3A for 200A thru 1200A units. 24V – 8A for 1600A units.

Table 3-2: Terminal Block Specifications continues on the next page.

R7E also includes:

TERMINAL	FUNCTION	ELECTRICAL SPECIFICATIONS	MIN WIRE AWG	MAX WIRE AWG	TORQUE
TB4-1&2	Discharge Bus Input	Dry Contact (24V, 100mA)	18	12	4.5 lb-in
TB4-3&4	Logic Power OK Output	140VAC / 200VDC @ 100mA max.	18	12	4.5 lb-in
TB4-5&6	Temperature OK Output	140VAC / 200VDC @ 100mA max.	18	12	4.5 lb-in
TB4-7&8	Not currently used		18	12	4.5 lb-in
TB4-9&10	Not Shorted IGBT	140VAC / 200VDC @ 100mA max.	18	12	4.5 lb-in
TB4-11&12	Not Blown Fuse	140VAC / 200VDC @ 100mA max.	18	12	4.5 lb-in

3.4.3. DC CONTROL WIRING

M3452-Dxxx units have 24VDC for control power. This connection is on ASB 3452I5 TB1 with positive in terminal 1 and negative in terminal 2. See Figure 3-8.

Figure 3-1: Customer Connections in K6 Chassis

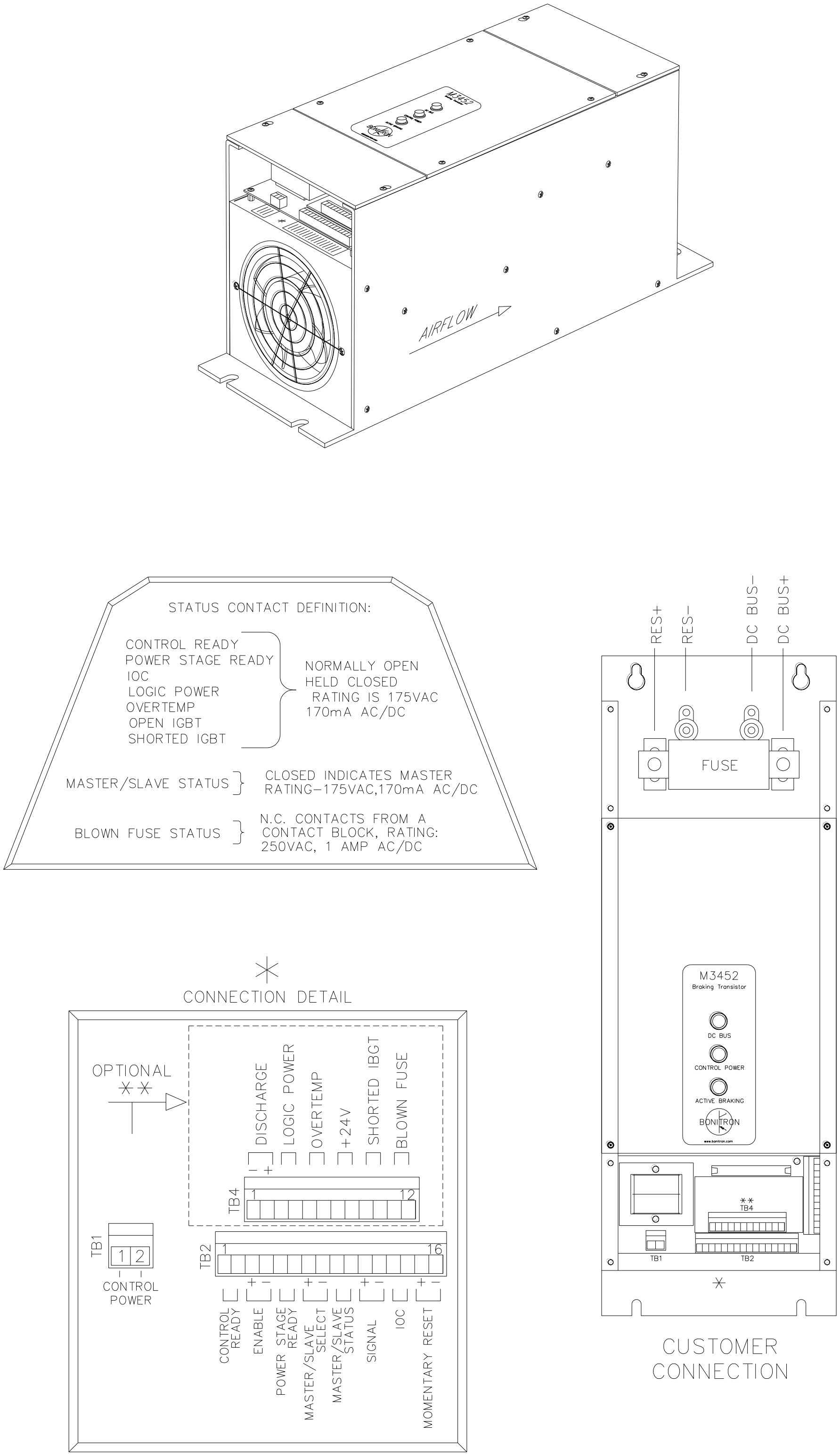
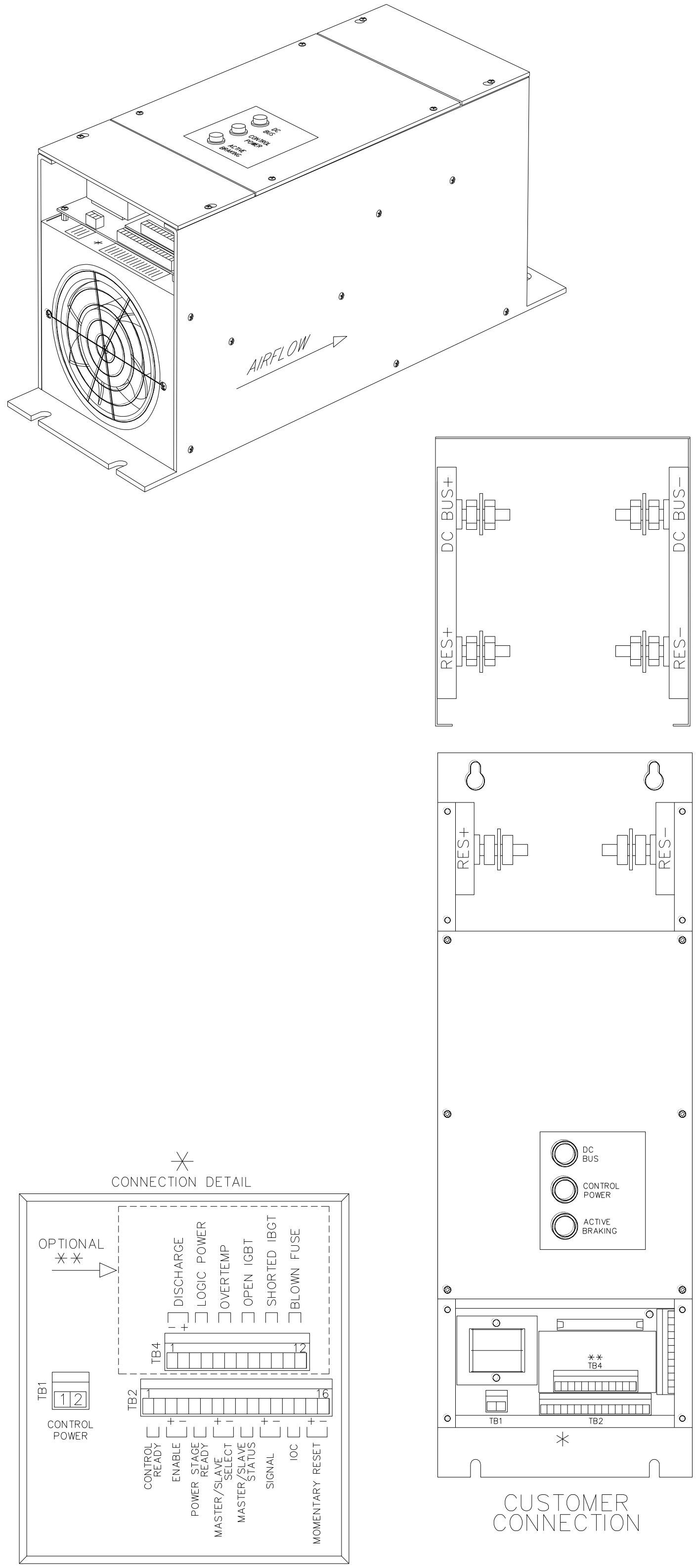


