BONITRON

Solutions for AC Drives

Model M3460

Ride-Thru

Enclosed Voltage Regulator

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

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

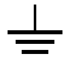
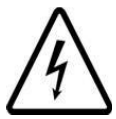
This manual is a user's guide for the model M3460 ride-thru voltage regulator. It will provide the user with the necessary information to successfully install, integrate, and use this in a variable frequency AC drive system.
In the event of any conflict between this document and any publication and/or documentation related to the AC drive system, the latter shall have precedence.

1.3. MANUAL REVISION

The initial release of M3460 voltage regulator is Rev 00a.

Figure 1-1: M3460R in E1 Chassis and M3460B in E2 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's M3460 ride-thru voltage regulators provide protection from power quality events for variable frequency drives (VFDs) that use a fixed rectifier and DC bus. The M3460R provides sag protection for up to 2 seconds at 50% line sag on all 3 phases. It can also provide protection from short term full outages of up to 2 seconds with the addition of storage systems, such as capacitors. The M3460B, in conjunction with a battery bank, provides full outage protection for up to 4 minutes at full power rating or 15 minutes at 50% power rating during a full outage.

Industries with continuous processes can suffer huge losses from equipment downtime, loss of production, or damaged product when VFDs trip on under-voltage conditions. Traditional UPS solutions are connected in series, which decreases the overall drive system reliability. All Bonitron ride-thru products connect in parallel with the drive, thus increasing system availability and reliability.

The M3460 regulates incoming voltage to the DC bus of the variable frequency drive. This allows the drive to "ride through" these events while maintaining motor speed and torque without experiencing drive shutdown.

ADVANTAGES

- Reliability
- Parallel connection to AC system
- M3460 maintenance can be done while normal process is on-line
- Works with almost any fixed bus, variable frequency, PWM drive
- Only 2-3 parallel connections
- Can use existing AC feed wiring and breakers
- Instant response
- Bumpless transfer
- Easy commissioning

2.1. RELATED PRODUCTS AND DOCUMENTS

2.1.1. PRODUCTS

S3460UR SERIES RIDE-THRU SYSTEMS

Complete systems that use ultracapacitor storage for short term power outages.

S3460BR SERIES RIDE-THRU SYSTEMS

Complete systems that use batteries for longer term power outages.

M3534 SERIES RIDE-THRU MODULES

Voltage regulators used for sag or outage protection of lower power systems.

M3528 BATTERY AND ULTRACAPACITOR CHARGERS

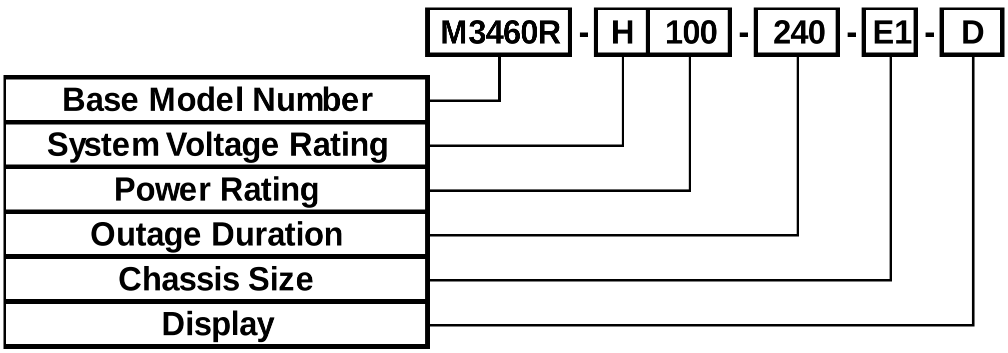
Chargers for high voltage storage strings.

2.1.2. DOCUMENTS

Please refer to the KIT 3660DD5 manual for more details about the DD5 Digital Display. This manual is available at www.bonitron.com or by contacting Bonitron.

2.2. PART NUMBER BREAKDOWN

Figure 2-1: Example of Part Number Breakdown



BASE MODEL NUMBER

The base model number for all ride-thru modules in this series rated for 2 second operation is **M3460R.** The base model number for all ride-thru modules in this series rated for 4-15 minute operation is **M3460B.**

SYSTEM VOLTAGE RATING

The M3460 is available in several input voltage ratings. This rating is indicated by a code as shown in Table 2-1.

Table 2-1: System Voltage Rating Codes

RATING CODE	NOMINAL VOLTAGE (AC LINE / DRIVE BUS)
L	230 VAC / 325 VDC
E	380 - 415 VAC / 540 - 585 VDC
H	460 VAC / 650 VDC

POWER RATING

The power rating indicates the maximum power in kilowatts that can safely be handled by the M3460 and is represented by a 3-digit value based on the nominal DC system voltage rating and the maximum output current rating of the M3460. For instance, the rating code for a 100kW M3460 is **100**.

OUTAGE DURATION

The outage duration indicates the amount of time (in seconds) the M3460B module is able to hold the DC bus at the threshold level while loaded to the rated current. This duration is directly represented by a 3-digit value. For example, **240** in this position, represents 240 seconds (4 minutes) of outage duration.
This code is omitted on M3460R models.

CHASSIS SIZE

five enclosed chassis sizes are indicated by a code as shown in Table 2-2. This chassis size is determined by the current rating of the unit.

Table 2-2: Chassis Size Codes

CHASSIS SIZE CODE	DIMENSIONS (H X W X D)	3460R	3460B
E1	30.00” x 24.00” x 13.00	85-127 A	-
E2	36.00” x 24.00” x 13.00”	170 A	85 A
E3	40.00” x 24.00” x 13.00”	-	127-170A
E4	48.00” x 24.00” x 13.00”	255-425 A	-
E5	60.00” x 24.00” x 13.00”	-	255-340 A

DISPLAY

The M3460R and M3460B modules are equipped with the DD5 digital display.

2.3. GENERAL SPECIFICATIONS

Table 2-3: M3460R General Specifications

PARAMETER	SPECIFICATION
Input AC Voltage	208 – 480 VAC
Input DC Voltage	200 – 585 VDC
Output DC Voltage	265 – 650 VDC
DC Bus Current Rating	85 – 425 ADC
Power Rating	25 – 250 kW
Inactive Power Consumption	<200W
Duty Cycle (Full Load)	1%
Sag/Outage Duration	2 seconds
Enclosure Rating	NEMA 1 Enclosure
Operating Temperature	0 to +40ºC
Storage Temperature	-20 to +65 ºC
Humidity	Below 90% non-condensing
Atmosphere	Free of corrosive gas and conductive dust

Table 2-4: M3460B General Specifications

PARAMETER	SPECIFICATION
Input DC Voltage	200 – 540 VDC
Output DC Voltage	265 – 650 VDC
DC Bus Current Rating	85– 340 ADC
Power Rating	25 – 200 kW
Inactive Power Consumption	<200W
Duty Cycle (Full Load)	1%
Sag/Outage Duration	4 minutes at full power or 15 minutes at 50% power
Enclosure Rating	NEMA 1 Enclosure
Operating Temperature	0 to +40ºC
Storage Temperature	-20 to+ 65 ºC
Humidity	Below 90% non-condensing
Atmosphere	Free of corrosive gas and conductive dust

2.4. 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 ADEQUATE TIME FOR RESIDUAL VOLTAGES TO DRAIN BEFORE OPENING THE ENCLOSURE.
- **FAILURE TO HEED THESE WARNINGS MAY RESULT IN SERIOUS INJURY OR DEATH!**

CAUTION!

- CERTAIN COMPONENTS WITHIN THIS PRODUCT MAY GET HOT DURING OPERATION.
- ALWAYS ALLOW AMPLE TIME FOR THE UNIT TO COOL BEFORE ATTEMPTING SERVICE ON THIS PRODUCT.
- INSTALLATION AND/OR REMOVAL OF THIS PRODUCT SHOULD ONLY BE ACCOMPLISHED BY A QUALIFIED ELECTRICIAN IN ACCORDANCE WITH NATIONAL ELECTRICAL CODE OR EQUIVALENT REGULATIONS.
- BEFORE ATTEMPTING INSTALLATION OR REMOVAL OF THIS PRODUCT, BE SURE TO REVIEW ALL SYSTEM DOCUMENTATION FOR PERTINENT SAFETY PRECAUTIONS.
- NO USER-SERVICEABLE PARTS ARE CONTAINED WITHIN THIS PRODUCT. INOPERABLE UNITS SHOULD BE REPLACED OR RETURNED FOR REPAIR.
- THIS PRODUCT DOES NOT PROVIDE MOTOR OVERLOAD PROTECTION.

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

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 M3460 ride-thru should be accomplished by following the steps outlined below. Be sure to refer to the AC drive instruction manual 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. Please read this manual completely before designing the drive system or enclosure layout to ensure all required elements are included.

3.1. ENVIRONMENT

The installation site for M3460 should be chosen with several considerations in mind:

1. The unit has a NEMA 1 enclosure rating and will therefore require some protection from the elements.
2. Conduit access for field wiring may be provided on the top-right surface of the enclosure if desired.
3. The unit will require a minimum clearance of two (2) inches in all directions around it when mounted near a non-heat source.
4. The mounting surface should be clean and dry.

The maximum ambient operating temperature of the M3460 should not exceed 40°C. Temperatures above this can cause overheating during operation.

The standby heat production of the M3460 is quite low, but can generate significant heat during boosting. This is only of concern with the M3460B models because the M3460R run time of 2 seconds will not allow the system to reach thermal equilibrium, and should not cause thermal issues.

3.2. UNPACKING

Inspect the shipping crate and M3460 for damage.

Notify the shipping carrier if damage is found.

3.3. MOUNTING

Mounting dimensions can be found in Section 6.4.

Once the installation site has been selected as outlined above, the unit should be mounted in place. The enclosure is provided with (4) 7/16" diameter mounting holes. Mounting holes should be drilled and mounting studs or anchors installed before positioning the enclosure. Mounting hardware is not supplied.

3.4. Wiring and User Connections

Review this entire section before attempting to wire the M3460.

3.4.1. Power Wiring

DANGER!

THE M3460 CAN HAVE MULTIPLE POWER SOURCES, INCLUDING THE MAIN AC INPUT, ENERGY STORAGE SYSTEMS AND THE DC CONNECTION TO THE VFD.

ENSURE THAT ALL SOURCES ARE DISCONNECTED AND LOCKED OUT BEFORE ATTEMPTING SERVICE OR INSTALLATION.

FAILURE TO HEED THESE WARNINGS MAY RESULT IN SERIOUS INJURY OR DEATH!

This section provides information pertaining to the field wiring connections of the M3460. Actual connection points and terminal numbers of the AC drive system will be found in the documentation provided with the drive system.

Be sure to review all pertinent AC drive system documentation as well as the connection details listed below before proceeding.

Table 3-1: M3460R Power Wiring Connections

Terminal Designation	Function	Wiring Specification	Connection	Torque
AC Line L1, L2, L3	AC Input	600 VAC	3/8" stud	150 lb-in
Storage Bus + -	DC Input	600 VAC	Existing Diode / SCR	Check Device Datasheet
Drive Bus + -	DC Output	600 VAC	3/8" stud	150 lb-in
⏚	Ground	600 VAC	5/16" stud	75 lb-in

Table 3-2: M3460B Power Wiring Connections

Terminal Designation	Function	Wiring Specification	Connection	Torque
Storage Bus + -	DC Input	600 VAC	3/8" stud	150 lb-in
Drive Bus + -	DC Output	600 VAC	3/8" stud	150 lb-in
⏚	Ground	600 VAC	5/16" stud	75 lb-in

Main power connections should be made with copper wire; use compression fitting lugs. Wire sizing should be appropriate for the current being carried. System ratings are listed in Section 6.1.

M3460 ride-thru units only provide full currents for a limited amount of time. Therefore, wire heating is not as much a concern as mechanical strength.

3.4.1.1. AC LINE (L1, L2, L3) CONNECTIONS

The AC input to the M3460R can temporarily reach up to 200% of the normal input current during a power quality event. Size the upstream current protection devices accordingly, so that the incoming AC will not be interrupted by the temporary power draw.

During a power quality event, the AC input to the drive will not be drawing current. Sizing the incoming AC feed to supply both the drive and the M3460R simultaneously is not necessary. Even though the input current during a power quality event may be higher than the normal input current, this temporary overload is allowed by most codes without upsizing the normal AC feed bus.

Due to the increased currents in the AC feed during a power quality event, the total voltage drop of the incoming AC feed should be considered to make sure the voltage doesn't dip too low.

If line chokes are to be used in the system, the M3460R must be installed on the load side of these chokes. This minimizes the possibility of circulating currents through the M3460R and converter section of the VFD.

There is no need to connect the AC line to the M3460R if an ultracapacitor bank is being used. The DC connections from the ultracapacitor bank can be made to any two of the AC line connections so that the existing fuses can be used for protection. Please note that one terminal will not be connected. See Figure 3-4.

3.4.1.2. STORAGE BUS (+ -) CONNECTIONS

If an electrolytic capacitor bank is used with the M3460R, the input can be attached directly to the diode bus bars marked Storage Bus. External fusing between the capacitor bank and the M3460R is recommended. The M3460B battery bank connections are made at the Storage Bus fuse blocks at the top of the module.

Make sure the polarity is correct for these connections, as failure to do so can cause severe damage to the system.

DANGER!

FOR SYSTEMS THAT HAVE DC STORAGE, ALWAYS MEASURE DC VOLTAGES AND FOLLOW PROPER PRECAUTIONS TO ENSURE THEY ARE AT SAFE LEVELS BEFORE MAKING CONNECTIONS.

3.4.1.3. DRIVE BUS (+ -) CONNECTIONS

The M3460 must have a DC bus connection directly to the DC bus filter capacitors within the drives. Connections cannot be made through the braking terminals or with precharge resistors or DC link chokes between the output of the M3460 and the DC bus capacitors in the drive. Consult the manufacturers' documentation or contact Bonitron for further assistance.

Make sure the polarity is correct for these connections, as failure to do so can cause severe damage to the system.

DANGER!

FOR SYSTEMS THAT HAVE DC STORAGE, ALWAYS MEASURE DC VOLTAGES AND FOLLOW PROPER PRECAUTIONS TO ENSURE THEY ARE AT SAFE LEVELS BEFORE MAKING CONNECTIONS.

3.4.1.4. GROUNDING REQUIREMENTS

All units come equipped with a 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. CONTROL INTERFACE AND I/O WIRING

Control wiring allows for remote enabling, testing, and monitoring of the M3460. All units are equipped with the 3660DD5 digital display interface, all connections are made to the 3660I4 interface board.

Refer to the KIT 3660DD5 manual for operational and functional details.