Figure 3-2: Customer Connections in K9 Chassis



<u>Figure 3-3: Customer Connections in K10 Chassis</u>

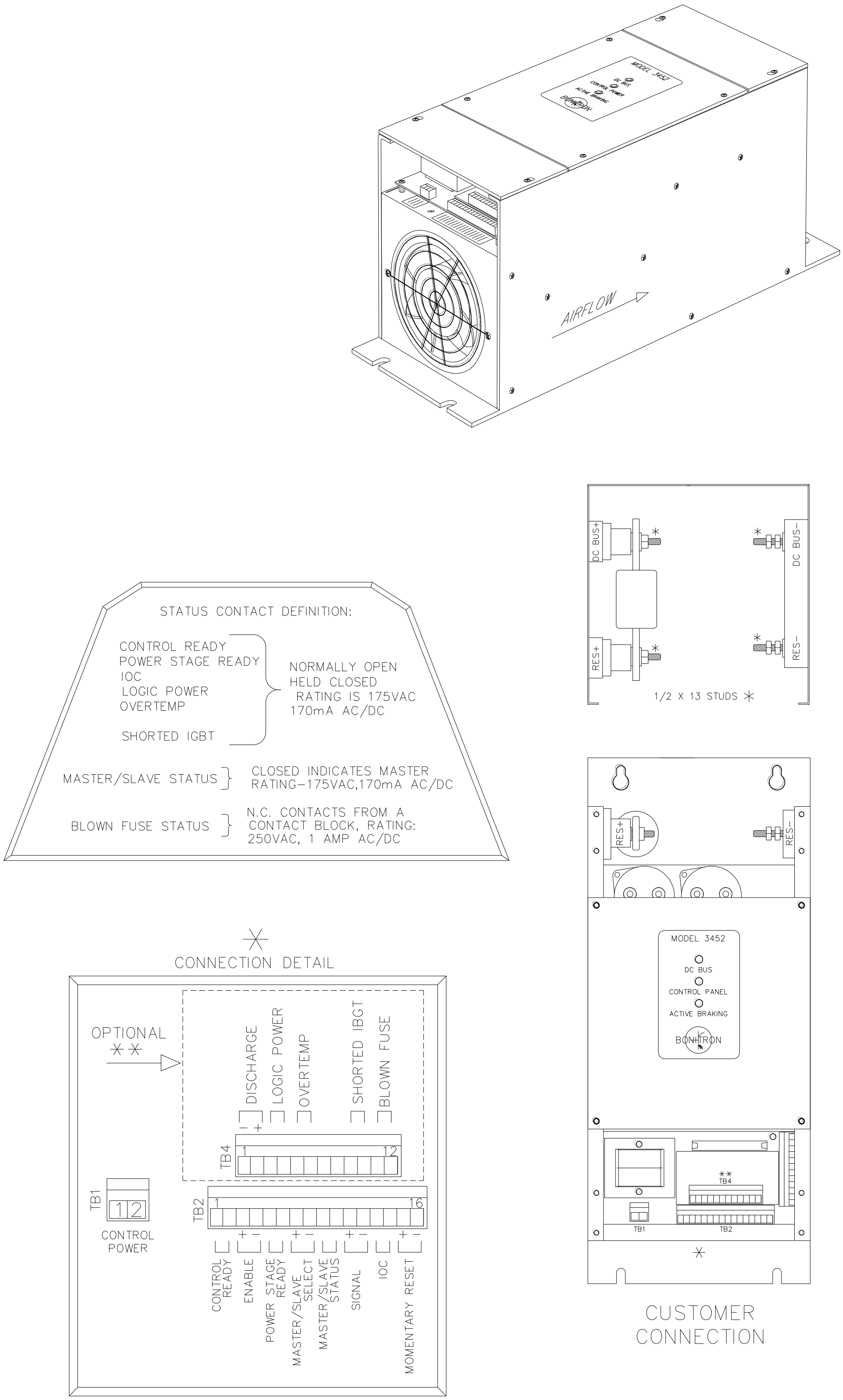


Figure 3-4: Customer Connections in M14 Chassis

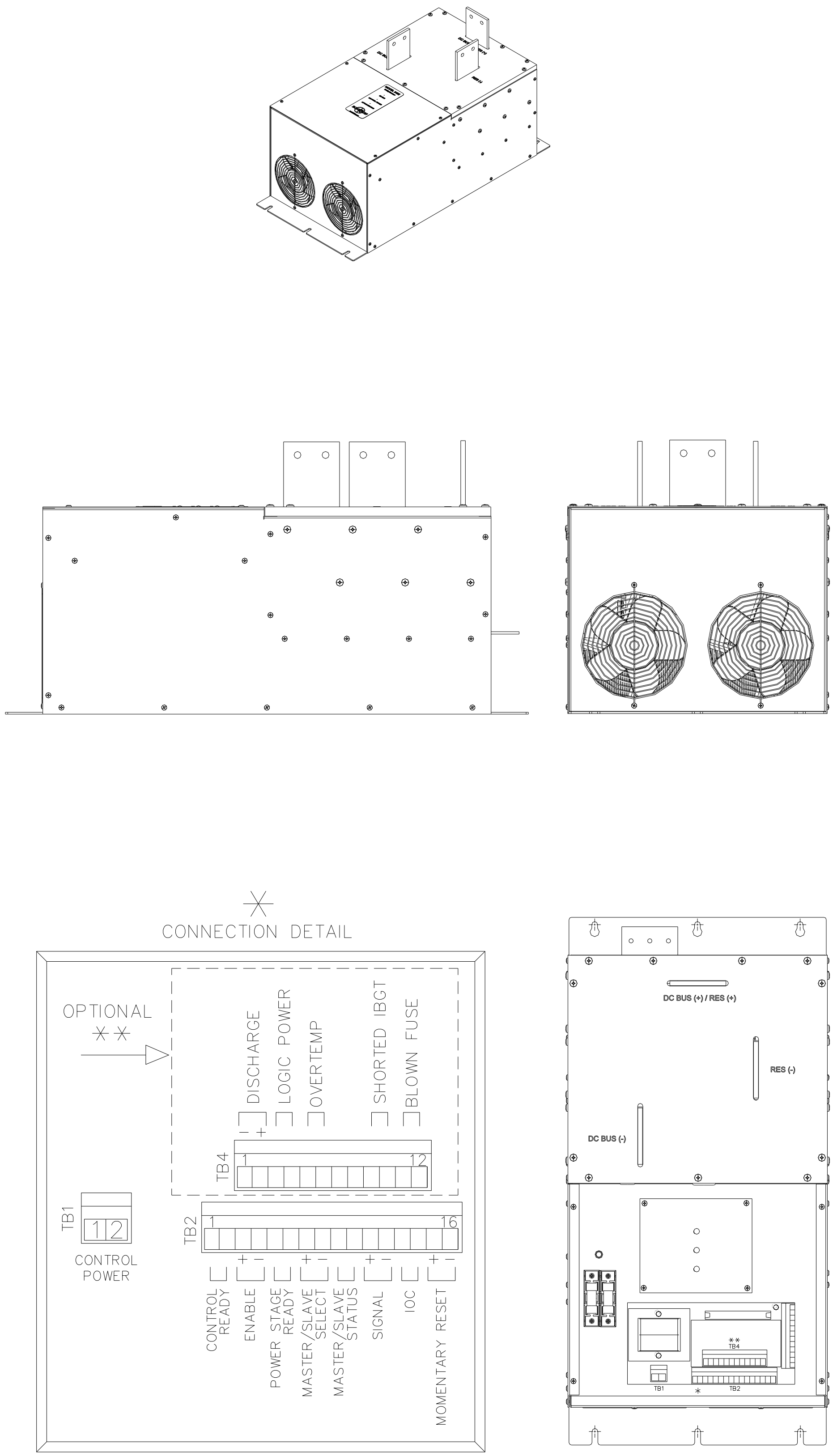
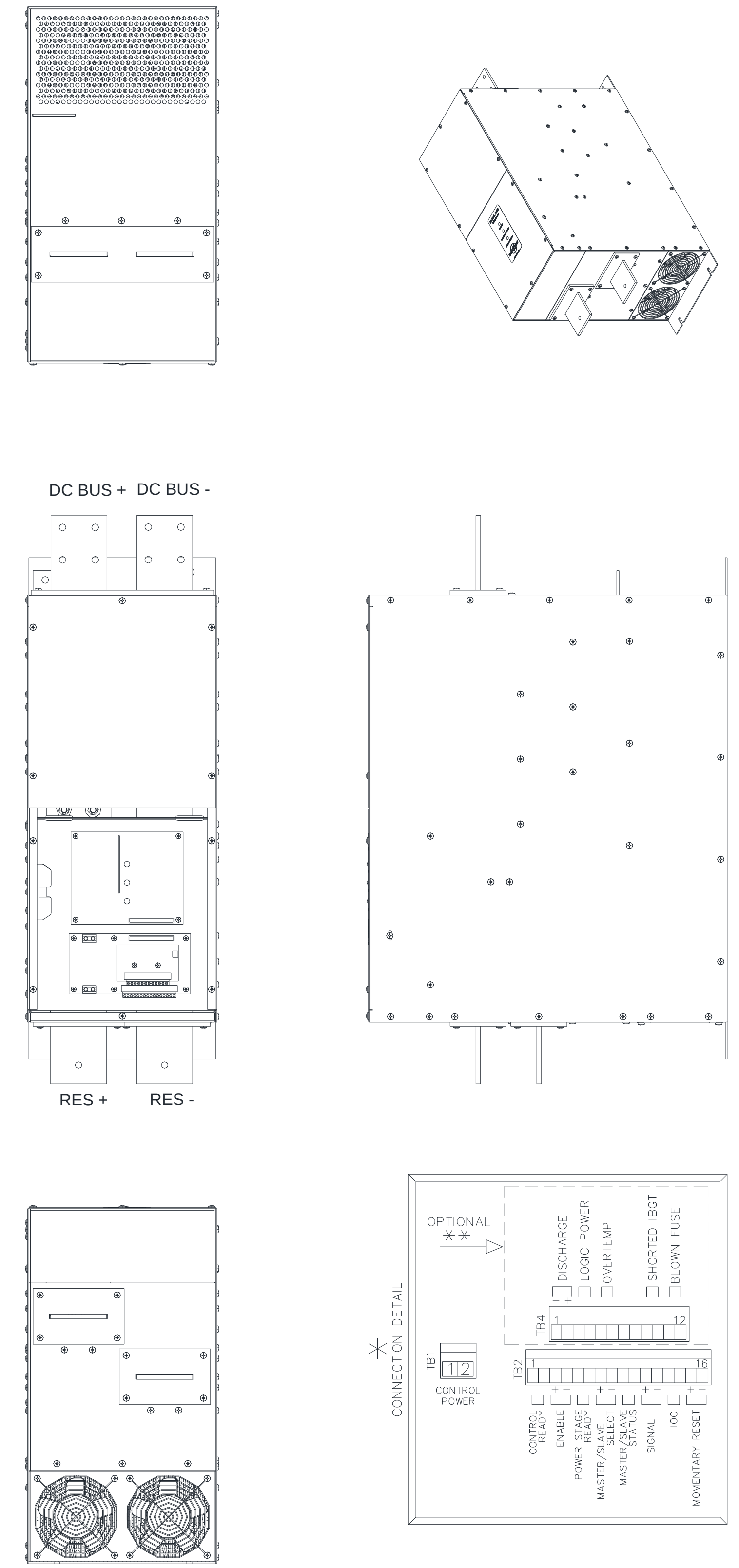


Figure 3-5: Customer Connections in T10 Chassis



3.5. TYPICAL CONFIGURATIONS

Figure 3-6: Master Stand-Alone Hookup

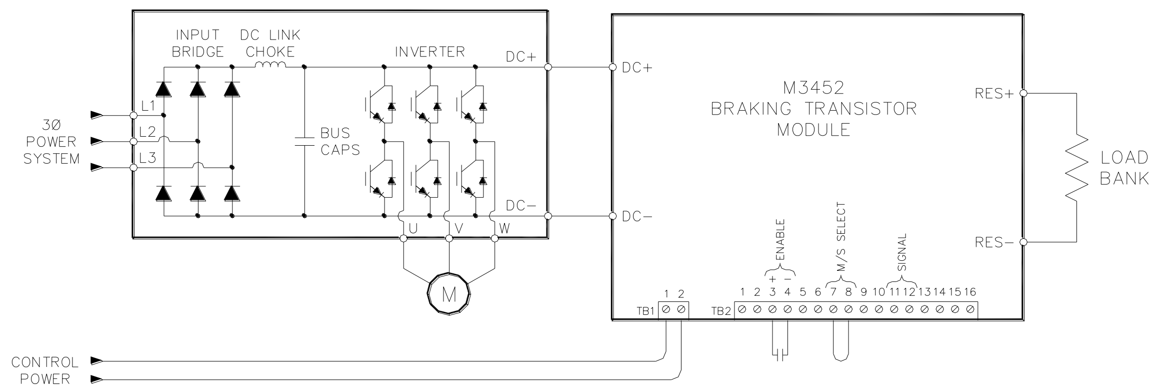


Figure 3-7: Master with Slave(s) Hookup

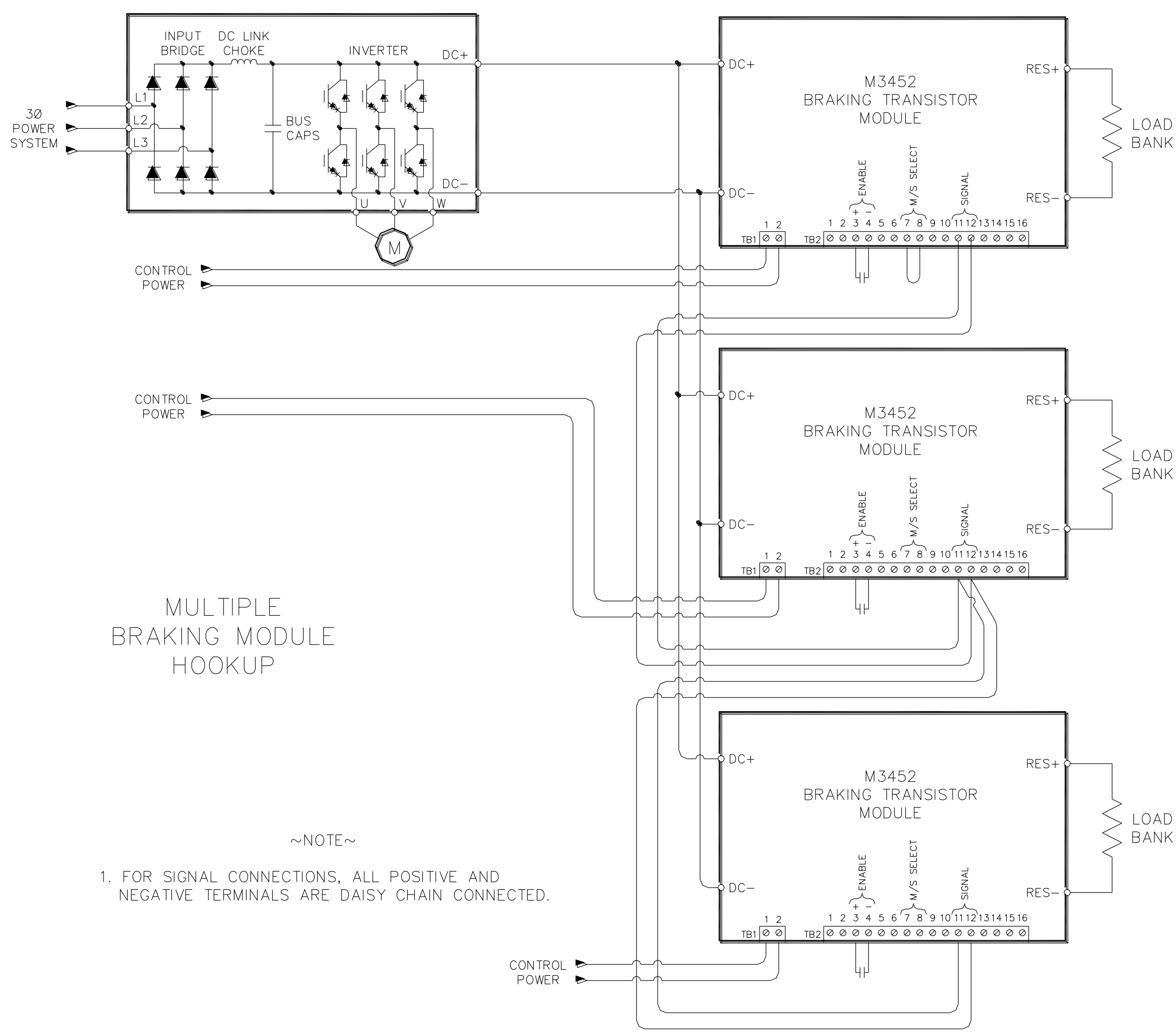
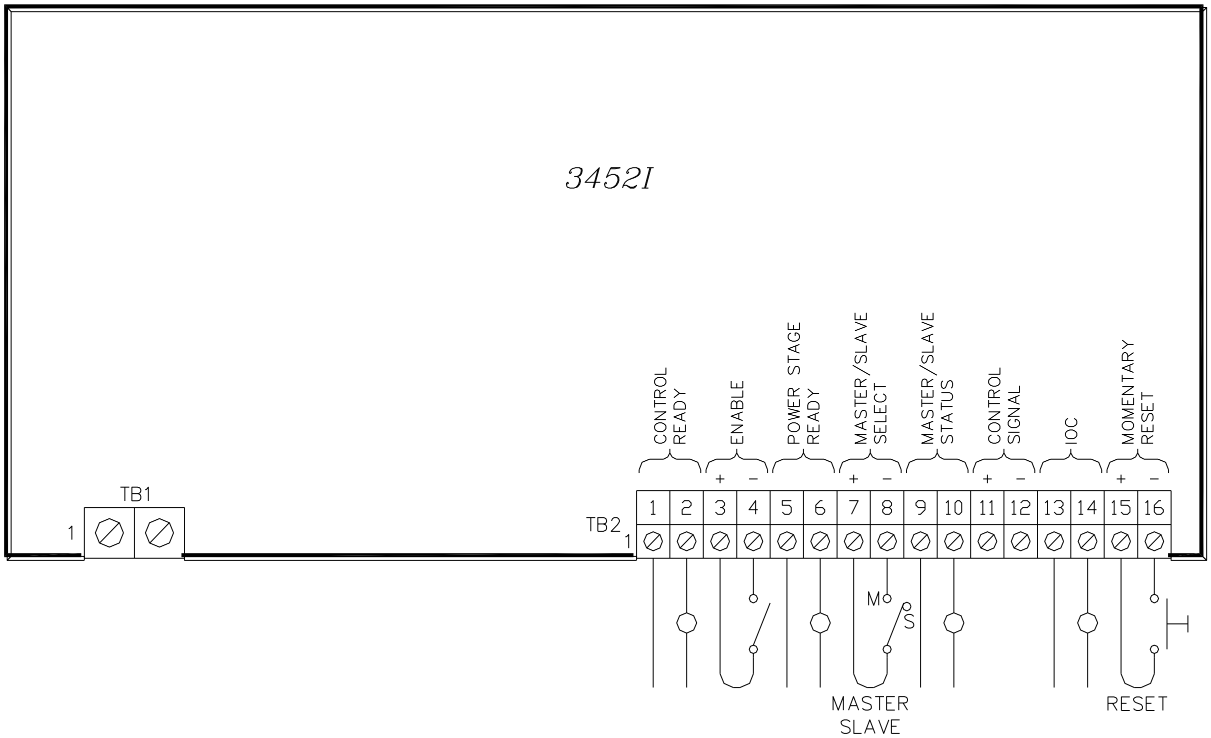