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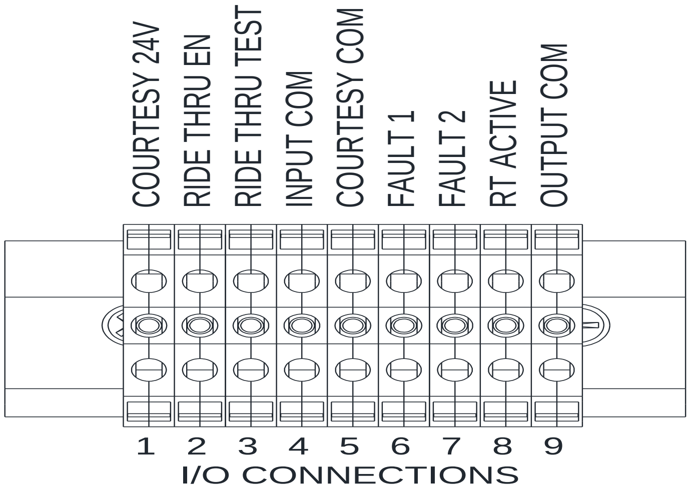
3.4.2.1. CONNECTIONS WITH DD5 DIGITAL DISPLAY

Table 3-3: User I/O Connections with 3660I4 Board

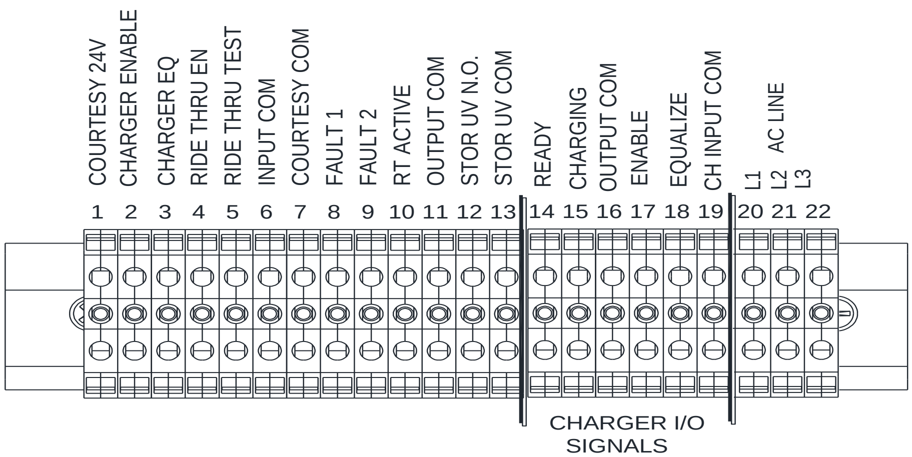
3660I4 TERMINAL	FUNCTION	ELECTRICAL SPECIFICATIONS	WIRE AWG	TORQUE
USER INPUTS				
TB15 - 1	24V Common	5 VDC, 25 mA	16	2.1 lb-in
TB15 - 2	Input Common			
TB15 - 3	Spare			
TB15- 4	Ride-Thru Test (RT Test) Input			
TB15 - 5	Ride-Thru Enable (RT EN) Input			
TB15 - 6	Charger Equalize (CH EQ) Input			
TB15 - 7	Charger Enable (CH EN) Input			
TB15 - 8	Courtesy 24V			
USER OUTPUTS				
TB14 - 1	Output Common	250 VDC, 120 mA	16	2.1 lb-in
TB14 - 2	Ride-Thru Active (RT ACTIVE) Output			
TB14 - 3	Fault 2 (N.O.) Output			
TB14 - 4	Fault 1 (N.O.) Output			
TB14 - 5	Spare 1 (N.O.)			
TB14 - 6	Spare 2 (N.O)			

Figure 3-1: M3460R I/O Terminal connection



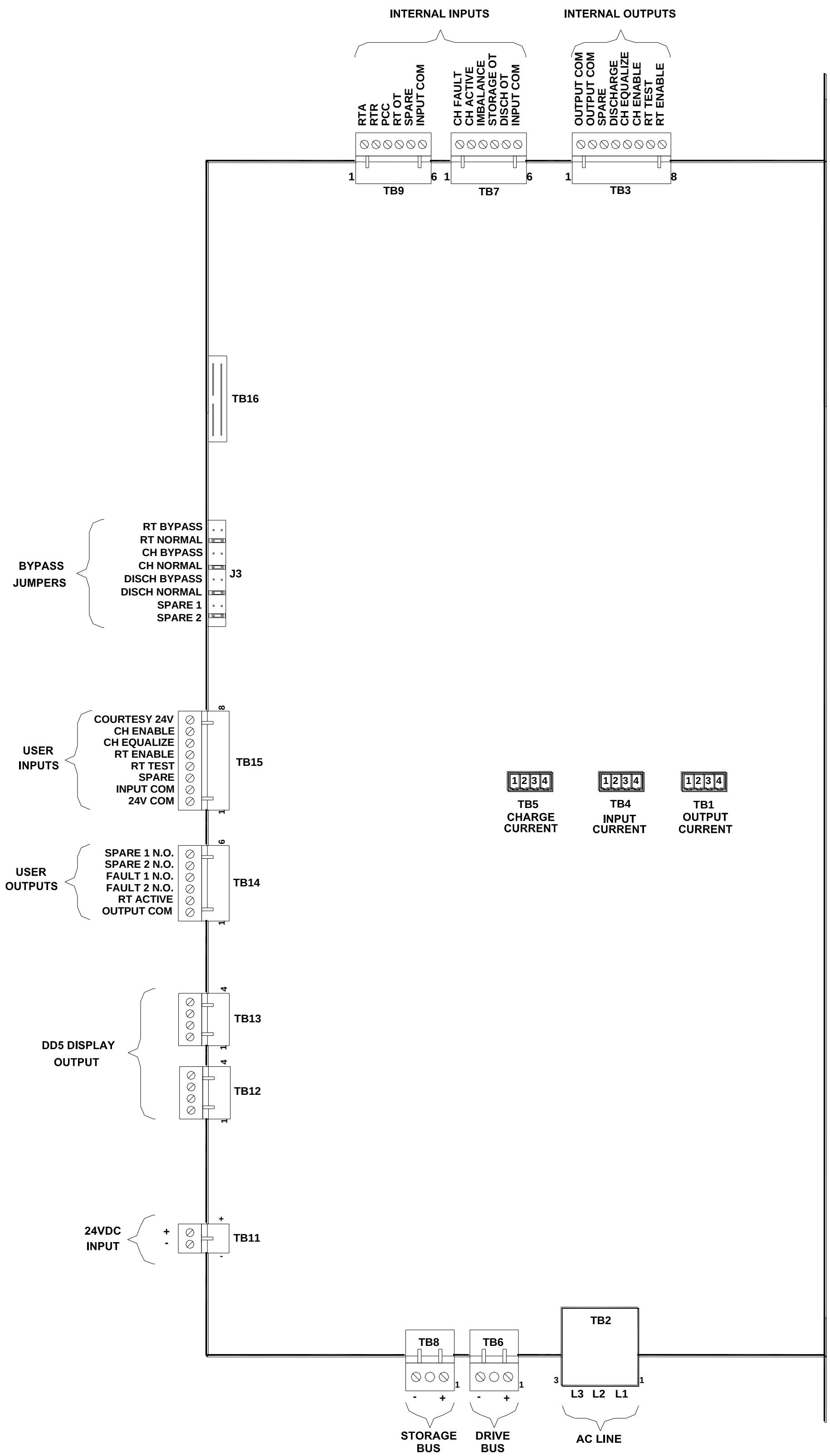
TERMINAL	FUNCTION
TB – 1	Courtesy + 24V
TB – 2	Ride-Thru ENABLE
TB – 3	Ride-ThrU TEST
TB – 4	Input COM
TB – 5	Courtesy COM
TB – 6	Fault 1
TB – 7	Fault 2
TB – 8	Ride-Thru Active (RTA)
TB – 9	Output COM

Figure 3-2: M3460B I/O Terminal connection



TERMINAL	FUNCTION
TB – 1	Courtesy + 24V
TB – 2	Charger ENABLE
TB – 3	Charger Equalize (EQ)
TB – 4	Ride-Thru ENABLE
TB – 5	Ride-Thru TEST
TB – 6	Input COM
TB – 7	Courtesy COM
TB – 8	Fault 1
TB – 9	Fault 2
TB – 10	Ride-Thru Active (RTA)
TB – 11	Output COM
TB – 12	Storage Undervoltage (NO)
TB – 13	Storage Undervoltage COM
TB – 14	Charger READY signal
TB – 15	Charger charginh signal
TB – 16	Charger output com
TB – 17	Charger enable signal
TB – 18	Charger equalize signal
TB – 19	Charger input com
TB – 20	AC LINE L1
TB – 21	AC LINE L2
TB – 22	AC LINE L3

Figure 3-3: 3660I4 Board Layout



3.5. TYPICAL CONFIGURATIONS

Figure 3-2: M3460R Typical Configuration without Energy Storage

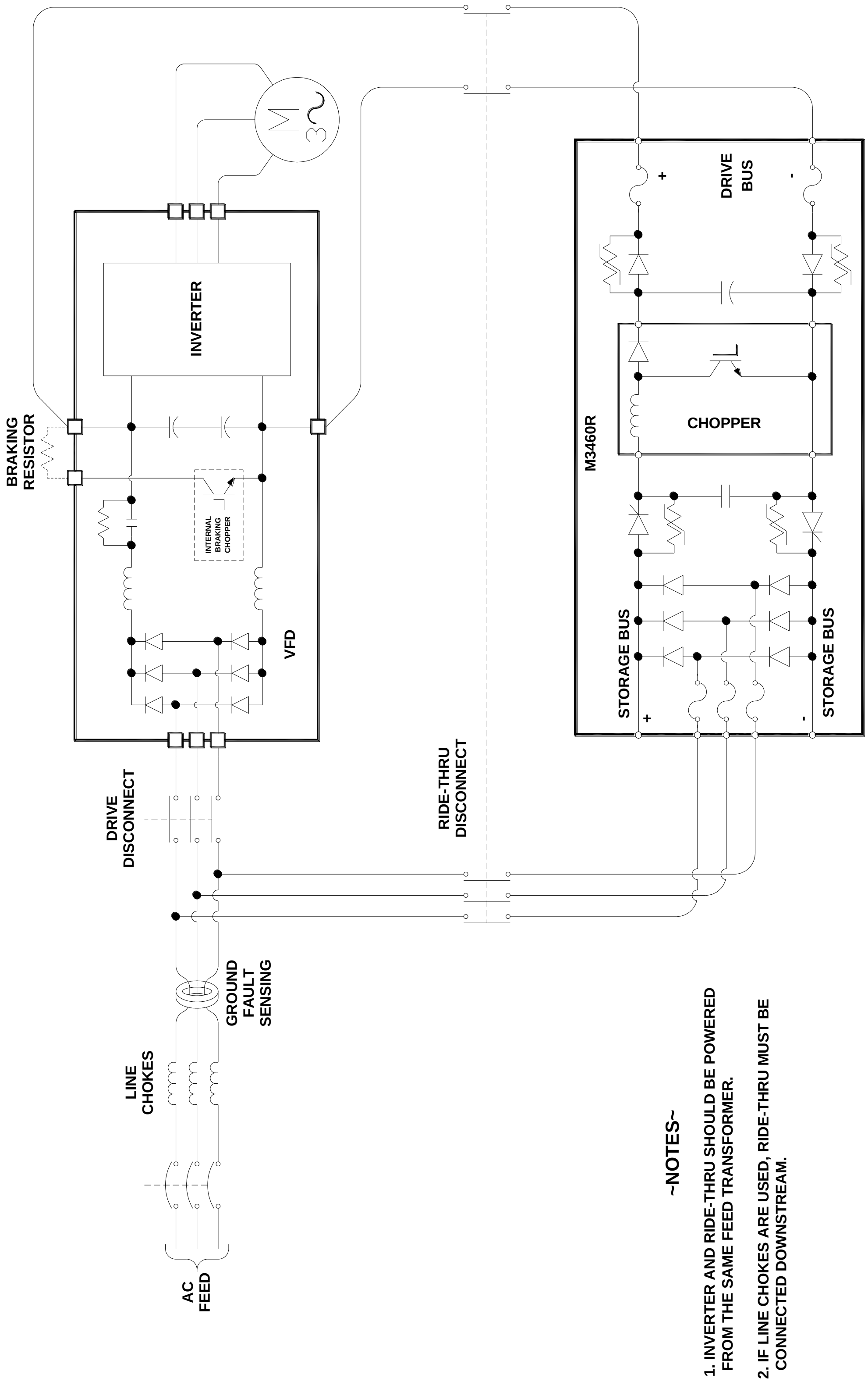
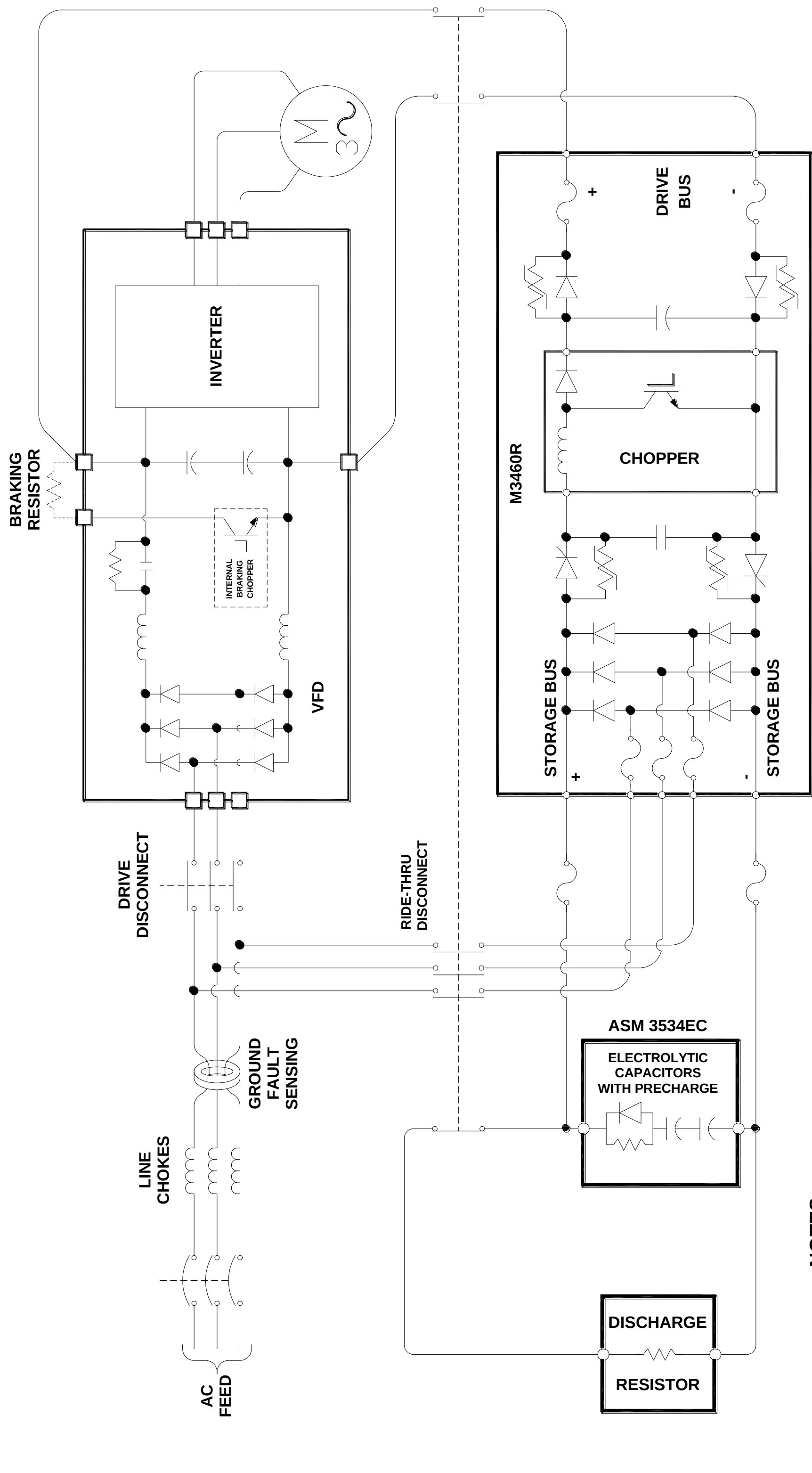


Figure 3-3: M3460R Typical Configuration with Electrolytic Capacitor Storage Bank



~NOTES~

1. INVERTER AND RIDE-THRU SHOULD BE POWERED FROM THE SAME FEED TRANSFORMER.
2. IF LINE CHOKES ARE USED, RIDE-THRU MUST BE CONNECTED DOWNSTREAM.