Figure 3-8: I/O Hookup

3452R7



3452R7E

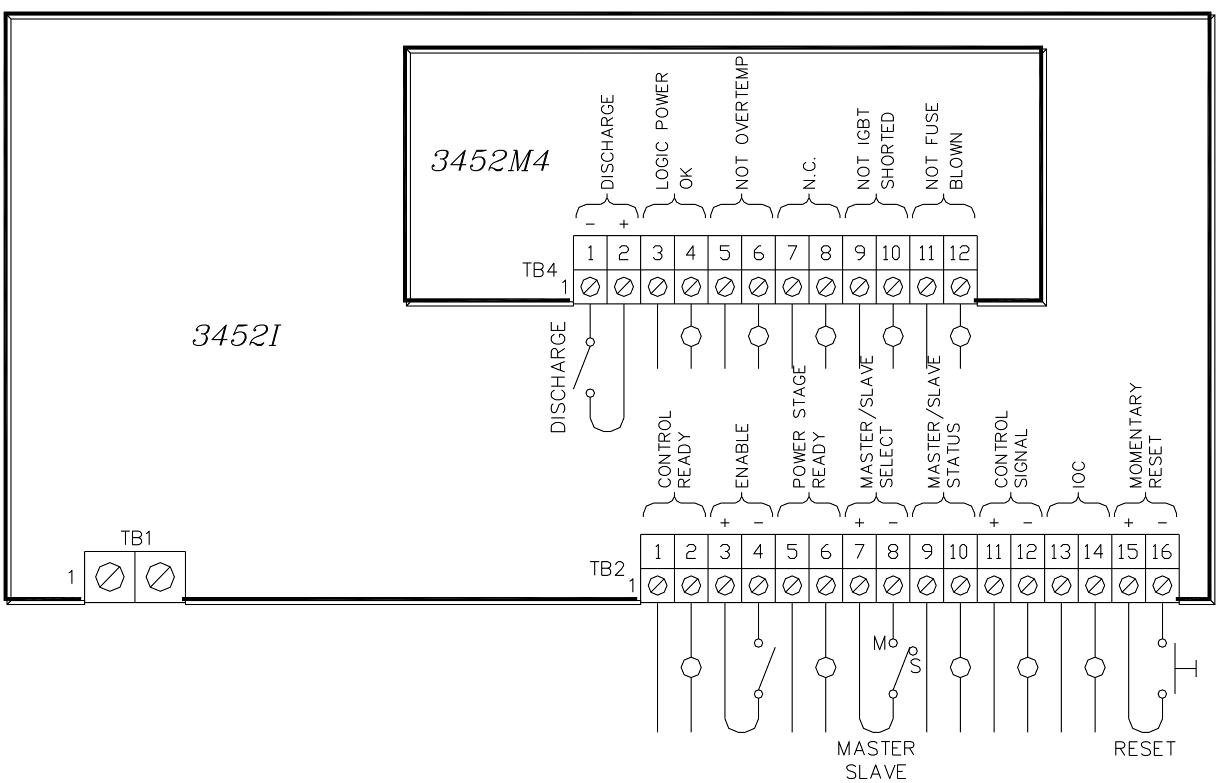
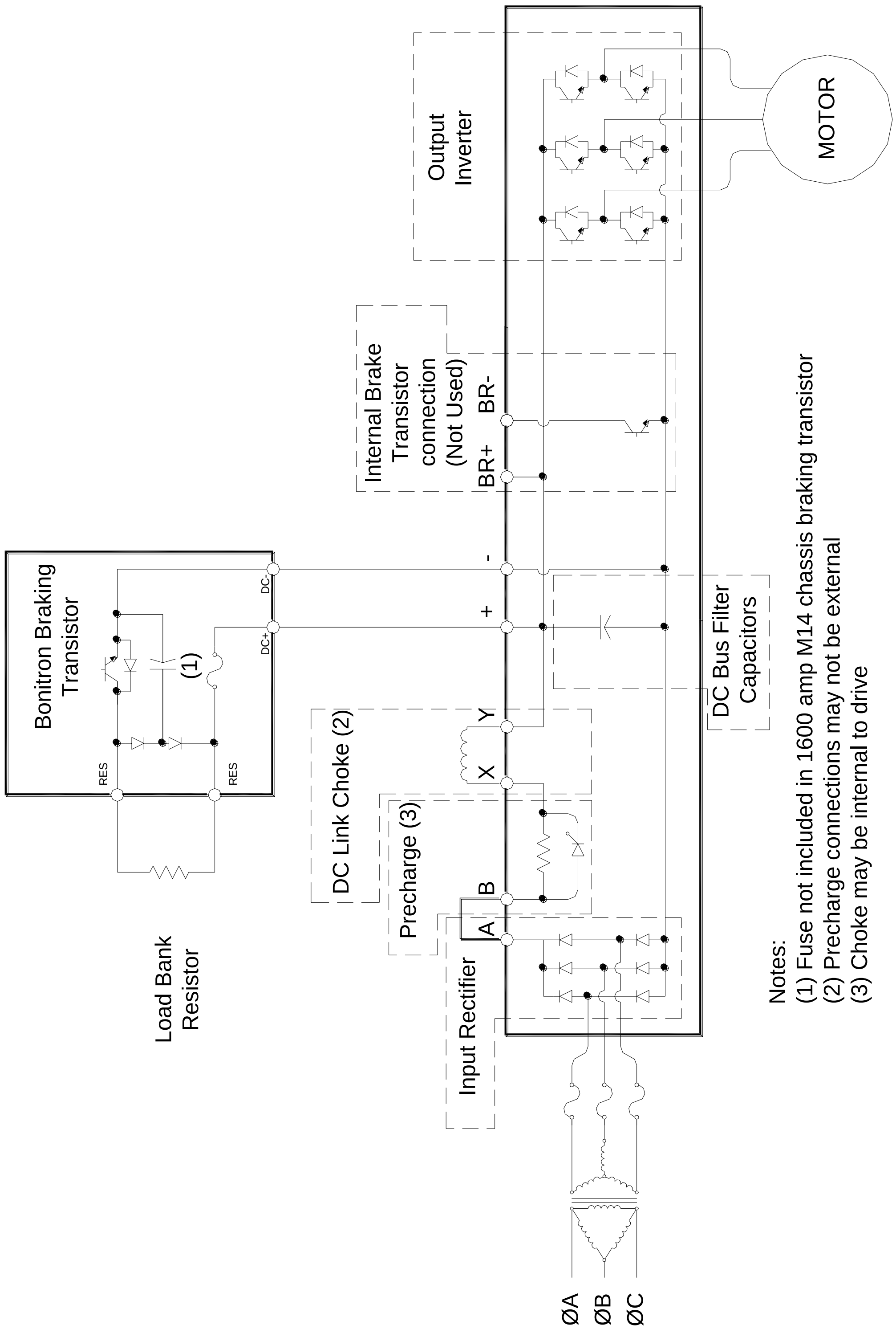


Figure 3-9: Braking Transistor Customer Connections



4. OPERATION

4.1. FUNCTIONAL DESCRIPTION

The M3452 module controls the bus voltage of a variable frequency drive by transferring energy to a resistor.

When the drive's DC bus voltage exceeds a fixed setpoint, the dynamic braking transistor module's control electronics turns on an IGBT transistor connecting a resistive load across the DC bus. When the DC bus drops below another threshold, the IGBT turns off. The setpoints are listed in Section 6.

4.2. FEATURES

For output and bus protection the M3452 includes a semiconductor fuse which limits the energy in the case of a bus or control fault.

4.2.1. INDICATORS

4.2.1.1. DC BUS

The amber DC bus indicator illuminates when the voltage between the DC+ and DC- terminals is greater than 50VDC.

CAUTION

Do not use this light as an indication that the DC bus is safe to work on! Always check the DC bus with a working voltmeter before servicing equipment, as the DC bus light may be broken!

4.2.1.2. CONTROL POWER / FAULT BLINK CODES

This green indicator illuminates when control power is applied to the unit. A solid green light indicates that no faults are present and the control circuit is functioning. A flashing green light indicates a fault, with the pattern of flashing lights indicating the type of fault (see Table 4-1 below). All faults latch until a reset signal is applied. See Section 4.2.2.1.8 for more information about the reset input. The master/slave mismatch fault will not reset until power-down.

The module keeps a record of the most recent fault encountered. To access this record, open the enable input (4.2.2.1.2), and toggle the reset input (4.2.2.1.8) three times. The fault LED will blink out the code of the most recent fault. Re-enable the unit to resume normal operation.

Table 4-1: Fault Conditions Table

NUMBER OF FLASHES	FAULT	INSTRUCTIONS	I / O POINT
1	Logic Voltage	Consult Troubleshooting in Section 5	TB2-1&2
2	Overtemp	Wait for unit to cool	TB4-5&6
3	Short IGBT	Contact Bonitron	TB4-9&10
4	Overcurrent	Reset	TB2-13&14
5	Master / Slave Mismatch	Reconfigure system with only one Master	N/A

4.2.1.3. ACTIVE BRAKING

This red indicator illuminates when the chopper IGBT is on. When the drive is idle, this red light should not be on. During braking, this red light will be on or flashing, depending on the amount of braking energy.

This red light will also be on if the bus discharge input is active.

4.2.2. TERMINAL STRIP I/O

4.2.2.1. R7 BASE I/O

All modules have the basic I/O structure. For extended I/O functions, use the R7E option.

4.2.2.1.1. CONTROL READY OUTPUT – TB2-1&2

This normally open contact indicates the status of the control section of individual modules. When this contact is closed, the control section of the module has no faults. The Power Stage Ready contacts must be closed for the module to switch the attached braking resistor.

For multiple chopper systems configured as Master/Slave, this contact must be closed for the chopper selected as master to control the attached choppers selected as slaves.

If the power stage is not ready to operate, the control stage can continue to operate attached slaves.

4.2.2.1.2. ENABLE INPUT – TB2-3&4

These terminals must be connected for the module to regulate the DC Bus.

Modules are enabled by closing a dry contact between the terminals. Once they are closed, the Control Ready contacts will close, indicating that the module is ready for operation.

4.2.2.1.3. POWER STAGE READY OUTPUT– TB2-5&6

This normally open contact indicates the status of the power stage of the module. If there are no faults in the power stage, these contacts are closed.

These contacts open on the following conditions:

- Loss of Control Power
- IOC Fault
- Shorted IGBT
- Overtemperature in module

If one of these conditions exists, the module will not operate, and the DC bus will not be regulated through the braking resistor.

Individual faults can be monitored with the R7E option.

4.2.2.1.4. MASTER/SLAVE SELECT INPUT – TB2-7&8

These terminals determine the operation mode of the module. When closed, the module operates in Master or stand-alone mode.

For stand-alone operation, place a jumper between these terminals.

See Section 4.2.3 below for further information on Master/Slave configurations.

4.2.2.1.5. MASTER/SLAVE STATUS OUTPUT – TB2-9&10

This normally open contact indicates the mode of operation for external monitoring.

When Master mode is selected, this contact will be closed.

When Slave is selected, this contact will be open.

See Section 4.2.3 for further information on Master/Slave configurations.

4.2.2.1.6. CONTROL SIGNAL – TB2-11&12

These terminals are used for the Master/Slave communication port used in multiple unit configurations. The signals of all modules are connected in a "daisy chain" (+ to +, - to -).

The port is bidirectional, serving as an output for modules operating in the Master Mode, inputs for modules operating in the Slave Mode.

The signal is a complex waveform that is not reproducible as an analog input or output.

See Section 4.2.3 for further information on Master/Slave configurations.

WARNING!

Do not attempt to use these signals for any purpose other than interconnecting Bonitron M3452 with R7 or R7E units! Damage may occur to the M3452 as well as to the connected equipment!

4.2.2.1.7. NOT INSTANTANEOUS OVERCURRENT OUTPUT – TB2-13&14

This normally open contact indicates that there has not been an instantaneous overcurrent condition that has caused the unit to be disabled. This is a latched fault, and can be reset by the Reset Input described in Section 4.2.2.1.8 below.

4.2.2.1.8. RESET FAULT INPUT TB2-15&16

This input will reset any latched faults that have occurred, provided the fault condition has been removed. Once the faults have been cleared, the module will return to normal operation.

This is a momentary dry contact input.

4.2.2.2. R7E EXTENDED I/O

The R7E option allows for individual module faults to be indicated for remote diagnostics, as well as add the Bus Discharge function.

It includes all the I/O listed above in the R7 option, as well as the added features below.

The Bus Discharge function is useful to quickly drain the DC bus to allow for safe working voltages in the drive systems with large capacitor banks.

4.2.2.2.1. Bus Discharge Input – TB4-1&2

These terminals cause the IGBT to go full on during normal operating conditions. The Enable input must be engaged, and the unit must be selected as Master for the input to have an effect.

This input can be used to drain the drive system's DC bus down. Closing a contact across this input will force the IGBT to go full on and stay until the input is removed.

Use care with this input. If the DC bus still has incoming power enabled, the braking resistor will go full on, and will stay on as long as this input is closed. This can cause resistor overheating as well as stress to the DC bus rectifier section.

DO NOT use this input as a clamp for maintenance purposes. Always ensure that voltage levels are safe and the equipment power source is properly locked out before attempting maintenance of any kind.

4.2.2.2.2. Logic Power OK Output –TB4-3&4

This contact indicates that the onboard control power is operating properly. It closes when the logic power is applied to terminals TB1-1&2, and the fuses on the input and outputs sides of the logic transformer are not blown.

If this contact is not closed once power has been applied, refer to the Troubleshooting Section.

4.2.2.2.3. Not Overtemp Output -TB4-5&6

This contact indicates that the module's heatsink is within operating temperature. If the heatsink gets too hot to safely operate, the module will stop braking control and this contact will open. Once the temperature of the heatsink falls to a safe operation temperature, the module will begin braking action again, and this contact will close.

4.2.2.2.4. Not IGBT Shorted Output - TB4-9&10

This contact indicates that the braking power transistor has not failed. The contacts are closed if the IGBT is operating properly.

If the IGBT shorts during operation, this contact will open, and stay opened until logic power is cycled.

When this contact opens, the IGBT is damaged and the unit needs repair. Contact Bonitron for assistance.

4.2.2.2.5. Not Fuse Blown Output -TB4-11&12

This contact indicates that the main power fuse is not blown, and is ready for braking operation. If the fuse blows, this contact will open. The module will not be able to brake if the main power fuse is blown.

This output has no function for the 1600A (M14 chassis) unit since there is no internal fuse.

4.2.3. MASTER / SLAVE CONTROL (200 AMP TO 1600 AMP)

In order to achieve current ratings higher than possible with a single module, several braking modules can be connected in parallel. This method requires that one module be in control of all other modules. This module is considered the Master and the others are slaved to it.

Each module must have its own dedicated load bank!

If the output of modules is wired in parallel, severe current imbalances will damage the units.

Parallel modules do not have to have the same current rating; however, each module must have a load resistor appropriate for the individual module's current rating.

Up to 10 additional modules can be driven from a Master module if all Slave modules are within close proximity of the Master module.

In this configuration, any module can be selected as the Master module, and can be changed "on the fly" remotely.

WARNING!

AT NO TIME *should more than one Master be selected simultaneously. If multiple masters are selected, all but one will detect the condition and cease operation. This fault can only be cleared by powering down the system and powering back up with only one master module. Ensure that the logic control will select only one Master at any given time.*

4.2.3.1. WIRING FOR MASTER / SLAVE OPERATION

The control signal for parallel systems should be wired in a "daisy chain" configuration, with all (+) signals connected and (-) signals connected. Use twisted/shielded pair cable for interconnection. See Section 4.2.2.1.6 for additional information.

Do not exceed 15 feet of total cable length to connect the Master pulse to the farthest Slave module.

Excessive distance can lead to unacceptable noise in the signal lines, and can cause false triggering, poor operation, or catastrophic system failure.

4.2.3.2. CONTROL SIGNALS

Terminals TB2-7&8 control the mode selection of the individual modules. Master mode is selected by closing a contact across these terminals.

All modules have two status outputs, Control Ready and Power Stage Ready. The Control Ready indicates that the module's bus regulation circuitry is functioning. The Power Stage Ready indicates that the modules power switching circuitry is functioning properly.

If a module is selected as Master, and the Power Stage is not ready, that module will continue to control slave modules as long as it is enabled and the Control Ready signal is active on the Master modules. The Master module with the power stage not ready will not switch its own power stage. This allows the braking system to operate at reduced capacity in the event of a Master module power stage failure.

If a module is selected as Master and the Control Ready status is open, the bus regulation circuitry is not active, and no bus regulation will occur.

For modules selected as Slaves, both the Control Ready and Power Stage ready signals must be active for that module to switch and regulate the DC bus. The operation of other modules is not affected.

The Master/Slave Status contact indicates the operation mode of a module.

4.2.3.2.1. STATIC MASTER

For systems that have a static Master module, place a jumper between terminals TB2-7&8. Leave terminals TB2-7&8 open on all other modules.

4.2.3.2.2. DYNAMIC MASTER

For large systems that require more flexibility or redundancy, the mode can be switched remotely. This changes the direction of the bi-directional port from input to output. Each module has its own bus regulation logic, but modules selected as Slaves will follow the signal on the Control Signal port.

WARNING!

> **AT NO TIME** *should more than one Master be selected simultaneously. This can lead to double pulsing, poor operation, catastrophic system failure and possible damage to the system. Ensure that the switching control logic keeps more than one module from being selected at once.*

The dynamic master switching sequence should follow these steps:

- Disable all modules by opening the “Enable” input. Bus regulation stops.
- Close “Master Select” contact on a single module.
- Ensure that only one Master/Slave Status contact is closed in the system, indicating that only one module is master.
- Enable all modules. Bus regulation resumes.

4.3. STARTUP

WARNING!

> *Bonitron Dynamic Braking Transistor Modules are designed to be used with stand-alone or common DC bus drive/inverter systems with bus capacitors. When using the Bonitron modules on common bus systems, special considerations may apply. Review the Application Notes in Section 7 prior to start-up!*

4.3.1. PRE-POWER CHECKS

Ensure that all connections are tight, DC bus polarity is correct, and that all field wiring is of the proper size for operational requirements. Check for exposed conductors that may lead to inadvertent contact. Verify the load bank is properly sized for the application. The ohms value and wattage rating of the load bank are important for proper and reliable system operation! ***Remember*: do not operate the module with less than its minimum ohms value rating!** Verify that the Master / Slave jumpers are in their proper position for intended use.

MASTER/SLAVE

All modules come from the factory set in Slave Mode. If the module is the only module used in the system, it should be set as Master. Place a jumper between TB2-7&8 for stand-alone systems or systems that have a static Master. In systems that have multiple units, refer to Section 4.2.3 for more information on setting up systems with multiple units.

4.3.2. Startup Procedure and Checks

Apply AC power to the drive system and the Dynamic Braking Transistor Module. Do not start the motors on the system.

On the Dynamic Braking Transistor Module, verify the following:

- Control voltage is within tolerance. Refer to Table 2-6: General Specifications for voltages and tolerances.
- Green **Control Power** indicator is **ON**.
- Amber **DC Bus** indicator is **ON**.
- Red **Active Braking** indicator is **<u>OFF</u>**! **Immediately** turn off all power if the indicator is **ON** to avoid possible load bank overheating and/or other equipment damage!
- Verify the drive system DC bus voltage, and make sure it is within tolerance for the drive system.
- Verify the DC current flow through the load bank is zero amps. Even though the Red **Active Braking** indicator is **OFF**, any significant current flow could indicate incorrect connections or damaged equipment. ***Immediately*** *turn off all power to avoid possible load bank overheating and/or other equipment damage!*
  - <u>Note</u>: Depending on the type of measuring equipment used, small currents could just be noise pickup and could be ignored.
- Check status contacts to ensure they are all closed. This indicates that the module is ready for operation.

If any of the above conditions are not as indicated, turn off all power and allow ample time for all system energy sources to discharge. **Verify that all voltages are zero and have discharged with a suitable meter!** Check all wiring connections and jumper configurations. Refer to the Troubleshooting Section of this manual for more information. For further assistance, contact Bonitron technical support.

Once the pre-checks are complete, the drive system can be enabled. Once the drive system is operational, run the motors with light deceleration, and decrease the braking time until the red **Active Braking** indicator lights.

4.4. Operational Adjustments

No adjustments are necessary for this module. All regulation points are factory adjusted, and should not be changed in the field. If your module is not functioning properly, refer to the Troubleshooting Section of this manual, or contact Bonitron for assistance.

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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.

5.1. PERIODIC TESTING

At least every other month, visually inspect the front panel indicator lights to be sure they are operating correctly. With control power applied, the green **Control Power** indicator should be illuminated. The amber **DC Bus** indicator will be on if the drive bus is above 50VDC. The red **Active Braking** indicator will only be on or flashing if the module is switching energy from the DC Bus. There are no operational tests to be performed.

5.2. MAINTENANCE ITEMS

Monthly, check the module for buildup of dust, debris, or moisture. Dangerous voltages exist within the module and the buildup of dust, debris, and moisture can contribute to unwanted arcing and equipment damage. Take whatever corrective or maintenance actions are necessary to keep the module clean and moisture free.

Monthly, check the cooling fan and heatsink for any buildup of debris. If they require cleaning **power down the drive system** and blow the debris out with clean dry air as necessary to maintain proper cooling performance. **Note:** After blowing out the fan and/or heatsink, blow off any dust or debris that may have gotten on any of the circuit boards.

5.3. TROUBLESHOOTING

DANGER!

Lethal voltages exist in these systems! Before attempting checks or repair, follow all precautions to ensure safe working conditions, including lockout / tagout procedures, and verifying safe working voltages with proper meters. Do not rely on the DC Bus indicator to ensure a safe condition.

DANGER!

Only qualified personnel familiar with variable frequency AC drives and associated machinery should plan or implement the installation, start-up, and subsequent maintenance of the system. Failure to comply may result in personal injury, death, and / or equipment damage!

Contact Bonitron any time the equipment appears to be having problems.