Figure 3-4: M3460R Typical Configuration with Ultracapacitor Storage Bank

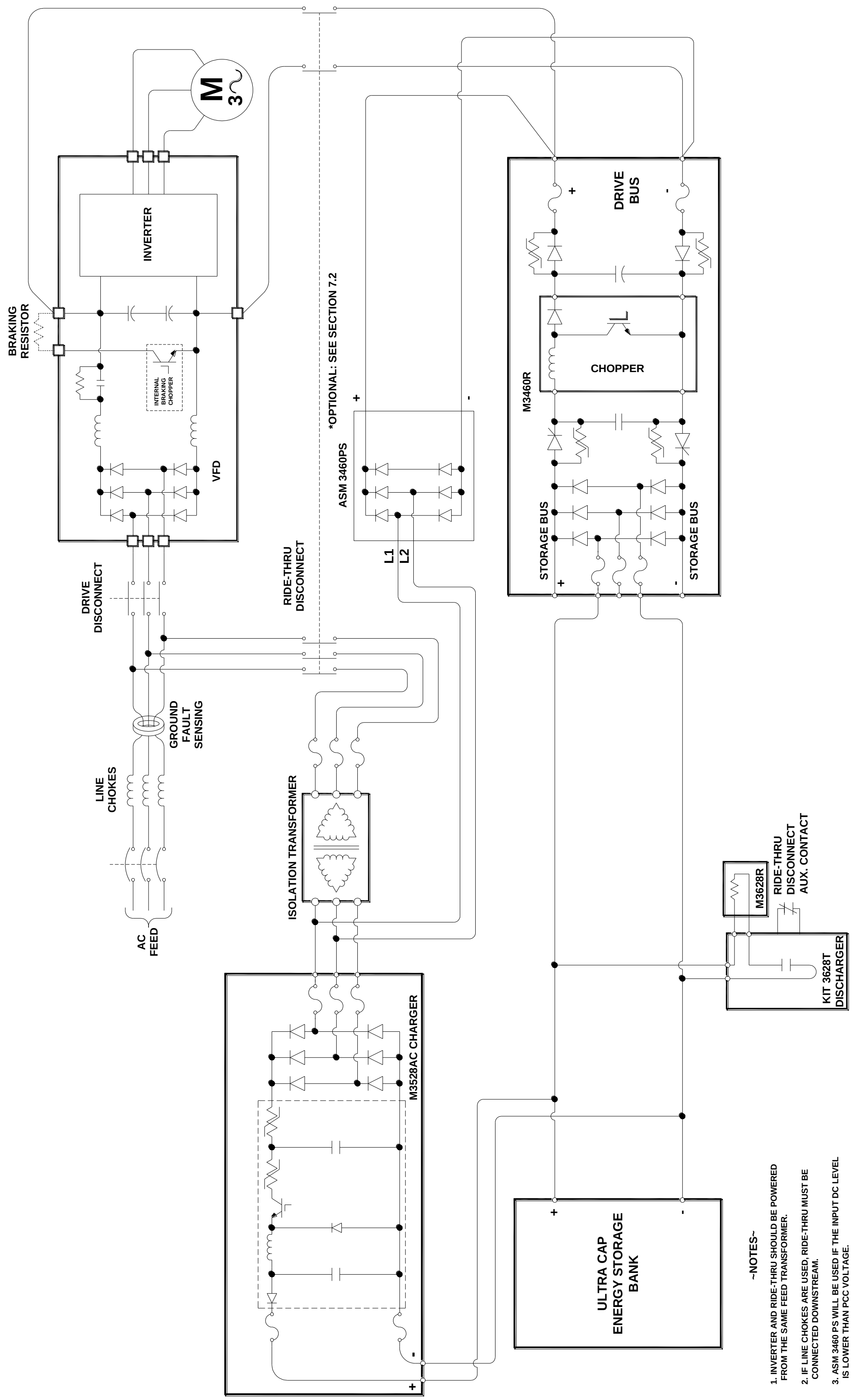
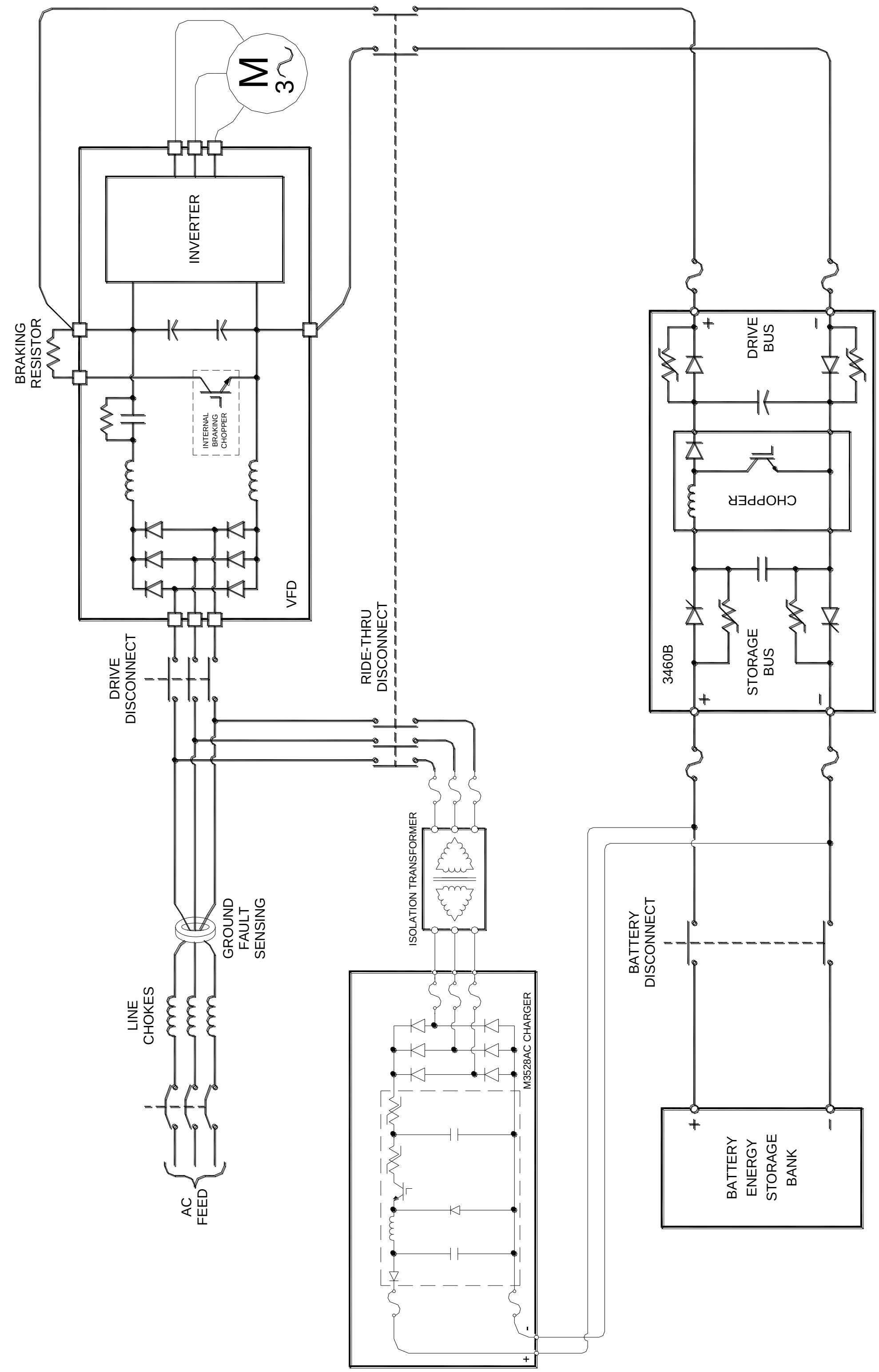


Figure 3-5: M3460B Typical Configuration with Battery Storage Bank



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4. OPERATION

4.1. FUNCTIONAL DESCRIPTION

The M3460 ride-thru voltage regulator monitors the DC bus of the attached variable frequency drive (VFD) and provides power in a voltage controlled, current limited supply directly to the filter capacitor section of the drive above the inverter stage. During a power quality event the internal DC bus of the VFD drops. When this level meets the DC bus threshold voltage of the M3460, power is delivered through blocking diodes to hold up the voltage in the VFD bus. The M3460 regulates and boosts the input voltage to the drive at a constant voltage.

In standby mode, when the incoming AC power is normal, the M3460 power consumption is minimal.

4.2. M3460R OPERATION FOR FULL OUTAGE PROTECTION

The M3460R can be used with an energy storage system to allow for protection against full outages for up to 2 seconds. This storage is typically double layer capacitors or ultracapacitors, but can be any DC power source that needs regulation to attach to the DC input of a variable frequency drive.

In order to use an ultracapacitor storage bank for outage support, the capacitor bank must be charged with a separate charger, such as the Bonitron M3528, as the M3460 does not have charging capabilities.

Refer to Section 7.2 for general guidelines on sizing a capacitor bank for full outage protection.

4.3. OPERATION MODES AND CONFIGURATION

4.3.1. NORMAL OPERATION

During normal operation, the M3460 will monitor the output DC bus. When the output DC bus voltage goes below the DC bus threshold voltage, the M3460 will become active and regulate the output DC bus and attached drive to the DC bus threshold voltage. As the input voltage drops, more current is required to maintain the same output power. If the input voltage drops to the point where the required output power makes the input current higher than the input current limit, the M3460 will operate in current limit, and the output voltage will drop according to the actual output load required by the drive.

This mode is activated by the Enable input.

4.3.2. TEST MODE

The Test mode allows the M3460 to be tested during normal power conditions. In this mode, the M3460 adjusts the DC bus threshold above the normal DC bus threshold setpoint. This forces the M3460 to begin sourcing power and driving up the DC bus voltage of the attached drive. When properly adjusted, the test voltage will be 50-100 VDC higher than the DC bus threshold. This level should not be high enough to overvoltage the attached drives or cause braking systems to activate. If the drive is heavily loaded when the test is done, the DC bus may not rise as much as if it were unloaded.

4.4. DISPLAY INTERFACE

The 3660DD5 is composed of two circuit boards, the 3660I4 interface board and the 3660D5 display board. The display board provides the user interface, and keeps time.

The interface board accepts digital and analog signals from the ride-thru system and the user, and processes them before sending them to the display board via CANbus. The interface board provides an isolated power supply to the display board, as well as an isolated serial connection.

4.4.1. DISPLAY

The display is a four-line, eighty-character LCD. This display shows information about the present status of the ride-thru system, records of power quality events and faults, and menus allowing the user to select actions or access other screens.

4.4.2. LEDS

Red, yellow, and green LEDs indicate the status of the ride-thru.

Red indicates a fault has occurred. The display will indicate the nature of this fault.

Yellow indicates that the ride-thru or the charger is active.

Green indicates that the display is receiving power from the ride-thru system.

4.4.3. BUTTONS

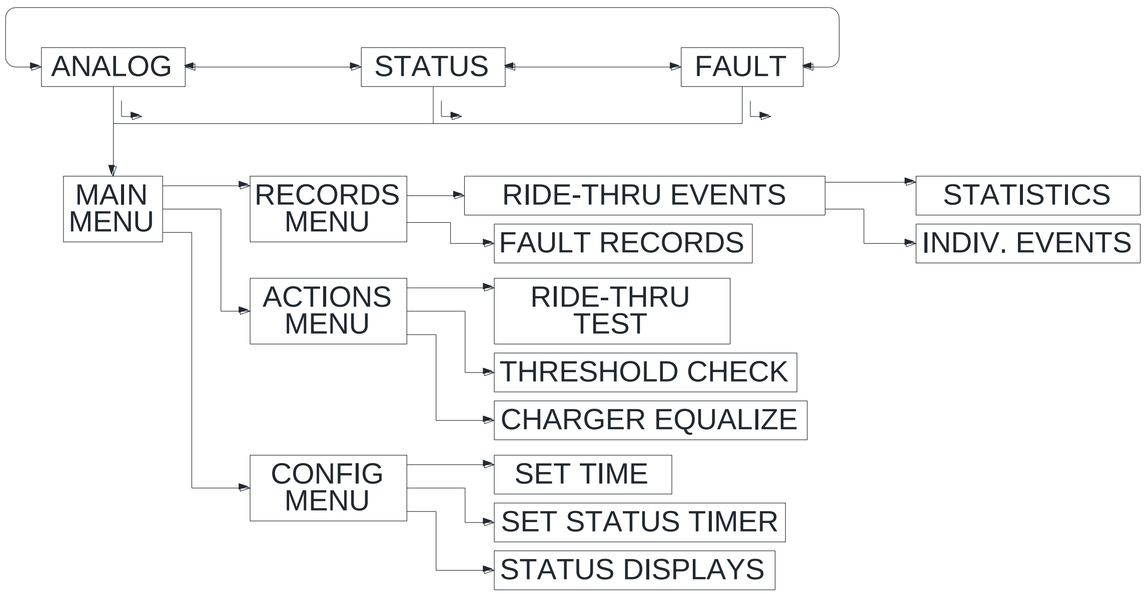
The function of each button depends on the active screen. For menu screens, *enter* selects a menu option, while *cancel* moves back to the previous screen. *Up* and *down* move the menu curser. On screens where numbers are input by the user, the *left* and *right* buttons move the cursor, while the *up* and *down* buttons change the selected digit. *Enter* stores the present value, while *cancel* undoes any changes. On some screens, certain buttons may have no function at all.

4.5. SCREENS & MENU NAVIGATION

Many screens are menus allowing access to other screens, or lists presenting a

number of options. The presently selected item on the menu is indicated by a '**>**' character. This selection indicator is moved using the *up* and *down* buttons. If a line on the menu represents another screen, that screen may be accessed with the *enter* key. The *cancel* button will return the display to the previous screen.

Figure 4-1: Screen Menu Tree



4.5.1. Status Screen

Upon system start, after a set period of inactivity, or during certain events, the system transitions to the Status screen. The status screen displays the present ride-thru and charger state, and two system voltages or currents. The variables displayed will be those selected by the user in the Configuration menu. Each value is indicated by both a number and a bar graph.

Left: Analog screen
Right: Fault screen
Enter: Main menu

4.5.2. Fault Screen

If a fault occurs, the red LED will turn on, and the display will transition to the Fault screen. If more than one fault is detected, the screen will scroll through all the faults at two-second intervals. Pressing *up* or *down* allows for faster manual scrolling through the faults. Pressing *left* and *right* simultaneously will clear any resettable faults.

Up: Show previous fault
Down: Show next fault
Left: Status screen
Right: Analog screen
Left & Right: Clear faults
Enter: Main menu
Cancel: Status screen

4.5.3. Analog Screen

This screen displays the present values of four of the eight system voltages and currents. One set shows storage voltage, storage current, output voltage, and output current; the other set shows the AC phase voltages and the charging current (not shown if charger is not connected). Which set is displayed can be changed by pressing *up* or *down*. Each value is indicated by both a number and a bar graph.

Up/Down: Switch analog set displayed
Left: Fault screen
Right: Status screen
Enter: Main menu
Cancel: Status screen

4.5.4. Main Menu

From this screen, the user may select viewing records, executing actions, or configuring the display system. This screen also displays the software version for the 3660I4 and 3660D5 boards.

Up/Down: Move cursor
Enter: Make selection
Cancel: Main menu

4.5.4.1. RECORDS MENU

From this screen, the user may select viewing ride-thru event records or fault records.

Up/Down: Move cursor

Enter: Make selection

Cancel: Main menu

4.5.4.1.1. RIDE-THRU EVENTS MENU

From this screen, the user may select whether to view event statistics or individual event records. The lifetime event counter is also displayed on this screen. The system ships with records of a single event describing the time between final power-off at the factory and the first power-on at installation.

Up/Down: Move cursor

Enter: Make selection

Cancel: Records menu

4.5.4.1.1.1. STATISTICS

This screen displays the number of RTA events since the last statistic reset, and their total and average duration. These records may be reset from the Super menu.

Cancel: ride-thru events menu

4.5.4.1.1.2. INDIVIDUAL EVENTS

This screen displays the time and duration of one of the thirty most recent ride-thru events.

Up: Display a more recent event

Down: Display an older event

Enter: Show the voltage records for the presently selected event

Cancel: Ride-Thru Events menu

4.5.4.1.1.2.1. RIDE-THRU EVENT VOLTAGES

This screen displays the voltages recorded for the selected ride-thru event.

Cancel: Individual Events

4.5.4.1.2. FAULT RECORDS

This screen displays a record of the 100 most recent fault states, including the number of faults, their nature, and the date and time they occurred. Multiple faults are scrolled through at two-second intervals.