5.3.1. GREEN CONTROL POWER LIGHT NOT ILLUMINATED

- Check Control Voltage input level on customer terminal TB1-1&2. Refer to *Table 2-1: Control Voltage Rating* and be sure it is within the specified range. The modules can be ordered with various control voltages, and the proper voltage must be used for the module's configuration.
- Check the status of the Control Ready contacts found on customer terminal TB2-1&2. Open contacts indicate insufficient logic voltage. This can be caused by a failure in the control circuit. The module will need repair.
- If the control voltage is correct and Control Ready status contacts are closed, the indicator may be burned out, and need replacement.

5.3.2. AMBER DC BUS LIGHT NOT ON

This can be a normal condition in systems where DC Bus power and logic control power is applied. This indicates that there is less than 50VDC on the inverter bus.

CAUTION!

Do not use this light as an indication that the DC bus is safe to work on! Always check the DC bus with a working voltmeter before servicing equipment, as the DC bus light may be broken!

- Use a DC voltmeter to check the Bus Voltage at the module terminals DC bus + and DC bus -.
- If the DC bus is above 50VDC, and the light is not on, the light or control circuit may be damaged, and the unit should be returned for repair.
- The main DC bus fuse may be blown. See next Section.

5.3.3. BLOWN DC BUS FUSE

CAUTION!

Do NOT replace a blown DC bus fuse and reapply power to the system without determining the cause.

This usually indicates serious problems exist and reenergizing the system can cause significant or catastrophic failure! In most cases, the module will need to be returned for repair. Contact Bonitron before changing the fuse.

Possible causes for a blown fuse are:

- Shorted heatsink IGBT power transistor.
- Shorted heatsink commutation diode.
- Load bank in use below minimum ohms value.
- Shorted load bank.
- Shorted resistor cabling and or ground fault in cable.
- Operating braking module on a DC bus without inverters present. This is typically encountered in common bus systems when drives are removed from service. See Section 7 for more information.

5.3.4. FAN RUNS CONSTANTLY

The fan only runs when the braking module heatsink is hot. If the heatsink is above 110°F, then the fan runs until the heatsink cools to 80°F. If the ambient temperature is above 80°F, the fan may run continuously. A constantly running fan does not indicate a problem with the module. If the heatsink temperature is below 80°F, the thermostat may be damaged. This will not affect DC Bus regulation.

5.3.5. FAN DOESN'T RUN

The fan only runs when the braking module heatsink is hot. If the heatsink is above 110°F, then the fan runs until the heatsink cools to 80°F.

If the fan never runs, even when the heatsink is hot or during heavy braking operation, the module may shutdown on heatsink over-temperature. This occurs at a heatsink temperature of 160°F. If for any reason the fan does not appear to be working properly, check the following:

- Verify proper polarity if fan is 24VDC.

- Input and output fuses on the fan transformer. These will be located on or around the fan transformer itself.
- Check fan for blockage. Clean if necessary.
- Check fan transformer primary voltage and ensure it is within tolerance for the control voltage input for that module.
- Replace fan.
- If fan still doesn't operate, the heatsink temperature switch may be faulty. Contact Bonitron for return for repair.

5.3.6. CONTROL READY CONTACTS WON'T CLOSE

If the status contacts listed in Section 4.2.2.1.1 above will not close, this indicates one of the following conditions:

- Loss of Control Power
- Failure in control circuit

5.3.7. POWER STAGE READY CONTACTS WON'T CLOSE

- Over-temperature in module
- Shorted IGBT (power transistor)
- IOC fault

The R7E option has each of these conditions broken out as separate status contacts. Refer to Section 4.2.2.2 for locations and status indicated.

If the over-temperature contacts will not close, check the temperature of the module see Section 5.3.8 below for overheating troubleshooting. If the module is hot, wait for the module to cool and see if it begins to function properly.

If one of the other contacts is open, and will not close, the module has a fault that needs to be repaired by Bonitron. Contact Bonitron for assistance.

If the module is cool and still will not operate, contact Bonitron for assistance or repair.

5.3.8. MODULE OVER-TEMP, OR MODULE SEEMS TOO HOT

It is normal for this module to produce heat. Temperatures of 150°F are not uncommon. If the modules fan is running, and the module is operating properly, it is within normal tolerances.

If you have the R7E option, check the contacts at TB4-5&6. If the contacts are open, then the module is inhibited due to over-temperature. If the fan is not running, see Section 5.3.5 above for assistance.

If the fan is running, check to make sure the airflow through and around the module is unobstructed.

If the ambient temperature is high in the cabinet or installation area, the module may overheat. Make sure the environment is within the operating temperature requirements listed in the General Specifications (Table 2-6).

5.3.9. DRIVE TRIPS ON OVERVOLTAGE

CAUTION!

Make sure the DC+ and DC- connections are made directly to the drive system bus. They should not be connected to terminals dedicated to an internal transistor circuit on the inverter.

If the drive trips on overvoltage, confirm that the green Control Power light is on (5.3.1), the status contacts are closed (5.3.6, 5.3.7), and the amber DC bus light is on (5.3.2). Watch the red Active Braking light on the front of the module during a braking cycle. If it never illuminates, ensure that the module is either configured as a master, or correctly wired to a properly configured master (4.2.3). There must be exactly one master in the system. Check the DC Bus voltage and make sure the bus voltage at the braking module exceeds the trip point of the module, i.e. 750VDC for a 460VAC nominal system. See Table 2-3: DC Bus Voltage Rating.

If the red Active Braking light comes on, check the wiring to the load bank, and check the current to the load bank with a clamp on current meter. If the wiring to the load bank is good, make sure the DC bus fuse is good.

If the red Active Braking light comes on, and current is flowing to the load bank, check to make sure that the module is sized properly for the system. If the resistance of the load bank is too large, not enough current will flow to allow for the braking energy to be dissipated. Check the system design to make sure the braking requirements are matched with the braking module capacity.

MASTER/SLAVE SYSTEMS

Master/Slave systems must be properly configured and operating to share the load.

Check your system layout and make sure there is only one selected and operating Master and that all the Slaves are properly wired to that Master.

Make sure that all the modules have the DC bus and control power lights on.

When the system is braking, watch the **Active Braking** lights on all modules. They should all go on and off at the same time. If they do not, there may be a wiring or module configuration issue.

If the lights all go on at the same time, check the current going to each load bank as above and correct problems found with the wiring.

5.3.10. RED BRAKING LIGHT FLICKERS

During motor deceleration, the red braking LED may flicker if the braking cycle energy is low. This is normal.

If the red braking light flickers when the inverter is idle, this may indicate high voltage, excessive noise, or harmonics on the main system rectifier input AC voltage. Check the incoming AC line for these problems. Consult the project engineer for the appropriate corrective action.

In rare instances, the module is installed on a system that has very little capacitance, or the inverters have been removed from the bus. This configuration can cause damage to the braking module. See Section 7 in this manual for more information.

5.3.11. RED BRAKING LIGHT STAYS ON ALL THE TIME

- Make sure the Bus Discharge input is not activated. This causes the braking module to go full on. Extended operation with this input can cause load bank overheating and improper operation.
- System voltage is too high or high harmonic content is present. Check main system rectifier input AC voltage. Refer to the DC Bus Trigger Level found in Table 2-3. The undistorted main system rectifier AC input voltage should always be less than
  $DC_{Bus\,Trigger\,Level} / 1.414$.
- Note: If the measured DC bus (in standby) is greater than the
  $RMS_{Line\,Voltage} * 1.414$
  then harmonic distortion may exist. Consult the project engineer for the appropriate corrective action.
- Setpoint too low. The DC bus setpoint pot on the main control board may have been tampered with. If this is a possibility, then the module needs to be sent in for recalibration.
- Wrong braking module installed. Check the module chassis sticker for the part number. Refer to Section 2.2 of this manual and verify the sticker information represents the correct part number for your application and voltage levels. Remove and replace as required.
- Main control board has gone bad and the module needs to be sent in for repair.

5.3.12. MASTER UNIT APPEARS TO FUNCTION PROPERLY, BUT SLAVE UNITS DO NOT SEEM TO FOLLOW THE MASTER

Slave(s) may have missing or insufficient control voltage. Refer to Section 5.3.1 and correct as required.

Check the signal wiring between modules. The terminals should be daisy chained as described in Section 4.2.3.1.

Make sure that only one module is selected as Master on a network. More than one master can cause improper triggering and system damage.

5.3.13. ATTACHED DRIVE WILL NOT PRECHARGE

Verify the polarity of the connection to the DC filter capacitors of the drive. If this connection is reversed, the commutation diode effectively shorts the DC bus and will not allow the drive to go through precharge.

5.4. TECHNICAL HELP – BEFORE YOU CALL

If technical help is required, please have the following information available when contacting Bonitron (615-244-2825 Email:info@bonitron.com):

- Serial number of unit
- Name of original equipment supplier
- Brief description of the application
- Drive and motor hp or kW
- The line to line voltage on all 3 phases
- The DC Bus voltage
- KVA rating of power source
- Source configuration Wye/Delta and grounding

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6. ENGINEERING DATA

6.1. RATINGS CHARTS

Table 6-1: Module Ratings: 230 – 240 VAC Drives (375 VDC Setpoint)

BASE MODEL NUMBER	CONTROL VOLTAGE	BRAKING POWER (PEAK)	BRAKING CURRENT (PEAK)	BRAKING CURRENT (RMS)	DUTY CYCLE	MINIMUM RESISTANCE	FUSING
M3452-U200LK6	115-120 VAC	100 HP	200 A	200 A	100%	1.90 Ω	FWP-200
M3452-L200K6	230-240 VAC						
M3452-U300LK6	115-120 VAC	150 HP	300 A	300 A	100%	1.25 Ω	FWP-300
M3452-L300K6	230-240 VAC						
M3452-U600LK6	115-120 VAC	300 HP	600 A	300 A	50%	0.63 Ω	A70QS600
M3452-L600K6	230-240 VAC						
M3452-U800LK9	115-120 VAC	400 HP	800 A	400 A	50%	0.47 Ω	A70QS800
M3452-L800K9	230-240 VAC						
M3452-U1200LK10	115-120 VAC	600 HP	1200 A	600 A	50%	0.32 Ω	A70QS800
M3452-L1200K10	230-240 VAC						

Table 6-2: Module Ratings: 380 – 415 VAC Drives (620 VDC Setpoint)

Base Model Number	Control Voltage	Braking Power (Peak)	Braking Current (Peak)	Braking Current (RMS)	Duty Cycle	Minimum Resistance	Fusing
M3452-U200EK6	115-120 VAC	160 HP	200 A	200 A	100%	3.10 Ω	FWP-200
M3452-E200K6	380-415 VAC	160 HP	200 A	200 A	100%	3.10 Ω	FWP-200
M3452-U300EK6	115-120 VAC	240 HP	300 A	300 A	100%	2.07 Ω	FWP-300
M3452-E300K6	380-415 VAC	240 HP	300 A	300 A	100%	2.07 Ω	FWP-300
M3452-U600EK6	115-120 VAC	490 HP	600 A	300 A	50%	1.04 Ω	A70QS600
M3452-E600K6	380-415 VAC	490 HP	600 A	300 A	50%	1.04 Ω	A70QS600
M3452-U800EK9	115-120 VAC	660 HP	800 A	400 A	50%	0.78 Ω	A70QS800
M3452-E800K9	380-415 VAC	660 HP	800 A	400 A	50%	0.78 Ω	A70QS800
M3452-U1200EK10	115-120 VAC	1000 HP	1200 A	600 A	50%	0.52 Ω	A70QS800
M3452-E1200K10	380-415 VAC	1000 HP	1200 A	600 A	50%	0.52 Ω	A70QS800
M3452-U1600EM14	115-120 VAC	1330 HP	1600 A	1200 A	75%	0.39 Ω	N/A
M3452-E1600M14	380-415 VAC	1330 HP	1600 A	1200 A	75%	0.39 Ω	N/A
M3452-U1600ET10	115-120 VAC	1330 HP	1600 A	1200 A	75%	0.39 Ω	A100P1200
M3452-E1600T10	380-415 VAC	1330 HP	1600 A	1200 A	75%	0.39 Ω	A100P1200

Table 6-3: Module Ratings: 460 – 480 VAC Drives (750 VDC Setpoint)