Up: Display a more recent fault record

Down: Display an older fault record

Cancel: Records menu

4.5.4.2. ACTIONS MENU

From this screen, the user may select to initialize a ride-thru test, perform a threshold check, or initialize a charger equalize.

Up/Down: Move cursor

Enter: Make selection

Cancel: Main menu

4.5.4.2.1. RIDE-THRU TEST

On this screen, the user is instructed to press and hold the *enter* button to perform a ride-thru test. The test will end when the button is released. The system transitions to the Status screen for the duration of the test.
Enter: Test
Cancel: Actions menu

4.5.4.2.2. THRESHOLD CHECK

On this screen, the user is instructed to remove AC power from the ride-thru cabinet momentarily. This will cause the ride-thru to become active. The display will show the ride-thru output when the ride-thru becomes active. This voltage is the threshold voltage of the ride-thru.
Cancel: Actions menu

4.5.4.2.3. CHARGER EQUALIZE

From this screen, the user may set how long the charger should stay in equalize mode for.
Up: Increment digit
Down: Decrement digit
Left/Right: Move cursor
Enter: Confirm time
Cancel: Actions menu

4.5.4.3. CONFIGURATION MENU

From this screen, the user may set the present time, select what status values are to be displayed on the Status screen, and set the status screen timeout value.
Up/Down: Move cursor
Enter: Make selection
Cancel: Main menu

4.5.4.3.1. SET TIME

On this screen, the user may set the present date and time. There is no automatic adjustment for daylight saving time or other local time variances. For this reason, the user may wish to set the clock to GMT. It is also recommended that this time setting be checked periodically to adjust for drift.
Up: Increment digit
Down: Decrement digit
Left/Right: Move cursor
Enter: Confirm time
Cancel: Configuration menu

4.5.4.3.2. SET STATUS TIMER

On this screen, the user may set how long the system will wait after the last button press before returning to the Status screen. If this time is set to 0 seconds, the Status screen timer is disabled, and the system will not leave the present screen without external stimulus.

Up: Increment digit
Down: Decrement digit
Left/Right: Move cursor
Enter: Confirm time
Cancel: Configuration menu

4.5.4.3.3. STATUS DISPLAYS

The user may select which two voltages or currents will be displayed on the default status screen.

4.6. FAULTS

The 3660DD5 monitors several faults. Some latch until reset, either from the display or by toggling the appropriate enable input. Faults that do not latch automatically reset when the fault condition is no longer present. Each fault activates one of the two fault outputs. Some faults disable either the ride-thru or charger until they are reset. See Table 4-1 to determine which properties apply to each fault.

Table 4-1: KIT 3660DD5 Faults

FAULT DESCRIPTION	FAULT 1	FAULT 2	LATCH	RIDE-THRU DISABLE	CHARGER DISABLE
Output Undervoltage	x				
Storage Undervoltage		x	x	Configurable	
Storage Overvoltage	x		x		x
Ride-Thru Not Ready		x			
Precharge Not Complete	x				
Ride-Thru Overtemp		x	x	Configurable	
Phase 1 Loss	x				
Phase 2 Loss	x				
Phase 3 Loss	x				
Ride-Thru Active Time		x	x	Configurable	
Storage Imbalance	x		x		x
Storage Overtemp	x		x		x
Charger Fault	x				
Discharge Resistor Overtemp	x				x
Display Communication Loss	x				
Interface Communication Loss	x				

4.6.1. OUTPUT UNDERVOLTAGE

This fault indicates that the bus voltage has dropped below the level set in the Super menu.

4.6.2. STORAGE UNDERVOLTAGE

This fault indicates that the storage voltage has dropped below the level set in the Super menu. This fault can be configured in the Super Menu to disable the ride-thru to prevent damage to the storage bank. If capacitors are used, the system will start-up with this fault, but can be reset after the capacitor bank is charged above the Storage Undervoltage level.

4.6.3. STORAGE OVERVOLTAGE

This fault indicates that the storage voltage has risen above the level set in the Super menu. There are two overvoltage fault levels, one for normal operation, and one for when the charger is executing an equalize cycle.

4.6.4. RIDE-THRU NOT READY

This fault indicates that the ride-thru is not ready to run.

4.6.5. PRECHARGE NOT COMPLETE

This fault indicates that the ride-thru has not successfully completed precharge.

4.6.6. RIDE-THRU OVERTEMP

This fault indicates that the ride-thru temperature has reached an unsafe level.

4.6.7. PHASE LOSS

This fault indicates that the listed phase has dropped below a preset level for longer than the time set in the Super menu. This is probably due to a blown fuse or incorrect wiring.

4.6.8. RIDE-THRU ACTIVE TIME

This fault indicates that the ride-thru has remained active for longer than the maximum safe time as set in the Super menu.

4.6.9. STORAGE IMBALANCE

This fault indicates that the voltage on one of the individual storage modules has risen to an unsafe level.

4.6.10. STORAGE OVERTEMP

This fault indicates that one of the individual storage modules has exceeded its safe temperature limit.

4.6.11. CHARGER FAULT

This fault indicates that the charger has reported some problem preventing it from continuing to operate.

4.6.12. DISCHARGE RESISTOR OVERTEMP

This fault indicates that the discharge resistor has exceeded its safe temperature limit.

4.6.13. DISPLAY COMMUNICATION LOSS

This fault indicates that the 3660D5 display board has lost communication with the 3660I4 interface board, probably due to a loose wire or cable.

4.6.14. INTERFACE COMMUNICATION LOSS

This fault indicates that the 3660I4 interface board has lost communication with the 3660D5 display board, probably due to a loose wire or cable.

4.7. USER CONNECTIONS

The 3660DD5 requires several connections to operate. These are identified as either power connections or user connections. The power connections are typically done to monitor the AC line and drive Bus voltage. The user connections are typically done to enable the unit as well as monitor status and faults.

4.7.1.1. USER INPUTS (FOR M3460B)

TB-1 (Courtesy 24V)

This provides an isolated 24V, which may be used to drive the user inputs.

TB-2 (CH Enable)

This input enables the charger.

TB-3 (CH Equalize)

This input initializes an equalize cycle on the charger.

TB-4 (RT Enable)

This input enables the ride-thru.

TB-5 (RT Test)

This input initializes a test cycle of the ride-thru.

TB-6 (Input COM)

This is the common used with all user inputs.

TB-7 (24V COM)

This is the common to the courtesy 24V supply. This must be connected to the “Input Com” if the courtesy 24V is used to drive the inputs.

4.7.1.2. USER OUTPUTS (FOR M3460B)

TB-8 (Fault 1 NO)

This output closes to “Output Com” when there is no class 1 fault.

TB-9 (Fault 2 NO)

This output closes to “Output Com” when there is no class 2 fault.

TB-10 (RT Active)

This output closes to “Output Com” when the ride-thru is active.

TB11 (Output COM)

This is the common used with all user outputs.

TB12 & TB13 (STOR UV N.O.)

Storage Under Voltage fault is a Normally Open status contact, this output contact will open when the storage voltage dropes below a preset threshold level.

4.7.1.3. USER INPUTS (FOR M3460R)

TB-1 (Courtesy 24V)

This provides an isolated 24V, which may be used to drive the user inputs.

TB-2 (RT Enable)

This input enables the ride-thru.

TB-3 (RT Test)

This input initializes a test cycle of the ride-thru.

TB-4 (Input COM)

This is the common used with all user inputs.

TB-5 (24V COM)

This is the common to the courtesy 24V supply. This must be connected to the “Input Com” if the courtesy 24V is used to drive the inputs.

4.7.1.4. USER OUTPUTS (FOR M3460R)

TB-6 (Fault 1 NO)

This output closes to “Output Com” when there is no class 1 fault.

TB-7 (Fault 2 NO)

This output closes to “Output Com” when there is no class 2 fault.

TB-8 (RT Active)

This output closes to “Output Com” when the ride-thru is active.

TB9 (Output COM)

This is the common used with all user outputs.

4.8. DC BUS THRESHOLD VOLTAGE SETTING

The DC bus threshold voltage is the voltage at which the M3460 maintains the DC bus during a power quality event. Whenever the output DC bus voltage drops below the DC bus threshold voltage setting, the M3460 becomes active to regulate the DC bus to the setpoint voltage.

The DC bus threshold voltage is important to the installation in that if it is set too low, the attached drive may trip on an undervoltage fault. If it is set too high, then minor power disturbances, such as line notching or high harmonics that would not normally cause the drive to have problems may cause the M3460 to become active when there is no need. If this is a constant or frequent occurrence, the M3460 may overheat and not be available in the event of an actual sag or outage.

The M3460 DC bus threshold voltage setting is determined by the drive installation. Consult the manufacturers' specifications on the attached drive, and make sure that the DC bus threshold voltage is above this value. For instance, many 460-480VAC input drives have an undervoltage trip point of 400VDC. This may allow the drive to keep operating, but the DC bus voltage may not be enough to allow the drive to operate at full power. Therefore, it's useful to set the DC bus threshold voltage setting above this value.

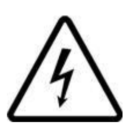
Generally, the DC bus threshold voltage should be set at 10% below the nominal DC bus level. Use the following formula to calculate this value:

$$\mathrm{Vdc} = \mathrm{Vac} * \sqrt{2} * 0.9$$

An actual on-site check may be performed to determine the loaded DC bus level as well as the amount of ripple present on the DC bus.

If you find that your incoming AC power is susceptible to long term sags or conditions below 10%, the M3460 may become active when not needed. In this case, the DC bus threshold voltage setting should be lowered to allow the M3460 to only be active during a true power quality event. The M3460 should not become active during normal operation.

The DC bus threshold voltage is factory preset on all M3460 modules according to Table 6-2 of this manual. However, field adjustment of this setting may be required to achieve the optimum setpoint level for any given system. There are two ways to determine the DC bus threshold voltage described below. Be sure to read through both methods completely before attempting any adjustment of the DC bus threshold voltage setting.



DANGER!

- **HIGH VOLTAGES WITH RESPECT TO CHASSIS ARE PRESENT!**
- **NEVER USE AN UNINSULATED TOOL OF ANY KIND!**
- **FAILURE TO HEED THESE WARNINGS MAY RESULT IN SERIOUS INJURY OR DEATH!**

4.8.1. Determining the DC Bus Threshold Voltage Setting Directly (M3460R Models)

Checking the DC bus threshold voltage setting directly requires the AC power to be removed from the M3460R. If the M3460R DC bus is not connected to the output of the drive, this can be done without powering down the drive. Otherwise, the drive must have the AC power removed from it as well. It may be difficult to get an accurate reading using a digital voltmeter due to the time it takes to calculate and average the reading. Use an analog meter if possible.

1. Monitor the output DC bus of the M3460R, or the input DC bus to the drive, if connected.
2. Remove input voltage supply from system.
3. As the DC bus voltage drops to the DC bus threshold voltage setting, the M3460R will become active and maintain the DC bus voltage at the threshold voltage setpoint for approximately 1 second while the M3460R input filter capacitor discharges. The DC bus will then continue to drop.
4. Read the DC bus voltage as it is being maintained. This is the DC bus threshold voltage setting.

4.8.2. Determining the DC Bus Threshold Voltage Setting Directly (M3460B Models)

Checking the DC bus threshold voltage setting directly requires disconnecting the M3460B DC bus from the drive DC bus while the battery bank supplies power to the M3460B.

1. Monitor the output DC bus of the M3460B.
2. Disconnect the M3460B DC bus from the drive DC bus.
3. The M3460B should now be active and the voltage at the M3460B output DC bus is the threshold setting.

4.8.3. Determining the DC Bus Threshold Voltage Setting Using the Test Mode

The DC bus threshold voltage setting may be checked with the drive connected using the test input to put the M3460 in Test mode. This raises the DC bus voltage approximately 50-100V above the actual DC bus threshold voltage setting, and is a fair indication of how the system is set. This has the advantage of not having to remove the AC power, and can actually be done while the system is loaded.

Please note:

- If heavily loaded, the M3460 may run in current limit and the DC bus voltage may not rise as much as if it were unloaded.
- If the DC bus threshold voltage is set too high, the DC bus test voltage may be limited by the overvoltage setting of the M3460, thus providing an inaccurate result.

The M3460 may shutdown from the timeout feature, depending on the load.

1. Monitor the output DC bus of the M3460, or the input DC bus to the drive, if connected.
2. Initiate a test with the display.

3. Monitor the DC bus voltage while the M3460 is in Test mode. This is the DC bus test voltage setting.

The DC bus test voltage setting is approximately 50-100V higher than the DC bus threshold voltage setting.

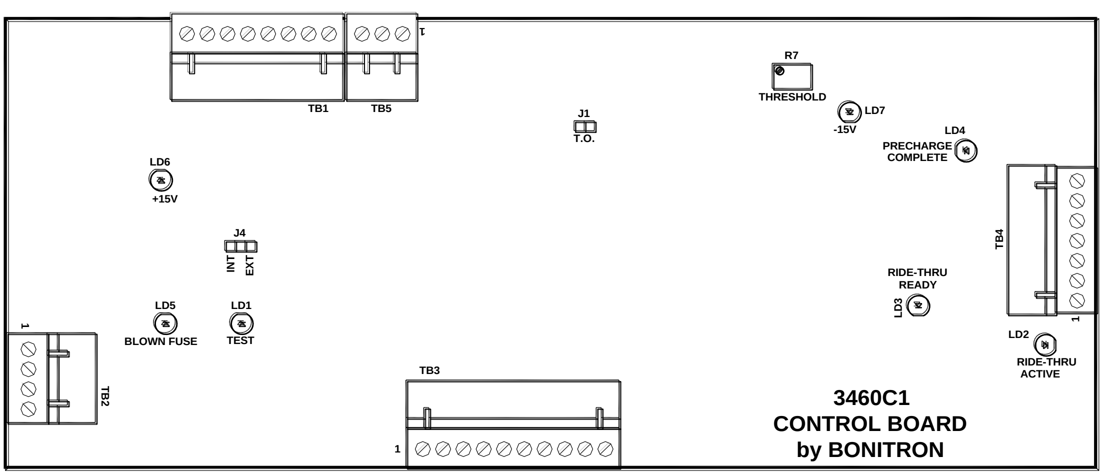
For example, for an M3460 with an input voltage of 460VAC, the DC bus threshold voltage setting is preset to be 585VDC and the DC bus test voltage setting is preset for an increase of 100VDC. Initiating the test described above would cause the DC bus voltage to rise to 685VDC (585VDC + 100VDC). Subtracting the DC bus test voltage (100VDC) from this reading shows that the actual DC bus threshold voltage setting is 585VDC.

4.8.4. ADJUSTING THE DC BUS THRESHOLD VOLTAGE SETTING

Adjustment of R7 on the 3460C1 control board (see Figure 4-2) is used to adjust the DC bus threshold voltage setting. Adjusting the pot in a clockwise direction will raise the setting. Alternately, a counter-clockwise adjustment of the pot will lower the setting.

After making the adjustments, repeat the test to verify the new setpoint. Fine tune the adjustment and retest as necessary.

Figure 4-2: 3460C1 Control Board Layout



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5. START-UP, MAINTENANCE AND TROUBLESHOOTING

5.1. M3460R START-UP / FIELD TEST PROCEDURE

1. Ensure the M3460R has been properly installed and is disabled.
2. Ensure the M3460R DC bus is disconnected from the drive DC bus.
3. Ensure the drive is operating properly with the M3460R disconnected.
4. Apply power to the input of the M3460R and observe the following conditions:
   - The display screen status indicates (Ride-Thru Disabled)
   - The display has Green LED on, that means the display is receiving power from the Ride-Thru.
5. Enable the M3460R with either the enable input or the digital display.
   - The display screen status indicates (Ride-Thru Standby)
   - No present fault on display.
6. Initiate the test mode with the display panel.
   - The DC bus should rise for as long as the test is performed. A timeout may occur when holding the test bottom longer than 2 seconds.
   - The display screen status indicates (Ride-Thru Testing)
7. Turn off the power to the M3460R and watch the DC bus voltage fall.
   - The Ride-Thru Active light should turn ON when the M3460R starts to operate.
   - The DC bus will hold at the DC bus threshold voltage setting momentarily while the filter capacitors drain.
8. With the M3460R and drive power off, connect the DC bus of the M3460R to the DC bus of the drive.
9. Turn on power to the drive and ensure it is working properly without any fault, **<u>the drive must be ON before applying power to the Ride-Thru</u>**. apply power to M3460R and ensure proper function without any faults.
10. Monitor the DC bus voltage and current with the display or with separate meters. Also, monitor the AC input current to the attached drive.
11. Load the drive as much as practical and put the M3460R into Test mode by activating the Test input or using the display panel.
    - DC bus voltage should rise to the test boost level.
    - Motor should not lose speed or torque.
    - DC bus current should flow from M3460R to drive.
    - Drive input current should decrease.

The M3460R and drive system should now be ready to be put into service.

CAUTION!

- ***IF THE M3460R IS ACTIVE FOR LONGER THAN THE TIMEOUT SETTING, IT WILL SHUT DOWN SWITCHING AND THE DC BUS WILL DROP TO THE NORMAL LEVEL.***
- ***IF THE OUTPUT DC BUS DROPS BELOW 70% THE M3460R WILL HAVE TO GO THROUGH PRE-CHARGE AGAIN.***

5.2.

5.3. M3460B START-UP / FIELD TEST PROCEDURE

1. Ensure the M3460B has been properly installed and is disabled.
2. Ensure the M3460B DC bus is disconnected from the drive DC bus.
3. Ensure the charger DC output is connected to the Charger terminals.
4. Ensure the drive is operating properly with the M3460B disconnected.
5. Apply battery bank power to the Storage Bus input of the M3460B and observe the following conditions:
   - The display screen status indicates (Ride-Thru Disabled)
   - (Charger Disabled)
6. Enable the M3460B and the Charger with the enable input or the digital display.
   - The display screen status will be (Charging) yellow LED is ON
   - When the storage bank is fully charged, the display status will be (Charger standby) and (Ride-Thru standby)
7. Initiate the test mode with the Test input or display panel.

   The DC bus should rise for as long as the test is performed. The display status indicates (Testing).
8. Turn off the battery bank power to the M3460B and connect the DC bus of the M3460B to the DC bus of the drive.
9. Turn on the AC power to the drive, then battery bank power to the M3460B **the drive must be ON before applying power to the Ride-Thru**.
10. Monitor the DC bus voltage and current with the display or with separate meters. Also, monitor the AC input current to the attached drive.
11. Load the drive as much as practical and turn off AC power to the drive. The display status should be (boosting).

    DC bus voltage should hold at threshold boost level.

    Motor should not lose speed or torque.

    DC bus current should flow from M3460B to drive.

    Drive input current should decrease.

    The Display will show (Time limit fault) at the end of the event.

The M3460B and drive system should now be ready to be put into service.

CAUTION!

- ***IF THE M3460B IS ACTIVE FOR LONGER THAN THE TIMEOUT SETTING, IT WILL SHUT DOWN SWITCHING AND THE DC BUS WILL DROP TO THE NORMAL LEVEL.***
- ***IF THE OUTPUT DC BUS DROPS BELOW 70% THE M3460B WILL HAVE TO GO THROUGH PRE-CHARGE AGAIN.***

5.4. MAINTENANCE ITEMS

The M3460 is designed to require very little maintenance. Bonitron recommends a yearly test of the system in order to ensure the system is functioning properly. If the system is equipped with displays, then the cycle counters should indicate the number of events since the last reset. If there are more than 10 events per month, the DC bus threshold voltage setting should be checked and/or adjusted.

5.4.1. CAPACITOR REPLACEMENT RECOMMENDATIONS

The M3460 uses high quality aluminum electrolytic capacitors and is designed for long life without maintenance. While a typical inverter may require capacitor replacement after a certain time due to the heavy ripple currents, the M3460 typically is in a standby mode waiting for a power disturbance, and by design has 50% more capacitance than needed.

The capacitors are rated for 11 years MTBF if ambient temp is 50°C, capacitors are held at 100% rated voltage, and caps run full ripple current at 1% duty.

With typical operating conditions of 35°C, caps running at 75% rated voltage, and a duty cycle of one event per month, Bonitron recommends the capacitors be checked or replaced every 20 years.

The recommended test is to measure the voltage across each series set of capacitors. Any voltage difference greater than 15% between each set of series caps would indicate a change in value in one cap and would constitute a more detailed out of circuit capacitance check. (A difference of 5% is allowed at time of production.)

Testing the capacitors in the unit requires trained personnel and should only be attempted observing appropriate safety and arc-flash precautions when working on live high voltage equipment.

DANGER!

- ***HIGH VOLTAGES ARE 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 ADEQUATE TIME FOR RESIDUAL VOLTAGES TO DRAIN BEFORE OPENING THE ENCLOSURE.***
- ***FAILURE TO HEED THESE WARNINGS MAY RESULT IN SERIOUS INJURY OR DEATH!***

5.4.2. Capacitor Testing Procedure

1. Open the panel door to expose the capacitor bank.
1. Measure voltage across each cap and make note for future reference.
2. Any voltage difference more than 15% indicates a substantial change in capacitance.

   Example: DC bus = 540V, each series cap = 270V
   15% of 270 = 40.5V
   cap 1 = 290V
   cap 2 = 250V

   Turn off power, discharge the capacitor bank voltage and replace both capacitors if the difference is more than 15%.

5.4.3. Cleaning

It may be necessary to clean off dust, debris, or chemical build-up on high voltage bus bars or other exposed components. If cleaning is needed:

- Remove power and allow all voltages to drain.
- Check for residual voltages with meter.
- Clean affected areas with rag, brush or denatured alcohol, depending on the type of contamination.
- Once area is clean and dry, reapply power.

5.4.4. Fans

Bonitron estimates fan life to be longer than 20 years in a properly adjusted M3460B in a clean cool environment, 4 years under constant running conditions with high ambient temperatures.

5.4.5. Heatsinks

Dirt can build up on heatsink surfaces degrading its ability to dissipate heat.

The heatsinks should be checked for large amounts of deposits and cleaned as needed. The maintenance interval depends upon the amount of activity and the environment inside the cabinet.

Checking the heatsink should be included when checking for fan operation.

5.5. TROUBLESHOOTING

Below are suggestions on how to check some common issues.
If you continue to have problems after going over this list, please contact Bonitron.

Table 5-1: Troubleshooting Guide

SYMPTOM	ACTION
No lights are ON	▪ Check incoming power.
Ride-Thru will not become active	▪ Check Enable Input. ▪ Check input and output fuses.
Test Mode Does Not Raise Output Voltage	▪ Check Enable Input. ▪ Check Test Input. ▪ Check input and output fuses. ▪ Check threshold voltage setting.
Stays in Test Mode	▪ Check Test Input.
Ride-Thru Ready light is OFF or Ride-Thru Ready output is open	▪ Check Enable Input. ▪ Check IGBT fuses. ▪ Check 3460M6 board jumpers.
Precharge Complete light is OFF or Precharge Complete output is open	▪ Check Enable Input. ▪ Check 3460M6 jumpers. ▪ Check Drive Bus voltage level.
Voltage Fault output is open	▪ Check input fuses. ▪ Check Drive Bus level. ▪ Check jumpers on 3460M6 board.
Overtemperature output is open	▪ Check jumpers on 3460M6 board. ▪ Check threshold voltage setting.
General Fault output is open	▪ Check Ride-Thru Ready output ▪ Check Voltage Fault output ▪ Check Overtemperature output ▪ Check jumpers on 3460M6 board.
Ride-Thru Active output is closed when Ride-Thru is not active	▪ Check Drive Bus voltage. ▪ Check threshold voltage setting. ▪ Check jumpers on 3460M6 board.

SYMPTOM	ACTION
Ride-Thru Active output does not close or Attached Drive Trips during power quality events	▪ Check Enable Input. ▪ Check Ride-Thru Ready output. ▪ Check Precharge Complete output. ▪ Check IGBT fuses. ▪ Verify Ride-Thru is connected to the attached drive. ▪ Initiate Test Mode to ensure Ride-Thru is operating properly.
Input Undervoltage output is open	▪ Check the DC input voltage. ▪ Check jumpers on the 3460M6 board.
Blown Fuse light is ON	▪ Check IGBT fuses.
DD5 display shows AC voltages 2x greater than what is correct or DC voltages and DC currents are zero	▪ Check the polarity of the 15V wires going to the current sensors.

CAUTION!

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.

5.6. TECHNICAL HELP – BEFORE YOU CALL

If possible, please have the following information when calling for technical help:

- Exact model number of affected units
- Serial number of unit
- Name and model number of attached drives
- Name of original equipment supplier
- Brief description of the application
- The AC line to line voltage on all 3 phases
- The DC bus voltage
- KVA rating of power source
- Source configuration Wye/Delta and grounding

This information will help us support you much more quickly. Please contact us at (615) 244-2825 or through www.bonitron.com

6. ENGINEERING DATA

6.1. RATINGS

Table 6-1: M3460 kW Ratings

DC BUS CURRENT (AMPS)	230VAC SYSTEM VOLTAGE	380-415VAC SYSTEM VOLTAGE	460VAC SYSTEM VOLTAGE
85 A	25 kW	43 kW	50 kW
127 A	38 kW	65 kW	75 kW
170 A	50 kW	87 kW	100 kW
255 A	75 kW	130 kW	150 kW
340 A	100 kW	175 kW	200 kW
425 A	125 kW	215 kW	250 kW

425A only available with M3460R models
M3460B 15-minute kW rating is half that listed in Table 6-1

Table 6-2: Factory Setpoints for DC Bus Threshold and Test Boost Voltages

SYSTEM VOLTAGE	DC BUS THRESHOLD	TEST BOOST
230 VAC	285 VDC	+50 VDC
380 – 415 VAC	485 VDC	+100 VDC
460 VAC	585 VDC	+100 VDC

Table 6-3: M3460R Minimum Input Voltages

SYSTEM VOLTAGE	MINIMUM AC INPUT VOLTAGE ①	MINIMUM DC INPUT VOLTAGE ② (IUV LEVEL)	MINIMUM DC INPUT REQUIRED FOR PRECHARGE COMPLETE ② (PCC)
230 VAC	115 VAC	160 VDC	270 VDC
380 – 415 VAC	190 VAC	265 VDC	445-487 VDC
460 VAC	230 VAC	320 VDC	540 VDC

① Minimum AC input power required after PCC for full power operation with energy storage.
② Minimum DC input required after PCC for full power operation with energy storage.

Table 6-4: M3460B Battery Bank Typical Values

SYSTEM VOLTAGE	MINIMUM BATTERY VOLTAGE (IUV LEVEL)	NOMINAL BATTERY VOLTAGE	FULL / FLOAT BATTERY VOLTAGE	EQUALIZE BATTERY VOLTAGE
230 VAC	200 VDC	240 VDC	270 VDC	277 VDC
380 – 415 VAC	340 VDC	408 VDC	459 VDC	470 VDC
460 VAC	400 VDC	480 VDC	540 VDC	554 VDC

Table 6-5: M3460R Model Specifications for 230 – 480 VAC Systems

DC Bus Current ①	Backplate Size	Circuit Configuration	Recommended Fuse Rating ②		SCCR Ratings
			Drive Bus	AC Line	
85 A	R10	2-stage	80 A, 700 V	125 A, 600 V	10 kA③
127 A	R10	2-stage	125 A, 700 V	200 A, 600 V	
170 A	R9	4-stage	175 A, 700 V	250 A, 600 V	
255 A	R11	4-stage	250 A, 700 V	400 A, 600 V	
340 A	R11	4-stage	350 A, 700 V	500 A, 600 V	18 kA④
425 A	R11	4-stage	400 A, 700 V	600 A, 600 V	

① The input power source must be capable of handling a 2-second current surge at twice the nominal rating for the M3460R. Maximum duty cycle is 1% at full rated load.
② Fuses recommended for use with the M3460R are Gould-Shawmut A70QS series, Buss FWP series, or equivalent semiconductor fuses. These are required for UL 508C compliance.
③ Suitable for use on a circuit capable of delivering not more than 10,000 RMS symmetrical amperes, 700 volts maximum when protected by recommended fuses.
④ Suitable for use on a circuit capable of delivering not more than 18,000 RMS symmetrical amperes, 700 volts maximum when protected by recommended fuses.

Table 6-6: M3460B Model Specifications for 230 – 480 VAC Systems

DC Bus Current ①	Backplate Size	Circuit Configuration	Recommended Fuse Rating ②		SCCR Ratings
			Drive Bus	Storage Bus	
85 A	R10	1-stage	80 A, 700 V	125 A, 700 V	10 kA③
127 A	R9	2-stage	125 A, 700 V	175 A, 700 V	
170 A	R9	2-stage	175 A, 700 V	250 A, 700 V	
255 A	R2	4-stage	250 A, 700 V	350 A, 700 V	
340 A	R2	4-stage	350 A, 700 V	500 A, 700 V	18 kA④

① The input power source must be capable of handling 1.5 times the nominal current rating for the M3460B. Maximum duty cycle is 1% at full rated load.
② Fuses recommended for use with the M3460B are Gould-Shawmut A70QS series, Buss FWP series, or equivalent semiconductor fuses. These are required for UL 508C compliance.
③ Suitable for use on a circuit capable of delivering not more than 10,000 RMS symmetrical amperes, 540 volts maximum when protected by recommended fuses.
④ Suitable for use on a circuit capable of delivering not more than 18,000 RMS symmetrical amperes, 540 volts maximum when protected by recommended fuses.

6.2. EFFICIENCY / POWER CONSUMPTION

All M3460 modules are 93% efficient or better at full load. Power consumption in standby mode is less than 200W.

6.3. BRANCH CIRCUIT PROTECTION AND WIRE SIZING

The following information is supplied for assistance in selecting the appropriate field wiring sizes and power source fuse ratings for the M3460:

- Wire size must be coordinated with circuit protection devices and IR drop of wire. It is NOT necessary to size wire for continuous duty. Maximum allowed duty cycle for the M3460 is 1%.
- For branch circuit protection, steady state Class J time delay or equivalent fusing should be used to support the requirement for 2-second 2x surge capability for M3460R models or 4-minute 1.5x current capability for M3460B models. The recommended minimum current rating for the power source fusing is listed in Tables 6-7 & 6-8, based on the DC bus current rating of the M3460.
- The field wiring sizes listed in Tables 6-7 & 6-8 ensure a ≤10V drop for wire lengths of ≤100 feet and are compatible with the recommended steady state circuit branch protection fusing listed. The wire gauge selected for field wiring to the M3460 should be equal to or greater than that listed in Tables 6-9 & 6-10.
- Use copper wiring rated 75°C or equivalent for field wiring terminals.
- These devices do not provide motor overload protection.