Base Model Number	Control Voltage	Braking Power (Peak)	Braking Current (Peak)	Braking Current (RMS)	Duty Cycle	Minimum Resistance	Fusing
M3452-U200HK6	115-120 VAC	200 HP	200 A	200 A	100%	3.80 Ω	FWP-200
M3452-H200K6	460-480 VAC						
M3452-U300HK6	115-120 VAC	300 HP	300 A	300 A	100%	2.50 Ω	FWP-300
M3452-H300K6	460-480 VAC						
M3452-U600HK6	115-120 VAC	600 HP	600 A	300 A	50%	1.25 Ω	A70QS600
M3452-H600K6	460-480 VAC						
M3452-U800HK9	115-120 VAC	800 HP	800 A	400 A	50%	0.93 Ω	A70QS800
M3452-H800K9	460-480 VAC						
M3452-U1200HK10	115-120 VAC	1200 HP	1200 A	600 A	50%	0.63 Ω	A70QS800
M3452-H1200K10	460-480 VAC						
M3452-U1600HM14	115-120 VAC	1600 HP	1600 A	1200 A	75%	0.47 Ω	N/A
M3452-H1600M14	460-480 VAC						
M3452-U1600HT10	115-120 VAC	1600 HP	1600 A	1200 A	75%	0.47 Ω	A100P1200
M3452-H1600T10	460-480 VAC						

Table 6-4: Module Ratings: 575 – 600 VAC Drives (940 VDC Setpoint)

Base Model Number	Control Voltage	Braking Power (Peak)	Braking Current (Peak)	Braking Current (RMS)	Duty Cycle	Minimum Resistance	Fusing
M3452-U200CK6	115-120 VAC	250 HP	200 A	200 A	100%	4.70 Ω	A100P200
M3452-C200K6	575-600 VAC						
M3452-U300CK6	115-120 VAC	380 HP	300 A	300 A	100%	3.20 Ω	A100P300
M3452-C300K6	575-600 VAC						
M3452-U600CK6	115-120 VAC	760 HP	600 A	300 A	50%	1.60 Ω	A70QS600
M3452-C600K6	575-600 VAC						
M3452-U800CK9	115-120 VAC	1000 HP	800 A	400 A	50%	1.20 Ω	A70QS800
M3452-C800K9	575-600 VAC						
M3452-U1200CK10	115-120 VAC	1500 HP	1200 A	600 A	50%	0.78 Ω	A70QS800
M3452-C1200K10	575-600 VAC						
M3452-U1600CM14	115-120 VAC	2015 HP	1600 A	1200 A	75%	0.58 Ω	N/A
M3452-C1600M14	575-600 VAC						
M3452-U1600CT10	115-120 VAC	2015 HP	1600 A	1200 A	75%	0.58 Ω	A100P1200
M3452-C1600T10	575-600 VAC						

Table 6-5: Module Ratings: 690VAC Drives (1090 VDC Setpoint)

Base Model Number	Control Voltage	Braking Power (Peak)	Braking Current (Peak)	Braking Current (RMS)	Duty Cycle	Minimum Resistance	Fusing
M3452-U200YK6	115-120 VAC	300 HP	200 A	200 A	100%	5.50 Ω	A100P200
M3452-U300YK6	115-120 VAC	440 HP	300 A	300 A	100%	3.60 Ω	A100P300
M3452-U600YK6	115-120 VAC	875 HP	600 A	300 A	50%	1.95 Ω	A70QS600
M3452-U800YK9	115-120 VAC	1170 HP	800 A	400 A	50%	1.40 Ω	A70QS800
M3452-U1200YK10	115-120 VAC	1750 HP	1200 A	600 A	50%	0.91 Ω	A70QS800
M3452-U1600YM14	115-120 VAC	2300 HP	1600 A	1200 A	75%	0.68 Ω	N/A

6.2. WATT LOSS

Table 6-6: Watt Loss

Unit Peak Current	Control Power Watt Loss	Heatsink Watt Loss
200 A	55 W	500 W
300 A	55 W	750 W
600 A	55 W	750 W
800 A	55 W	1000 W
1200 A	55 W	1440 W
1600 A	55 W	2500 W

6.3. CERTIFICATIONS

The following modules with the R7 or R7E option are UL and cUL listed by Underwriter's Laboratories under file number E204386 for UL508C Power Conversion Equipment:

- M3452 200A, 300A, and 600A models
  - L, H, C System Voltage Rating codes.
- All M3452 M14 1600A models.
  - L, H, C, Y System Voltage Rating codes.

6.4. UL 508A SHORT CIRCUIT CURRENT RATING

When braking transistors are used with Underwriters Laboratories listed or recognized drives, the short circuit current rating (SCCR) is determined by the SCCR rating of the attached drive.

6.5. FUSE/CIRCUIT BREAKER SIZING AND RATING

Each module (except the 1600 amp M14 chassis) comes equipped with its own internal DC bus fuse. ***If the fuse happens to fail, it is not recommended to replace the fuse and reapply power. Further damages could result*.** Consult Bonitron if this situation arises. If you wish to place fuses in your DC link, coordinate the fuse size with the proper wire size used in your link as per local codes and regulations. Fast acting semiconductor type fuses should be used.

6.6. DC BUS LINK LENGTH LIMITS

The distance that the chopper is mounted from the main DC bus filter capacitors within the drive is limited by the amount of inductance in the connection. During switching, the inductance in the DC bus between the chopper and capacitors stores energy that must be absorbed by the snubbing circuit in the chopper.

In general, this distance should be kept to a maximum of 30 feet total (10m), or 15 feet (5m) for the DC+ link and 15 feet (5m) for the DC- link.

The values listed in Table 6-7 are the maximum inductance allowed in the DC bus link to and from the filter capacitors in the drive and the chopper connections.

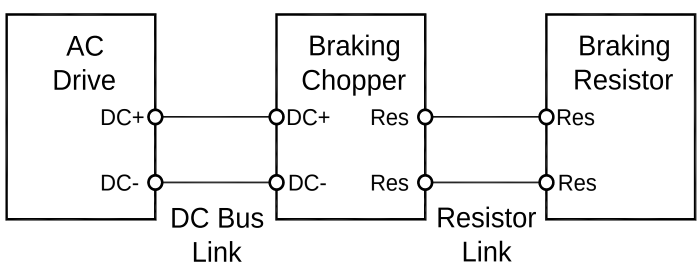
Table 6-7: Maximum Inductance for DC Link Cable

UNIT PEAK CURRENT	MAXIMUM INDUCTANCE
200 A	620 µH
300 A	275 µH
600 A	70 µH
800 A	39 µH
1200 A	34 µH
1600 A	58 µH

The distance between the DC bus filter capacitors and the braking chopper can be increased by using lowering the inductance of the buswork or cables. Typically this means using buswork or cable with a higher cross sectional area. The inductance of the buswork can be calculated from the length and inductance/foot published by the cable manufacturer. There are also standard tables to help this calculation.

If there is an extreme distance with inductance that cannot be removed from the DC bus, additional bulk capacitance can be added to decouple the DC bus inductance from the system, or the chopper can be repositioned to minimize the distance from the DC bus filter capacitance.

Figure 6-1: DC Link



6.7. RESISTOR LINK LENGTH LIMITS

The distance that the resistor is mounted from the chopper is not a concern for the chopper as the components used will not be affected by this inductance.

Some ceramic or wirewound resistors can have significant inductance, grid or plate resistors do not. In very extreme cases, the inductance of the resistor and connecting cables may limit the risetime of the current to the resistor, but this will not have an impact on chopper operation.