Table 6-7: M3460R Input Power Wiring Sizes and Fusing

M3460R DC Bus Current Rating	Minimum Circuit Branch Protection Fusing (Class J Time Delay)	Recommended Field Wiring Sizes
85 Amps	70 Amps	4 AWG
127 Amps	100 Amps	2 AWG
170 Amps	125 Amps	1/0 AWG
255 Amps	175 Amps	2/0 AWG
340 Amps	225 Amps	3/0 AWG
425 Amps	225 Amps	4/0 AWG

Table 6-8: M3460B Input Power Wiring Sizes and Fusing

M3460B DC Bus Current Rating	Minimum Circuit Branch Protection Fusing (Class J Time Delay)	Recommended Field Wiring Sizes
85 Amps	70 Amps	2 AWG
127 Amps	100 Amps	1/0 AWG
170 Amps	125 Amps	2/0 AWG
255 Amps	175 Amps	3/0 AWG
340 Amps	225 Amps	4/0 AWG

6.4. DIMENSIONS AND MECHANICAL DRAWINGS

Figure 6-1: M3460-E1 Enclosure Dimensional Outline

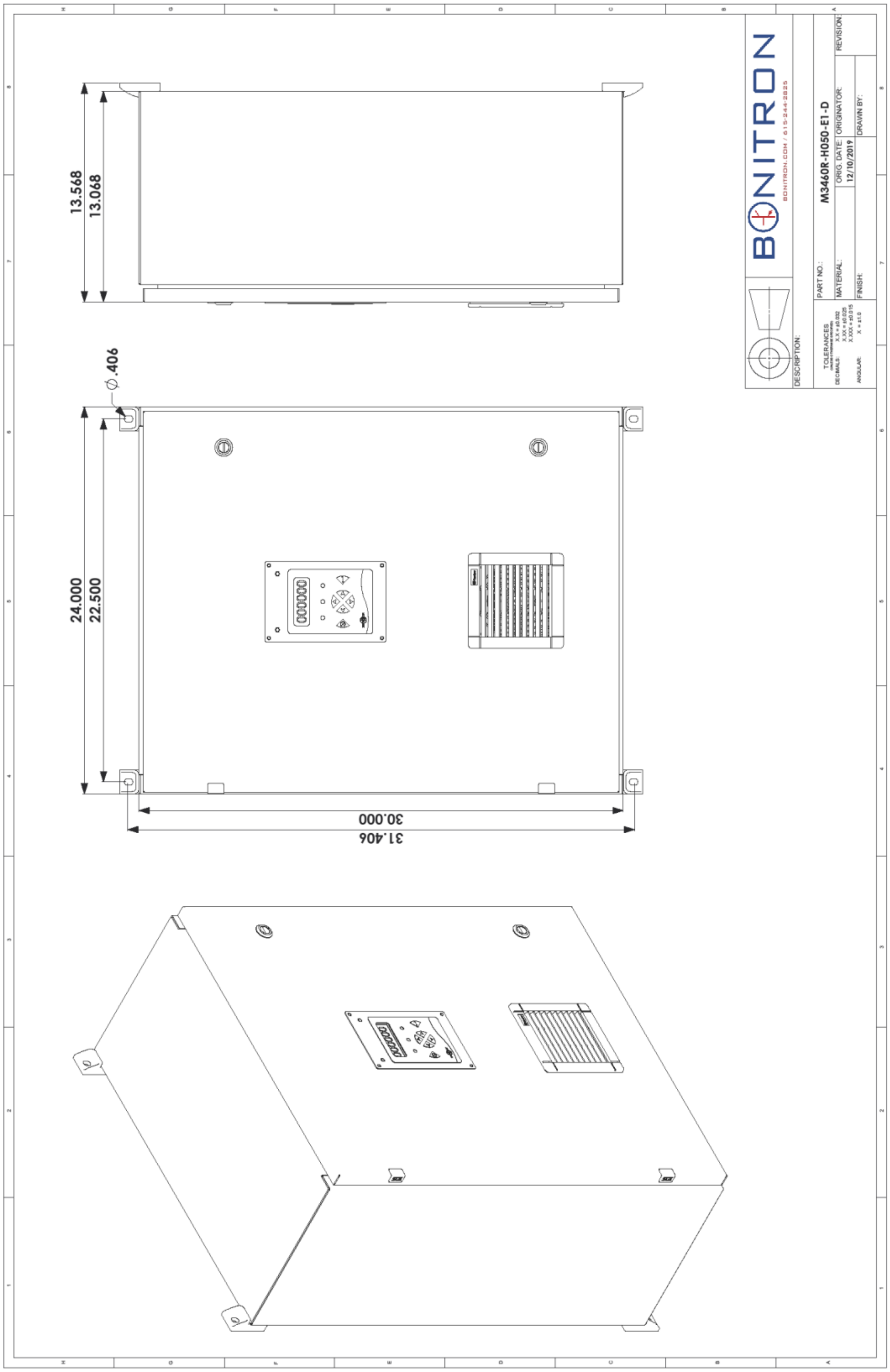


Figure 6-2: M3460-E2 Enclosure Dimensional Outline

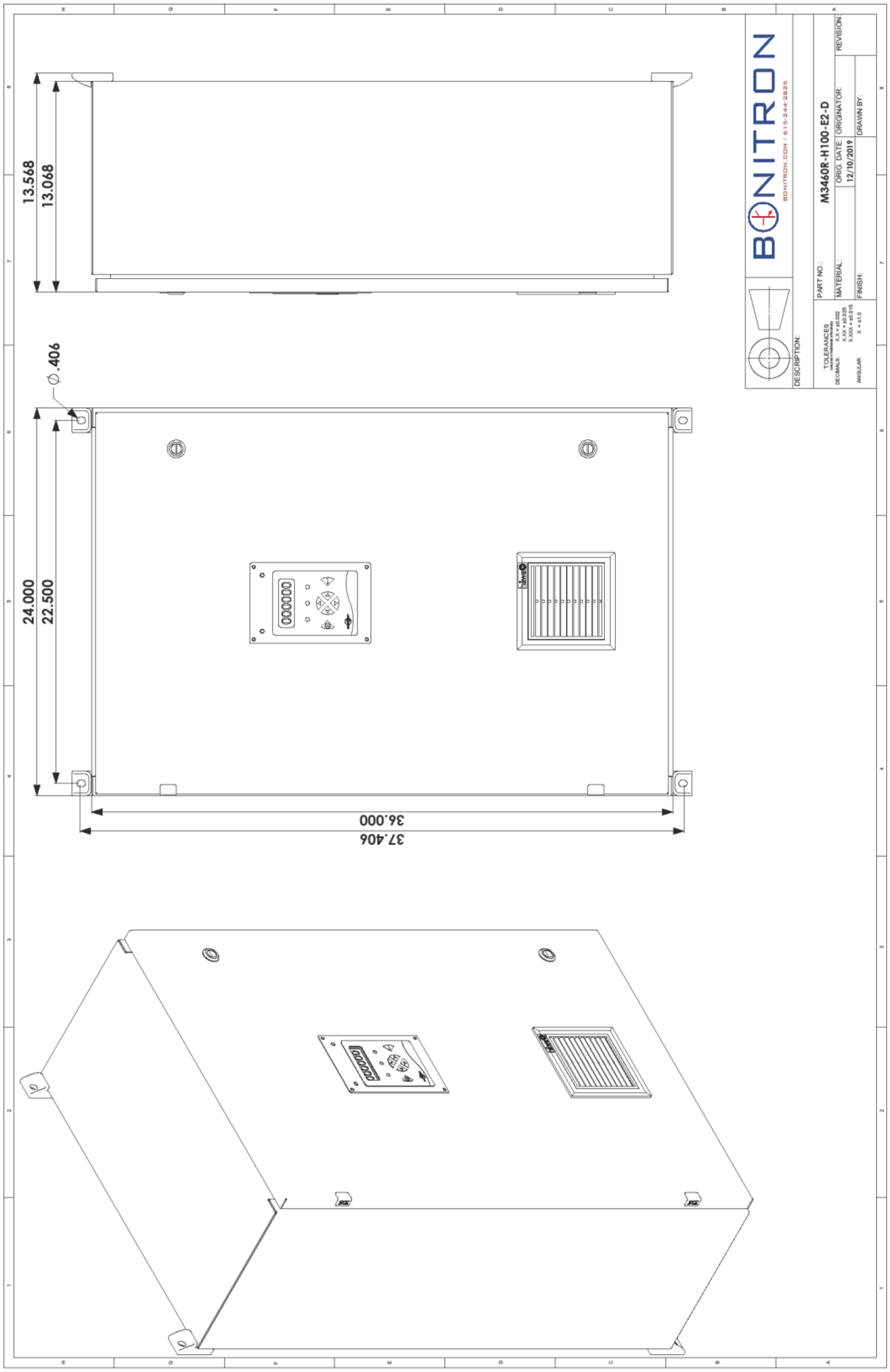


Figure 6-3: M3460-E3 Enclosure Dimensional Outline

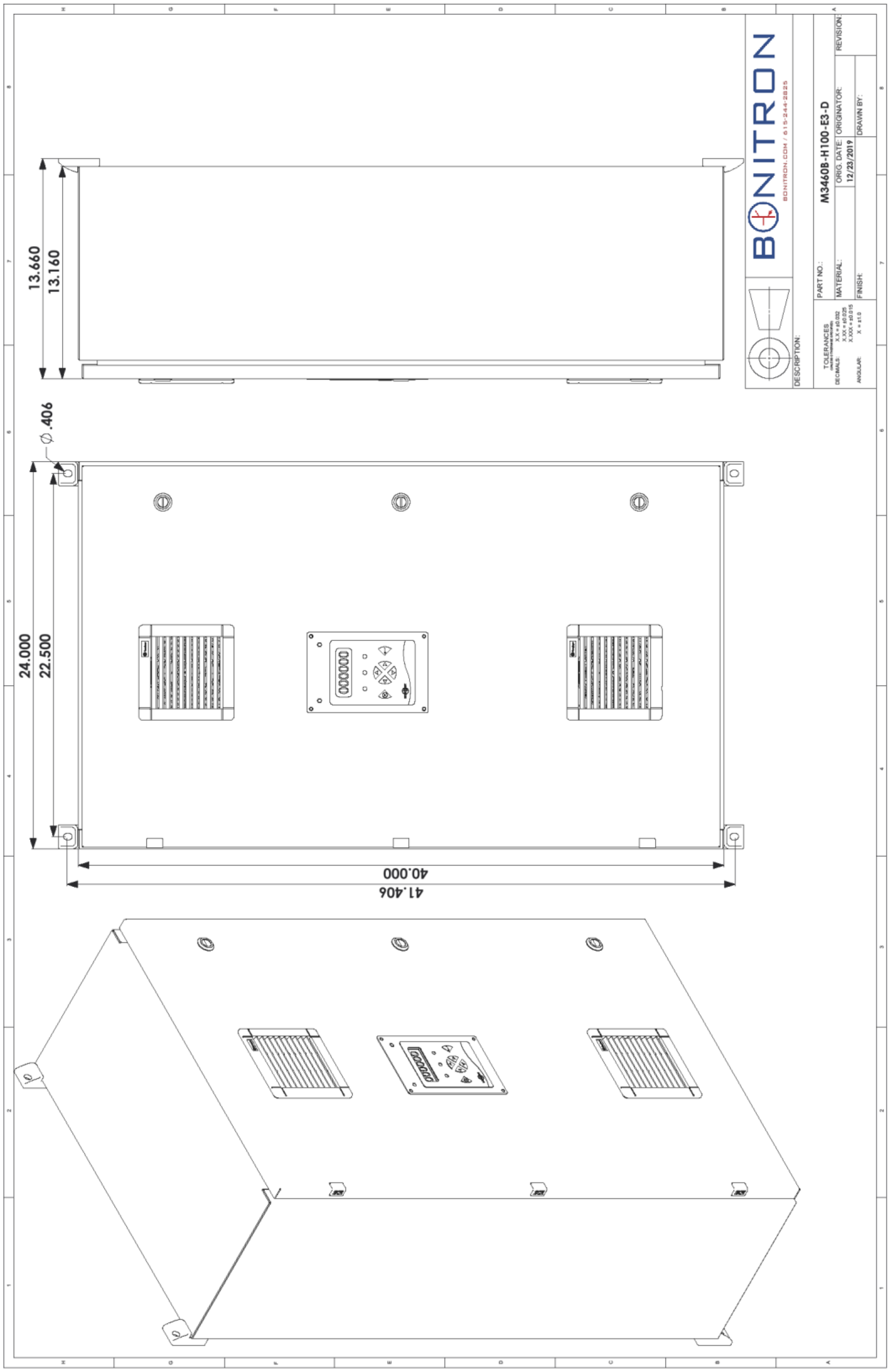


Figure 6-4: M3460-E4 Enclosure Dimensional Outline

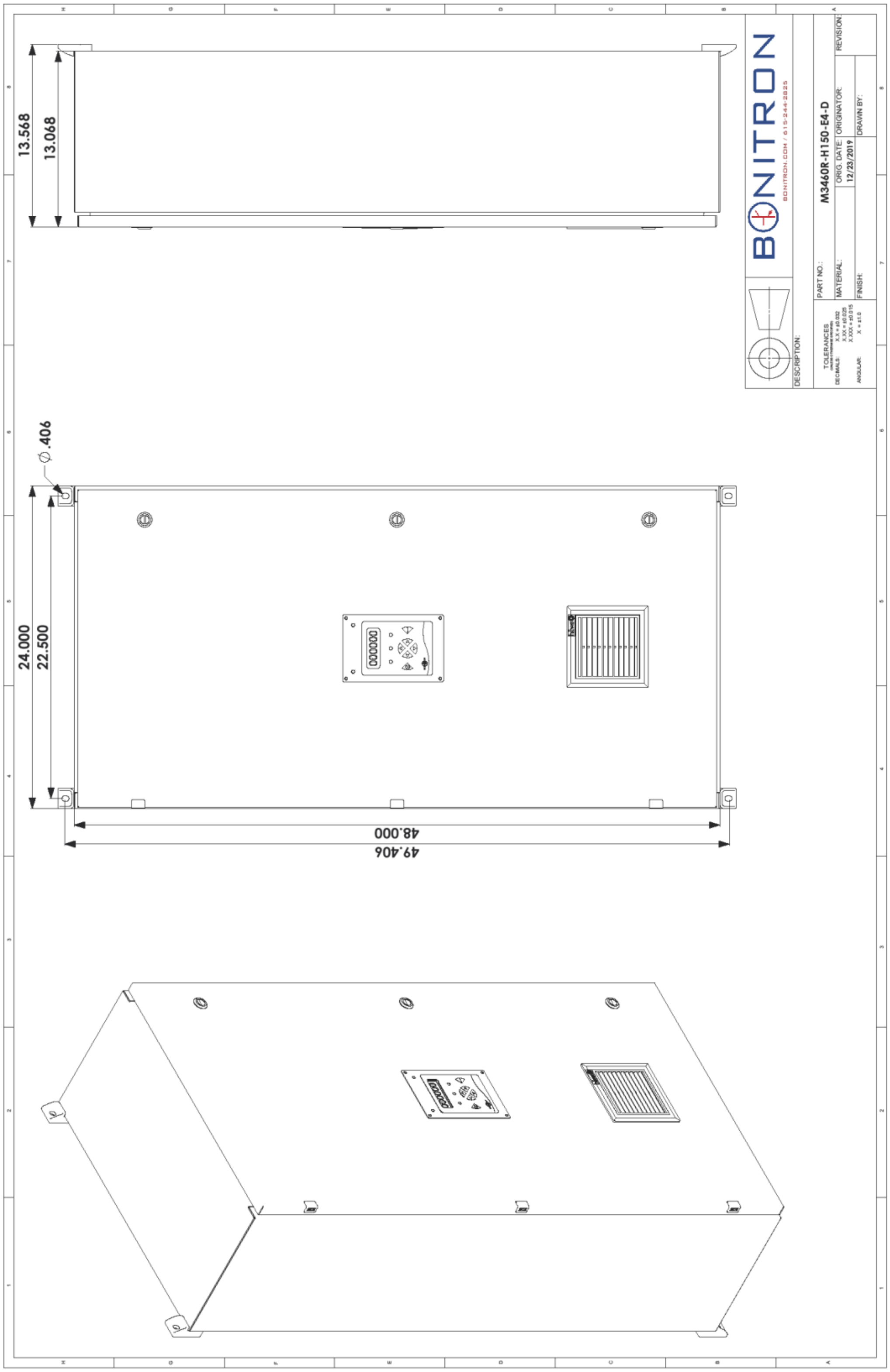
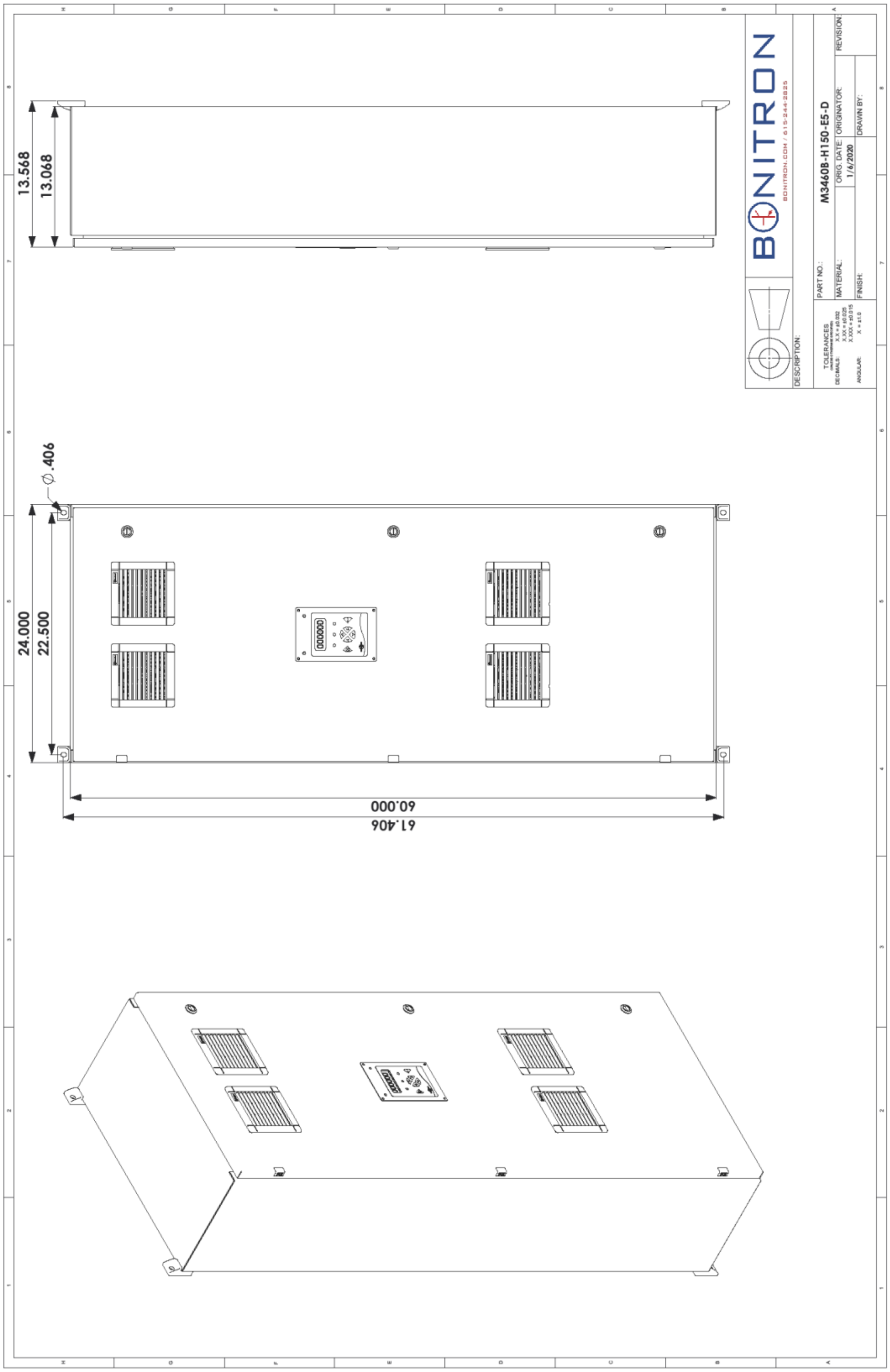


Figure 6-5: M3460-E5 Enclosure Dimensional Outline



7. APPENDICES

7.1. M3460 INSTALLATION CONSIDERATIONS

There are several things to take in to account when backing up a drive system. The M3460 is designed to back up the power section of an AC drive and, does so within the DC link of the drive.

DANGER!

MAKE SURE THE M3460R AND DRIVE HAVE THE SAME AC FEED, AS THE M3460R WILL CONTINUE TO SUPPLY THE DRIVE WITH POWER IF BOTH SYSTEMS ARE NOT TURNED OFF AT THE SAME TIME. LETHAL VOLTAGES EXIST IN THE M3460R.

DANGER!

FOR SYSTEMS THAT HAVE BACKUP STORAGE SYSTEMS, SUCH AS CAPACITORS OR BATTERIES, THE M3460 WILL CONTINUE TO SUPPLY POWER EVEN THOUGH THE AC LINE IS DISCONNECTED! TAKE SPECIAL PRECAUTIONS WITH THESE SYSTEMS TO ENSURE THAT THE POWER CAN BE REMOVED FROM THE SYSTEM AND LETHAL VOLTAGES DRAINED OR DISCONNECTED FOR SERVICE!

1. The M3460 must have a DC bus connection directly to the DC bus filter capacitors within the drives. Connections cannot be made through the braking terminals or with precharge resistors or DC link chokes between the output of the M3460 and the DC bus capacitors in the drive. Consult the manufacturers' documentation or contact Bonitron for further assistance.
2. The drive system may depend on other parts of a larger control system that requires backup to allow the drive to keep operating, like sensors or external commands from PLC or relay logic. These systems will need to be backed up separately with AC UPS systems or logic power backup systems like 24VDC buffers.
3. Most drives have control and cooling power supplies that are connected to the DC bus of the drive. These will be backed up by the M3460. Some larger frame AC drives require consistent AC power to keep operating as they have fans that get power directly from the AC line. In this case, there may be special requirements to keep the drive operating.
4. Any AC line outage sensing must be disabled in the drive to keep the drive from automatically shutting down on a phase loss.
5. Any kinetic buffering option needs to be disabled in the drive. This can cause interference with the operation of the M3460.
6. If there is ground fault sensing within the drive, this may need to be disabled, as uneven currents can flow through the AC drive's input bridge causing a trip.

7.2. SPECIFYING AN ULTRACAPACITOR STORAGE BANK FOR FULL OUTAGE PROTECTION WITH M3460R MODELS

Bonitron M3460R models can have energy storage devices added to cover complete outages. This involves adding a capacitor bank with an appropriate charging and discharging system. Bonitron can source complete capacitor cabinets or individual capacitors. This section gives some instruction for sizing and specifying these storage devices.

The process described below is a good way to estimate the capacitor bank required. Since the discharge characteristic of a capacitor bank with a constant power load is a nonlinear differential equation, optimizing the capacitor bank selection is an iterative process. A general estimate of needs must be used to build a capacitor bank and then the actual values must be cross checked to make sure they are suitable.

There are several steps in the process. The capacitor bank will be comprised of capacitors connected in series for voltage support, with one or more strings in parallel to support the energy requirements.

However, an additional power supply, the ASM 3460PS is required when the total voltage across the ultracapacitor bank is lower than the Precharge Complete Voltage (PCC). See Table 6-3 for the minimum PCC voltage required to bring the Ride-Thru into operation.

Since the extraction losses due to the electrostatic resistance (Esr) of the capacitor can be significant, they must be taken into account. If the Esr losses get too high, parallel capacitor strings can be used to reduce the current in each series string.

The steps to specify the string will include:

1. Determine the energy required for the outage.
2. Determine the minimum voltage acceptable for full power backup.
3. Determine the maximum current required to support the load at minimum voltage.
4. Specify the capacitor to be evaluated.
5. Estimate the losses for each capacitor.
6. Determine the minimum number of capacitors per series string required for the minimum voltage.
7. Add capacitors in series for outage energy.
8. Determine if parallel strings are required to provide outage energy.

These are the definitions of the variables we will use in the following equations:

C_{eol} - Capacitance at end of life
C_{tot} - Total capacitance of the entire cap bank
Esr_{tot} - Total equivalent ESR for the entire cap bank
Esr - Internal resistance at end of life
I_{peak} - Peak current into the M3460R during the discharge cycle
$J_{Available}$ - Total energy in charged capacitor bank prior to discharge
$J_{LossTot}$ - Total losses during discharge
J_{out} - Energy required to hold up the system during the outage
n_{series} - Number of capacitors in each series string
P_{sys} - System power in kilowatts
T_{out} - Time outage in seconds
V_{Charge} - Charge voltage at beginning of discharge
V_{CapEnd} - The capacitor string voltage at the end of the discharge
V_{CapMax} - Maximum charge voltage for the capacitor
V_{end} - Lowest voltage the capacitor bank can reach
$V_{TermEnd}$ - Terminal voltage of an individual capacitor during discharge

7.2.1. ENERGY REQUIRED FOR OUTAGE

The total energy required for the event must be calculated first.

Using the following equation, the total number of joules required for the outage can be calculated:

$$J_{Out} = P_{sys} * T_{out}$$

We will use a specification of 100 hp. for a 2 second outage for this example. For instance, a 100 hp drive outage for 2 seconds would be

$$P_{sys} = 100hp * .746 \ ^{kwatts}/_{horsepower} = 75kW$$

The total number of joules required is:

$$J_{Out} = 75kW * 2s = 150kJ$$

7.2.2. MINIMUM CAPACITOR BANK VOLTAGE

There is a minimum voltage level that must be maintained at the end of the discharge during backup. An M3460R has, for a 460VAC nominal system, a minimum input voltage of 320VDC. Therefore, the final discharge voltage of the capacitor bank (V_{end}) should be 320 VDC.

These data are available in the specifications for the specific M3460R by nominal system voltage.

7.2.3. PEAK CURRENT

The peak current from the capacitor bank will occur at the minimum voltage. This can be estimated from the equation

$$I_{peak} = \frac{P_{sys}}{V_{end}}$$

For our example,

$$I_{peak} = \frac{75kW}{320Vdc} = 235A$$

7.2.4. CAPACITOR SPECIFICATIONS

At this point, a specific capacitor's characteristics can be used. It is best to use the values that are listed at end of life for the capacitor to make sure that the storage system is sized for the eventual degradation of performance over time. The critical points to use are

Esr = Internal resistance at end of life, typically 150-200% of the initial value.

C_{eol} = Capacitance at end of life

V_{CapMax}= Maximum charge voltage for the capacitor. (A general rule is to use 95% of the value listed on the datasheet for a reasonable margin)

For our example, we will use the following values:

Esr = .01Ω

C_{eol} = 132F

V_{CapMax} = 46V

7.2.5. MINIMUM SERIES STRING

From V_{capMax}, we can calculate the minimum series string of capacitors that will be required by the voltage rating. Below this voltage, there is an amount of stored energy that cannot be used, and will remain in the capacitor bank. Since there can be significant terminal voltage drop at the end of the discharge cycle due to Esr, it is best to use the terminal voltage of the capacitors ($V_{TermEnd}$) for this calculation.

$$\mathrm{V_{TermEnd}} = \mathrm{V_{CapMax}} - \left(\mathrm{I_{peak}} * \mathrm{Esr}\right)$$

$$\mathrm{V_{TermEnd}} = 46\mathrm{V} - (235\mathrm{A} * 0.01\Omega) = 43.7\mathrm{V}$$

For our example, the minimum number of caps in a series string would be:

$$\mathrm{n_{series}} = \frac{\mathrm{V_{end}}}{\mathrm{V_{TermEnd}}} = \frac{320\mathrm{V}}{43.7\mathrm{V}} = 8$$

7.2.6. AVAILABLE JOULES

At this point, the available maximum joules for the string can be calculated.

$$\mathrm{V_{Charge}} = \mathrm{n_{series}} * \mathrm{V_{CapMax}}$$

$$V_{Charge} = 8 * 46V = 368V$$

The capacitor voltage at the end of the discharge V_{CapEnd} will be given by:

$$\mathrm{V_{CapEnd}} = \mathrm{V_{end}} - \mathrm{n_{string}} * \mathrm{I_{peak}} * \mathrm{Esr}$$

$$\mathrm{V_{CapEnd}} = 320\mathrm{V} + 8 * 235\mathrm{A} * 0.01\Omega = 338\mathrm{V}$$

The total capacitance of the series string is given by:

$$C_{tot} = \frac{C_{eol}}{n_{series}} * n_{parallel}$$

$$C_{tot} = \frac{132F}{8} * 1 = 16.5F$$

Now, the total energy that can be delivered to the load is given by:

$$J_{Available} = \frac{1}{2} * C_{tot} * \left(V_{Charge}^2 - V_{CapEnd^2}\right)$$

$$J_{Available} = \frac{1}{2} * 16.5F * (368V^2 - 338V^2) = 175kJ$$

The equivalent Esr of the string is given by

$$Esr_{tot} = \frac{n_{string} * Esr}{n_{parallel}}$$

$$Esr_{tot} = \frac{8 * .01\Omega}{1} = 0.08\Omega$$

The total extraction losses of the string is given by

$$J_{LossTot} = Esr_{tot} * I_{Peak}^2 * T_{out}$$

$$J_{LossTot} = 0.08\Omega * 235A^2 * 2s = 9kJ$$

Now the total required energy can be compared.

$$J_{Out} + J_{LossTot} < J_{Available}$$

$$150kJ + 9kJ < 175kJ$$

This combination of capacitors will be adequate for our example application.

If the application required more energy, then capacitors can be added in series, and the calculations redone as in 7.2.1. If the charge voltage exceeds the maximum input voltage for the M3460R, then the minimum series string combination should be used in parallel and the process repeated.

7.3. STEERING DIODE SHARING WITH A BONITRON M3460 RIDE-THRU

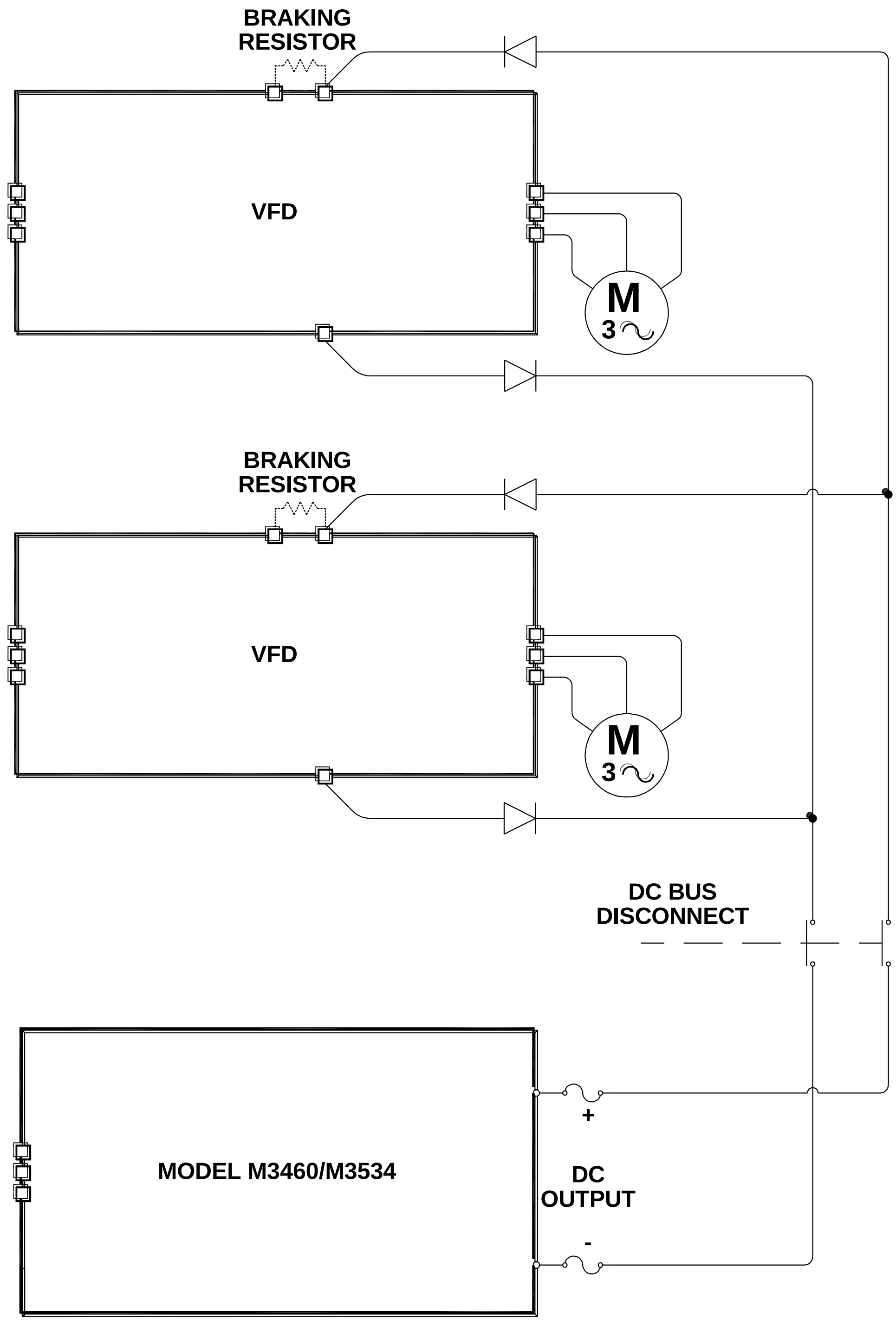
Diode sharing is used to decrease the cost of implementing M3460 modules to existing drive systems that are not common bussed. The use of diodes will prevent drive busses from “back feeding” each other, by allowing energy to pass one way only. This can be useful to keep the bridge from one drive feeding other drives and becoming overloaded during normal operations.