6.8. DIMENSIONS AND MECHANICAL DRAWINGS

Figure 6-2: M3452 K6 Chassis Dimensional Outline Drawing

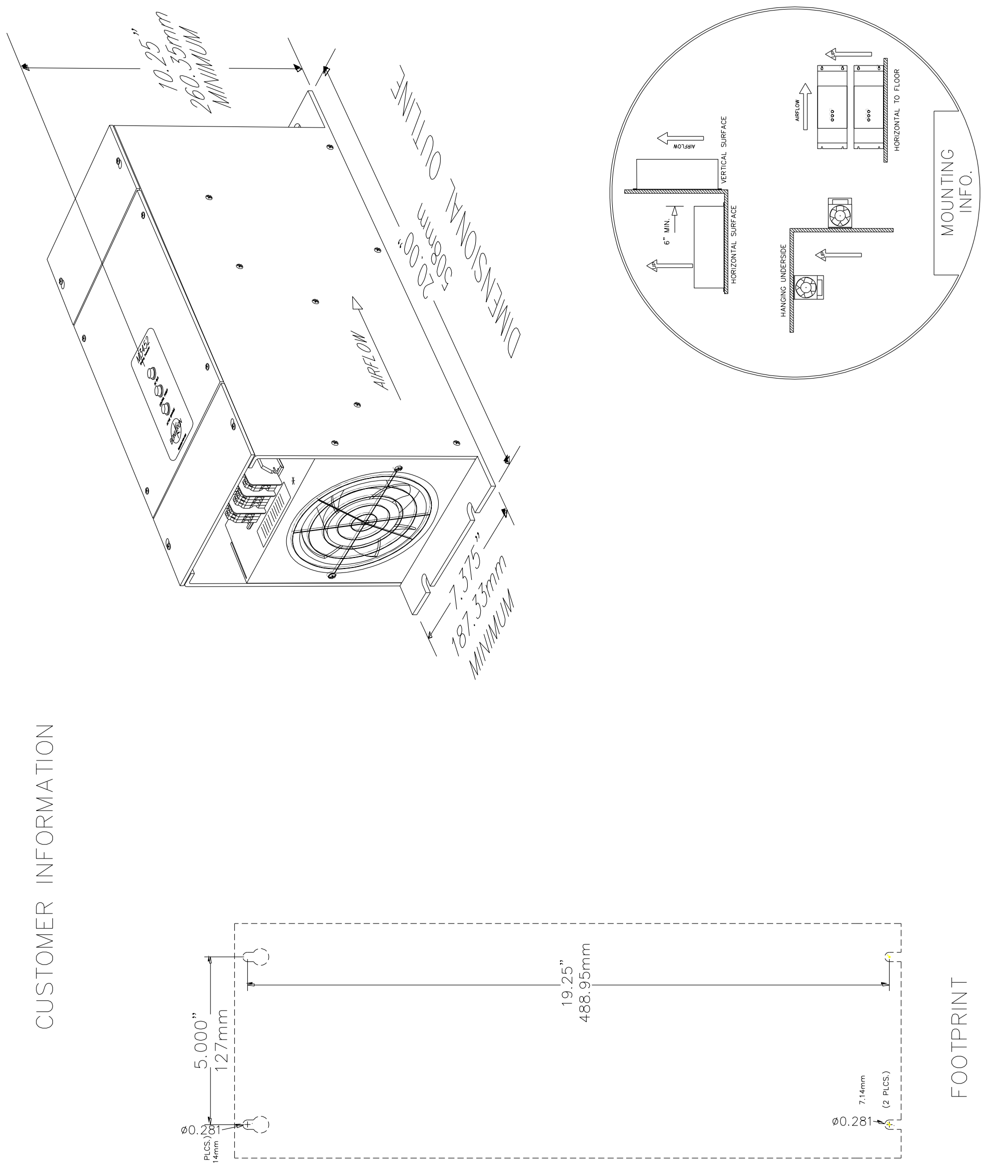


Figure 6-3: M3452 K9 Chassis Dimensional Outline Drawing

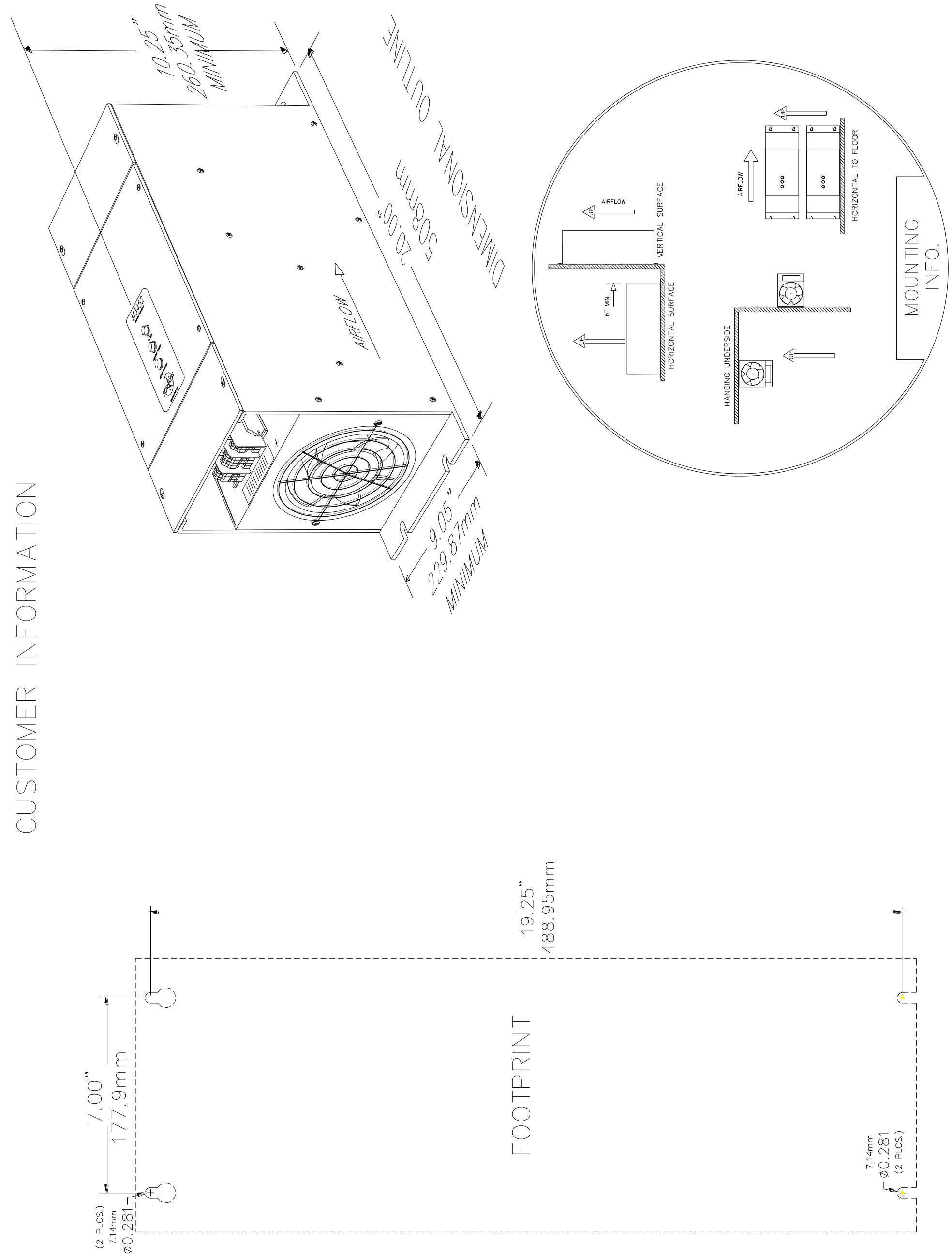


Figure 6-4: M3452 K10 Chassis Dimensional Outline Drawing

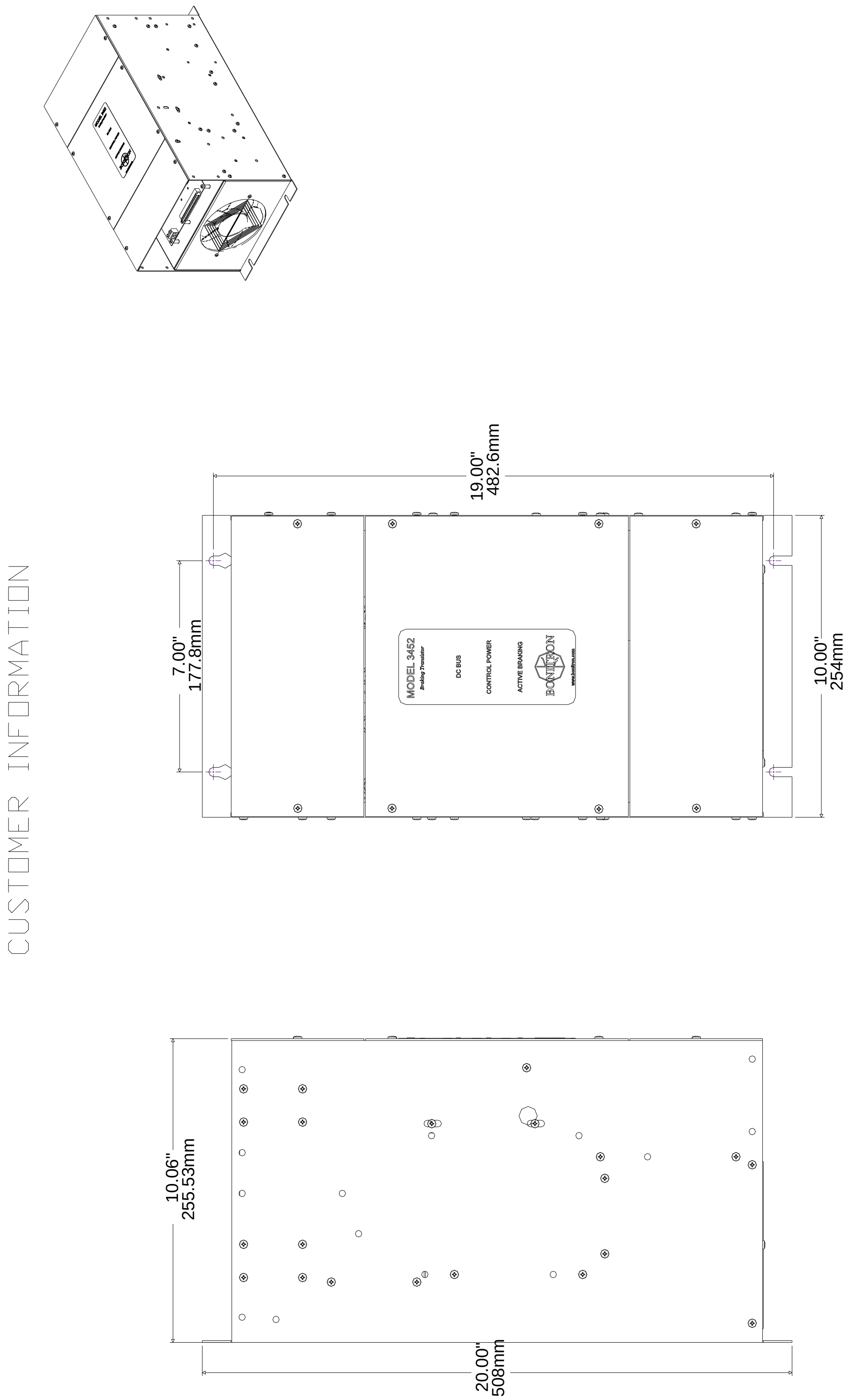


Figure 6-5: M3452 M14 Chassis Dimensional Outline Drawing

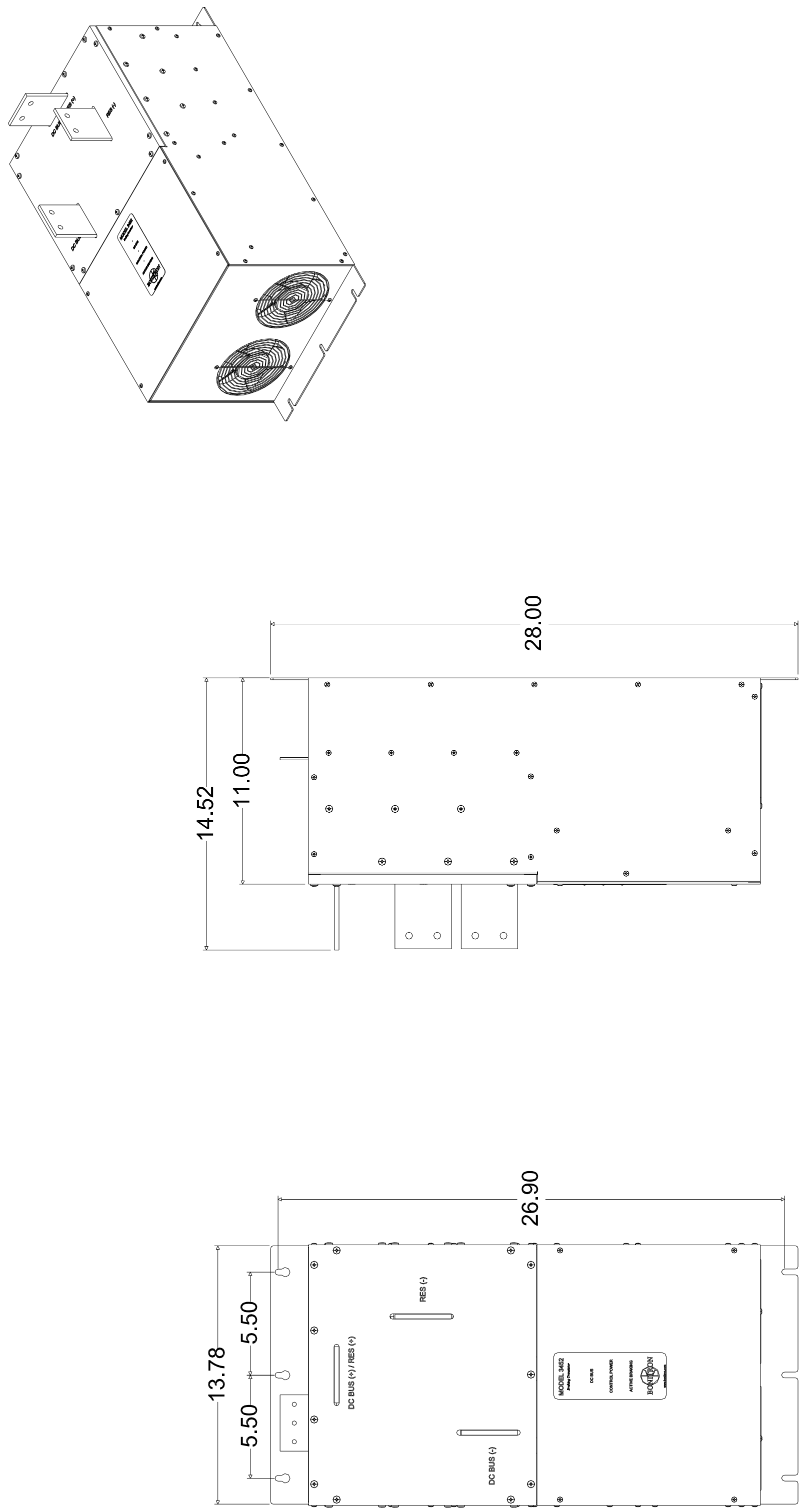
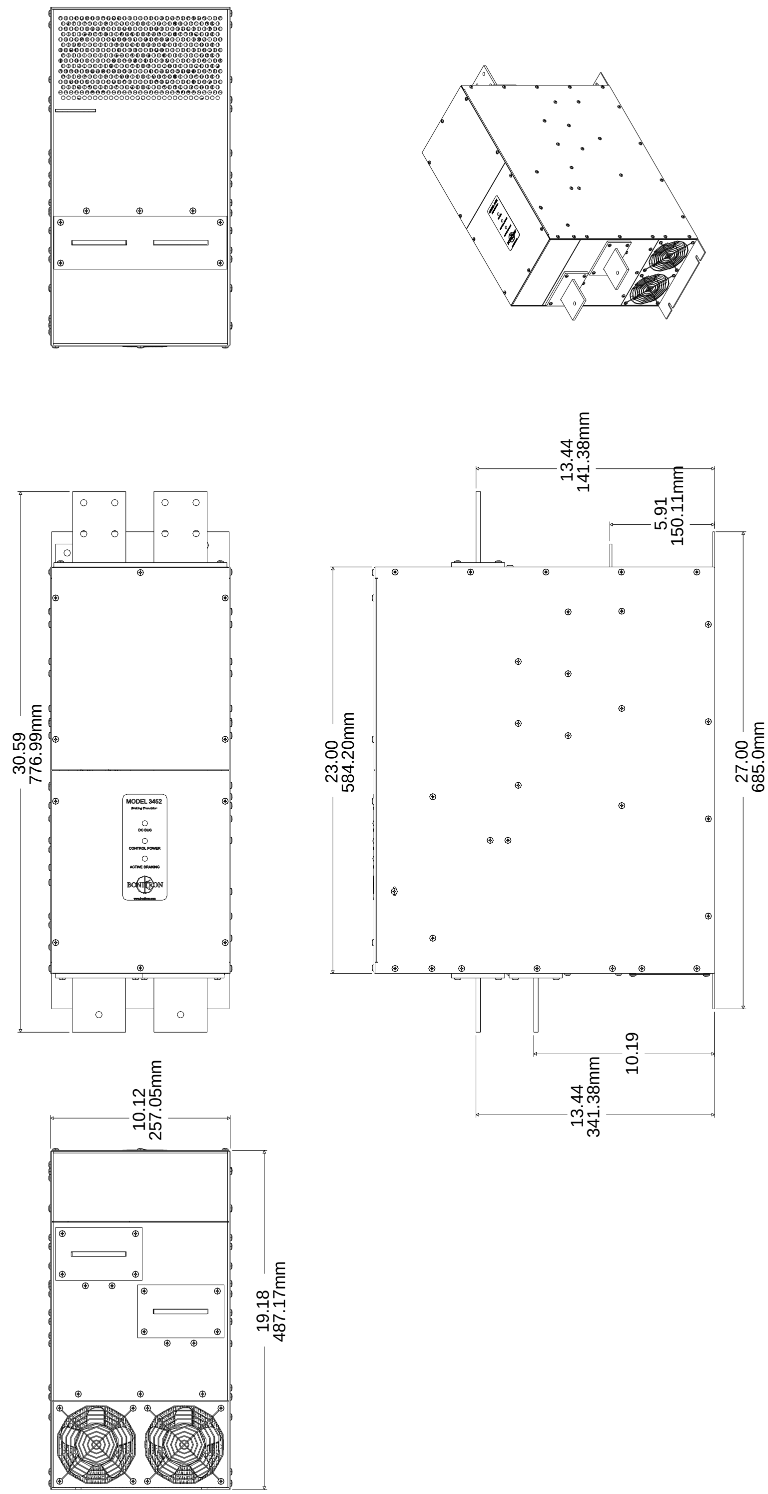


Figure 6-6: M3452 T10 Chassis Dimensional Outline Drawing



6.9. BLOCK DIAGRAMS

Figure 6-7: Block Diagram (All 200A thru 1200A and 1600A in T10 Chassis)

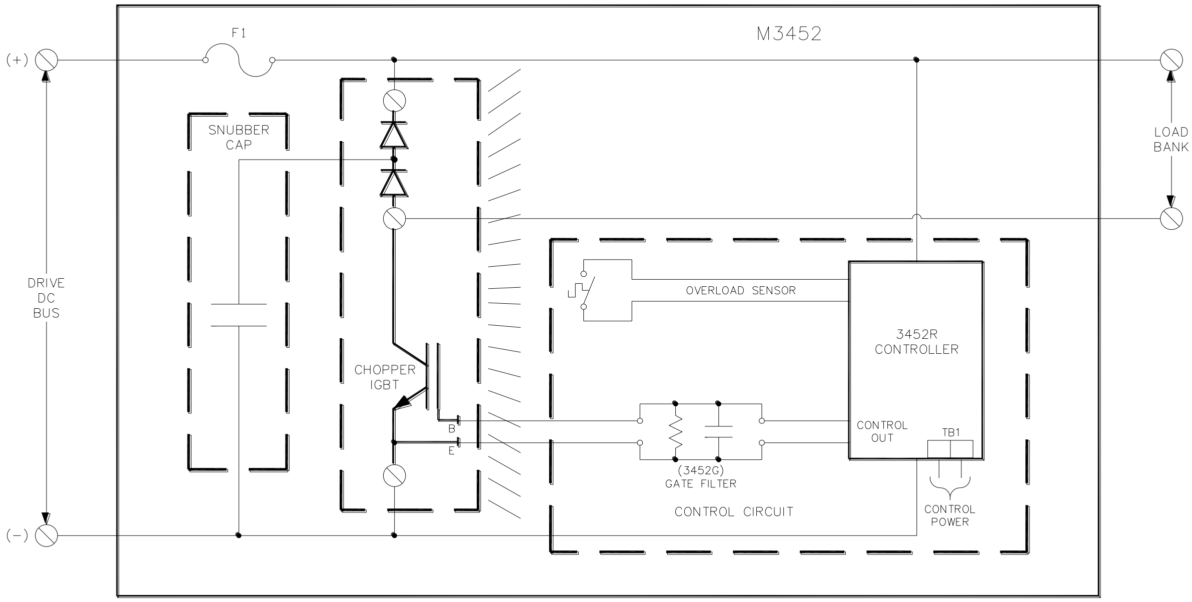
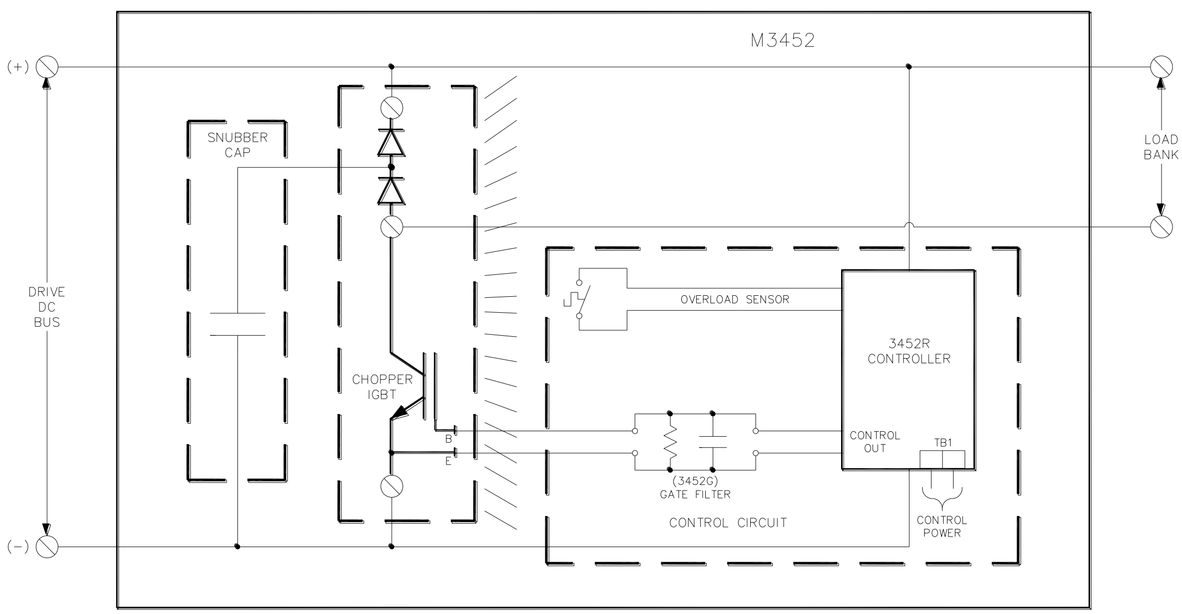


Figure 6-8: Block Diagram (1600A in M14 Chassis)



7. APPENDICES

7.1. APPLICATION NOTES

7.1.1. SIZING YOUR BRAKING REQUIREMENTS

Braking transistor modules are sized by peak current requirements and system voltage. Please use the following guidelines:

- Verify the amount of peak power needed for braking. This must be determined from the mechanical system layout, and should be calculated in either peak watts or horsepower.
- VFD's are rated for braking power as well as peak braking capacity. This information is available in the drive manual. This will be the maximum amount of power that the output inverter stage of the VFD can absorb from the load before having an overcurrent condition. Refer to your VFD documents for information on drive sizing. Keep in mind that the current rating of the drive is for three phase current, not DC bus current. The braking current in the DC bus will be higher than the AC current absorbed from the load.
- Because Bonitron braking transistor modules are rated for peak current, determine the peak braking power required.

7.1.1.1. HORSEPOWER TO WATTS

Once the braking requirements for the mechanical load are determined, multiply the horsepower by the scaling factor of 746 to determine the wattage required. For instance, with a 400 hp system, the peak braking power may be 600 hp. In this case the peak power required would be:

$$P_{brake} = H.P._{Braking} * 746 \qquad P_{brake} = 600\,H.P. * 746 = 447600\ watts$$

7.1.1.2. PEAK AMPERAGE

The peak amperage of the braking cycle can be determined by dividing the peak braking wattage by the system bus trip point of the Braking Transistor Module used. If the above example were on a 480VAC system, the trip point is 750VDC, as determined from Table 2-3: In this case the peak current required would be:

$$I_{brake} = P._{Braking} / 750VDC \qquad I_{brake} = 447600\ watts / 750VDC = 596.8\text{ADC}$$

In this case, a 600 Amp module should be used.

7.1.1.3. OHMIC VALUE

The ohmic value of the resistive load can usually be determined from the Tables in Section 6-1. The ohmic value shown indicates the capacity of the braking transistor module, and may not be directly related to the horsepower of the drive. In order to calculate the required ohmic value for the braking load, use the following formula:

$$R_{brake} = {(V_{DCbus})^2} / {P_{brake}}$$

The DC bus voltage for the equation is determined by the level that the drive begins braking. For 460/480VAC systems, this is typically 750VDC, for 230VAC systems, it is typically 375VDC. Refer to your drive manual for specifics.

For the above example, the ohmic value would be:

$$R_{brake} = (750VDC)^2 / 447600watts = 1.26ohms$$

This value must be verified with the ratings of the Braking Transistor Module selected that it is not less than the "minimum ohmic value" for that model. If so, the braking requirements may be more than the Braking Transistor Module can absorb, and a larger module may be required.

It is also possible to parallel two modules with two separate braking resistors to achieve the braking power required.

If the ohmic value calculated is greater than the value listed in the ratings table, it is possible to select a resistor value lower than the calculated value.

7.1.1.4. DUTY CYCLE

The duty cycle is based on the amount of time the drive is actually braking as opposed to accelerating, running at constant speed, or idle. For instance, if a pick and place operation requires 3 seconds to accelerate, traverses for 44 seconds and then decelerates for 3 seconds, the total cycle time is:

$$T_{cycle} = T_{acc} + T_{run} + T_{dec} = 3 + 44 + 3 = 50\sec$$

The duty cycle for braking is:

$$\%_{duty} = T_{dec} / T_{cycle} = .06 = 6\%$$

This rating assumes the load will be linearly decreasing from peak braking power to zero braking as the load comes to a stop.

Check this rating against the modules duty cycle rating, and if it is higher than rated, go to the next higher rated module. If a duty cycle is required over 50%, please call for assistance with your application.

7.1.1.5. CONTINUOUS RATING

The continuous rating is listed for long term heating calculations should the unit be installed in an area where heat dissipation is an issue. The rating is based on a triangular cycle that starts at peak value and reduces to zero within the rated duty cycle. Therefore, the average braking power during the deceleration cycle is ½ the power required if full power was required during the entire braking cycle. This value is:

$$P_{continuous} = P_{peak} * \%_{duty} / 2$$

For the above example, the

$$P_{continuous} = 447600\text{W} \; * 6\% / 2 = 13428\, W$$

7.1.2. COMMON BUS APPLICATION NOTE

Bonitron Dynamic Braking Transistor Modules are designed to be compatible with individual stand-alone inverter/drive systems, or systems that incorporate a Common DC Bus arrangement. The Common DC Bus can be composed of multiple inverter/drive sections tied together where all or some of the sections use their respective AC input, or there may be a large independent Master DC Bus Supply feeding the DC inputs of all inverter/ drive sections. In the case of the large Master DC Bus supply, it is common to find multiple rectifier sections in parallel to provide very high power levels. Some high power systems also include redundant or back up sections as well.

Once power is applied, all Bonitron modules are designed to be sourced from DC buses that have all the bus capacitors present.

Common DC Bus Systems composed of separate Master DC bus or rectifier sections have important imbedded differences. It is common to have a main distributed DC bus, and this is typically where the Dynamic Braking Transistor Modules connect. In this way, the Resistive Braking system is always present, even if some of the inverter/drive sections need to be removed from the bus for maintenance or other purposes. In emergency situations, it may even be necessary to "limp" along until repairs or swap outs can occur. Even though the modules are well suited for use in these systems, the following modes of operation could arise or exist and **are not allowed**:

1. **Do not** connect the Dynamic Braking Transistor Module on the rectifier side of a DC link choke. The connections must always be made to the inverter/drive side directly to the DC bus capacitors. During normal system operation, the choke can cause the braking system to begin ringing. This ringing causes high voltages that will damage the system.
2. **Do not** energize the system with no inverters/drives present on the distributed DC Bus.
3. **Do not** energize, operate, or run the system with less than 60% of the total expected system capacitance present.
4. Operating the modules in conditions 2 and 3 may make the modules respond to inbound line transients caused by SCR type rectifiers, powering up the system, or any number of other sources. Without sufficient DC bus capacitance, the DC bus will not be filtered, and can cause ringing that will produce high voltages that will damage the system.
5. In some drives, the pre-charge contactor may open under fault conditions, leaving the bulk system capacitance only resistively coupled to the Dynamic Braking Transistor Modules. **Do not** enable the modules in this situation. Review inverter/drive DC Bus pre-charge circuit operation with the drive manufacturer.

If there is the possibility of these situations:

- Open the enable input on the R7 or R7E options.
- Use a properly rated contactor in series with the modules' control voltage AC Input. The modules are effectively disabled when they do not have their control power.
- Keep the modules disabled during power up or any other time until all system capacitances are present.
- Disable the modules in the event system pre-charge contactors open.

Always consult Bonitron with any questions or concerns surrounding this topic.

7.1.3. BONITRON LINE REGENERATION MODULES

The Bonitron Line Regens return regenerative energy back onto the AC line instead of dissipating the energy as heat in a resistor, and are ideal for applications with high duty cycles, frequent deceleration, or where heat from a resistor may be an issue. The regenerated energy is returned to the AC line with near-unity power factor and can be used to power other equipment, which quickly offsets the slightly higher initial investment of the Line Regen Solution.

NOTES

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