For Ride-Thru applications, the energy is allowed to pass from the M3460 to the drives, but is blocked from the drives to the M3460. Figure 7-1 is a block diagram of a diode sharing example.

Below are some basic guidelines for using diodes in this manner for M3460 applications.

1. In general, it's best to use drives from a common manufacturer and series of drives. Questions about the suitability of combining drives can be answered by the drive manufactures.
2. Drives must be on same AC feed and grounding. There must be no isolation transformers between the drives or M3460 modules. Different feeds may have different potentials and may cause circulating currents or ground faults.
3. If line chokes or harmonic filters are used, all the drives should be connected to the output of a single choke or filter. Individual input harmonic filters or line chokes can cause unequal potentials with respect to earth.
4. The M3460 connection should be downstream of any input line filter. Input line filters cause lower DC bus levels. If a M3460 is placed upstream, the Ride-Thru DC bus can be higher than the drive bus, and current can flow through the M3460 during normal operation. This can cause constant activity and overheating. It may be necessary to lower the threshold for these applications.
5. Ground Fault sensing should be done upstream at common point of line connection.

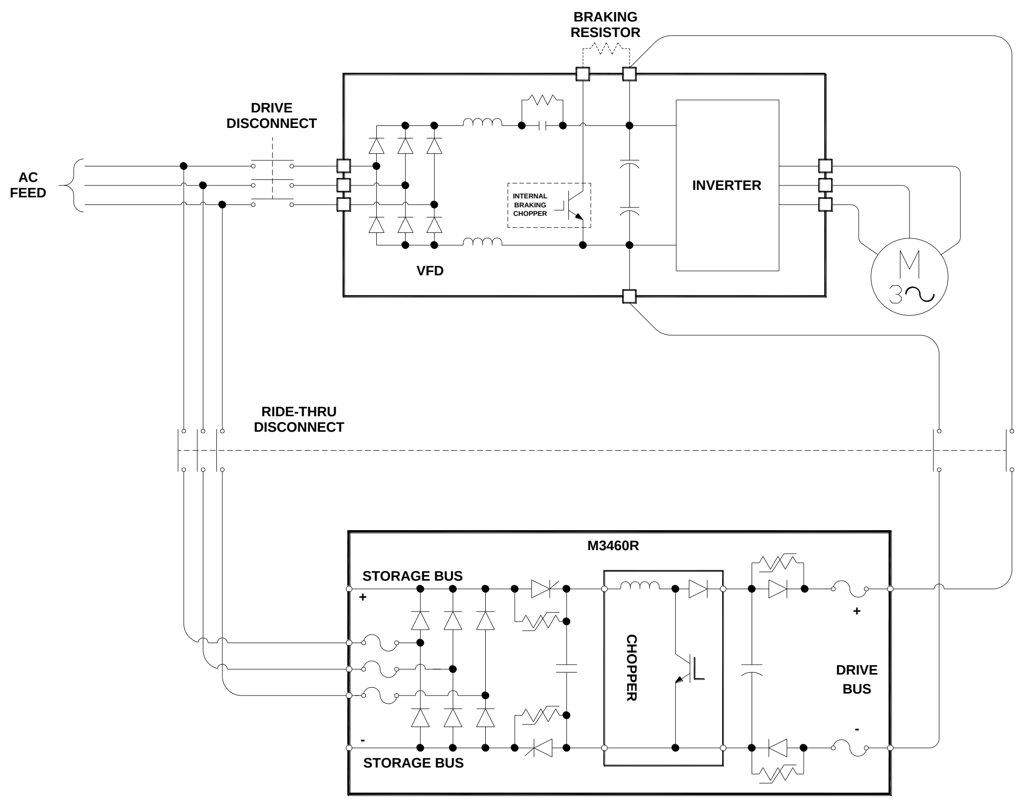
Figure 7-1: Diode Sharing Example



7.4. SAG ONLY INSTALLATIONS & CIRCULATING CURRENTS

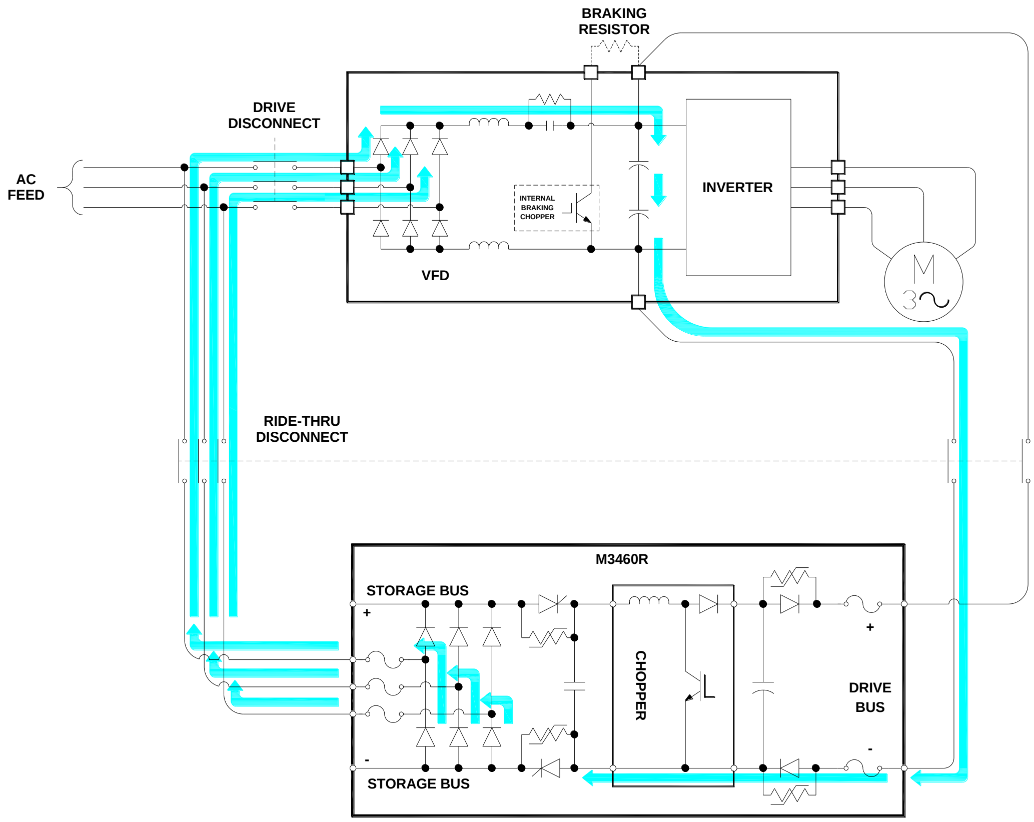
The topology of the M3460R voltage boost module incorporates a six diode full wave three phase rectifier bridge. When the M3460R is connected to the DC bus of the variable frequency drive, the input rectifier bridge of the variable frequency drive is in parallel with the M3460R input rectifier bridge. There are two diodes in parallel from the DC bus to the AC line for each connection.

Figure 7-2: M3460R Typical Configuration without Energy Storage



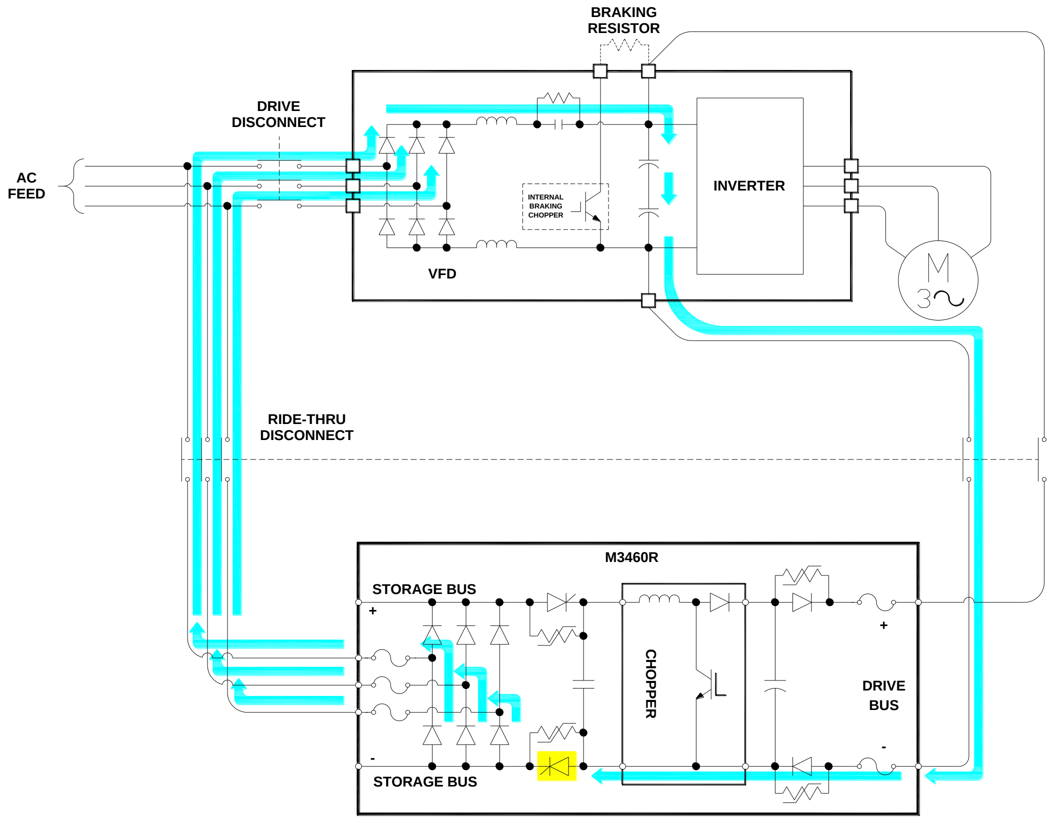
The current will follow the path with the least resistance, this can cause “circulation currents”, or currents that may enter the DC bus of the M3460R through one bridge and return to the AC source through the other bridge.

Figure 7-3: M3460R Typical Configuration with Current Flow



If the circulation current shown above in Figure 7-2 is established and remains during standby operation, the highlighted SCR/Thyristor in Figure 7-3 can remain on and overheat due to the continuous current flow.
If the circulating current situation is not corrected the SCR may be permanently damaged and fail.

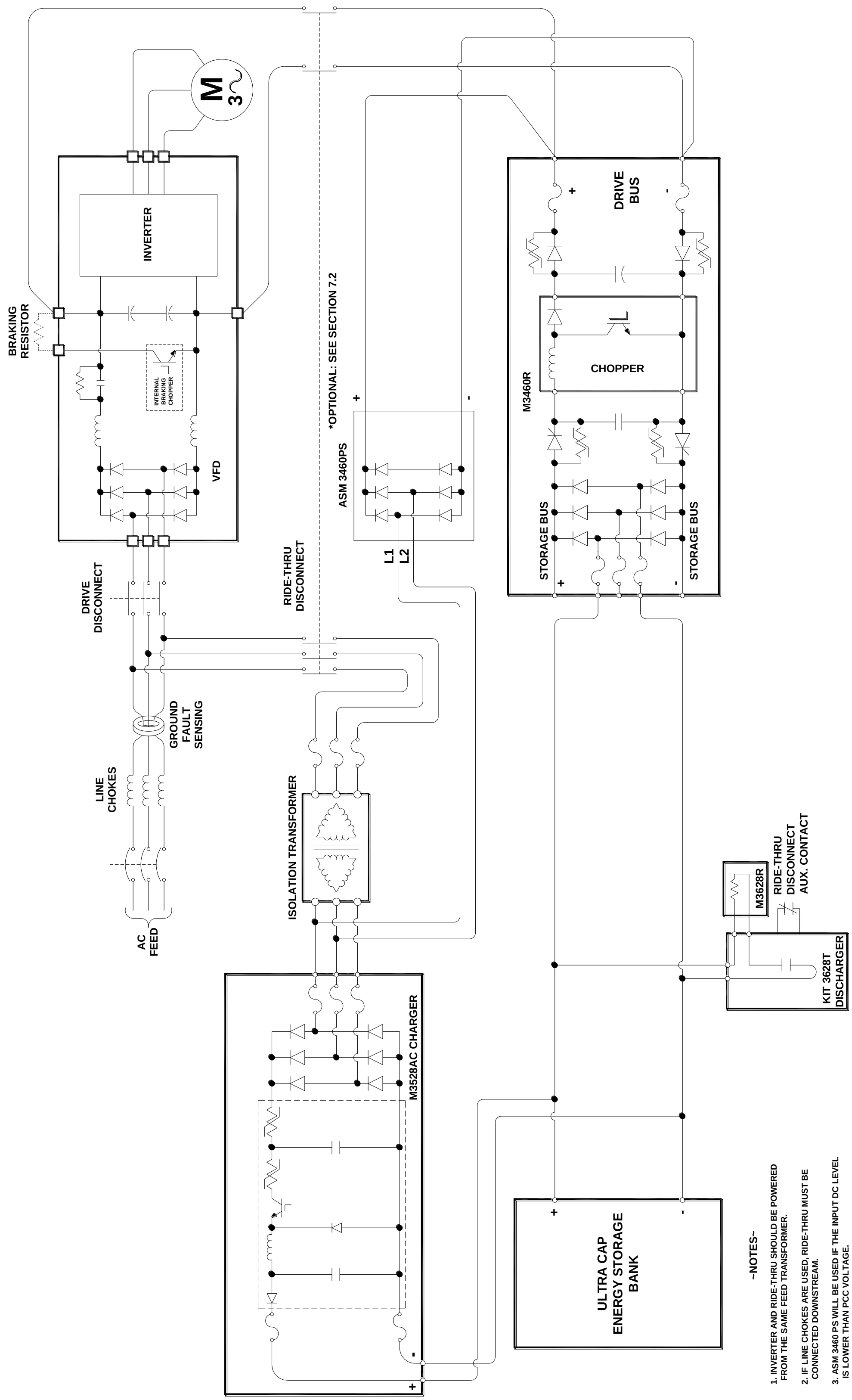
Figure 7-3: M3460R Typical Configuration with Current Flow with affected SCR Highlighted



In order to prevent this situation, extra impedance should be added to the negative connection of the ride-thru to the drive. This prevents the circulation current from being sustained after a sag event.
The M3460RD is not required in all installations, however determining the requirement is difficult due to the variables involved with the physical installation. Using the M3460RD does not reduce the Ride-Thru capacity for the system, and is recommended for all installations.

Please note that this situation can only occur when there is an AC connection to the input bridge of the M3460R unit. If the installation contains energy storage, such as capacitors, the two input bridges are galvanically isolated from each other by the isolation transformer of the charging system. In this case, the M3460RD is not required. See Figure 7-4 for an example of a galvanically isolated system.

Figure 7-4: M3460R Typical Configuration with Ultracapacitor Storage Bank



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