Model M3460
Ride-Thru
Voltage Regulator

Customer Reference Manual

Web: www.bonitron.com • Tel: 615-244-2825 • Email: info@bonitron.com

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.

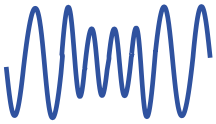
The Bonitron engineering team has the background and expertise necessary to design, develop, and manufacture the quality industrial electronic systems demanded in today's market. A strong academic background supported by continuing education is complemented by many years of hands-on field experience.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

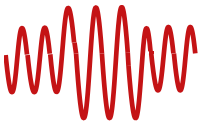
In 1975, Bonitron began working with AC inverter drive specialists at synthetic fiber plants to develop speed control systems that could be interfaced with their plant process computers. Ever since, Bonitron has developed AC drive options that solve application issues associated with modern AC variable 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

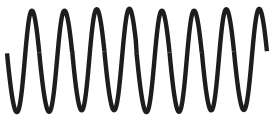
Braking Transistors
Braking Resistors
Transistor/Resistor Combo
Line Regeneration
Dynamic Braking for Servo Drives

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

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

Figures 3-2, 3-3, 3-4, and 3-5 were updated in Rev 00d.
Manual template was updated in Rev 00e
Section 7.4 Application Note for Circulation Currents was added in Rev 00f.
Figure 6-5 was updated in Rev 00g
Updates to Section 5.4 and 7.2, and Figure 3-4 were made in Rev 00h.
The display options were updated in Rev 00i.
Updated tables 2-3, 2-4, 6-1, 6-2, 6-3, 6-4 and figures 6-1, 6-2, 6-3 in Rev 00j.
Update to include DD5 display in Rev 01a.
Added Power Wiring connections diagram in Rev 01b.
Updated table 6-2 in Rev 01c.
Added Figure 3-6 and 3-8 in Rev 01d.

Figure 1-1: M3460R in R11 Chassis and M3460B in R2 Chassis

This page intentionally left blank

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

S3460CR SERIES RIDE-THRU SYSTEMS

Complete systems that use electrolytic capacitor storage for short term power outages.

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

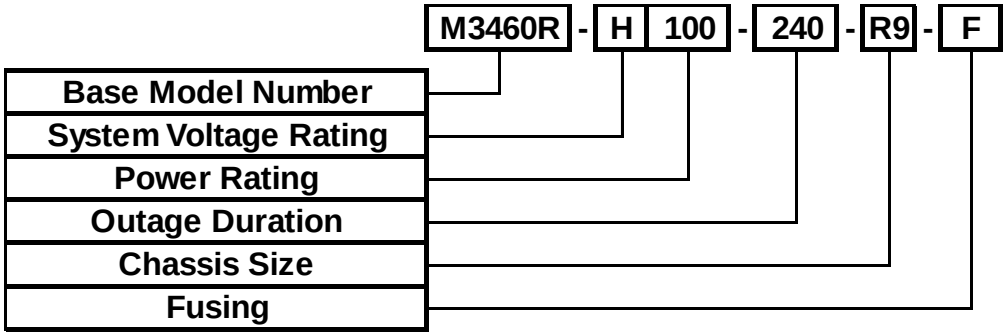
Chargers for high voltage storage strings.

2.1.2. DOCUMENTS

Please refer to the KIT 3660DD5 manual when this unit is equipped with the DD5 Digital Display option. 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
C	575 - 600 VAC / 810VDC

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

Four open-backplate 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
R10	28.00" x 16.00" x 13.50"	85-127 A	85 A
R9	34.00" x 16.00" x 13.50"	170 A	127-170 A
R11	44.00" x 15.25" x 13.50"	255-425 A	-
R2	52.00" x 24.00" x 12.50"	-	255-340 A

FUSING

The M3460R comes with internal fusing. This code is omitted on all M3460B models and M3460R models if internal fusing is not desired.

2.3. GENERAL SPECIFICATIONS

Table 2-3: M3460R General Specifications

PARAMETER	SPECIFICATION
Input AC Voltage	208 – 575 VAC
Input DC Voltage	200 – 675 VDC
Output DC Voltage	265 – 810 VDC
DC Bus Current Rating	85 – 425 ADC
Power Rating	25 – 305 kW
Inactive Power Consumption	<200W
Duty Cycle (Full Load)	1%
Sag/Outage Duration	2 seconds
Enclosure Rating	Open
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 – 675 VDC
Output DC Voltage	265 – 810 VDC
DC Bus Current Rating	85– 340 ADC
Power Rating	25 – 245 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	Open
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

The M3460 has an open frame construction. It is intended to be part of a larger variable frequency drive system, and will require different hardware for interconnection based on the installation. An appropriate enclosure may need to be provided to protect personnel from contact and the system from damage. The enclosure may also need to protect the equipment from the installation environment.

Please read this manual completely before designing the drive system or enclosure layout to ensure all required elements are included.

3.1. ENVIRONMENT

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.

Non-condensing, filtered air may be required to cool the system if other components cause excessive heat buildup in the enclosure.

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 6.5.

1. Lift M3460 backplate off the crate bottom using the 4 handles. Eyebolts may be installed in the mounting holes for lifting with hooks or chains.
2. Install the module to the backplate. Secure the M3460 backplate to the rack using the backplate's ½" diameter mounting holes. Mounting hardware is not supplied with the M3460. The power input terminals will be at the top of the installation.
3. If supplied, install the display panel in an appropriate location.

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 terminal 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.

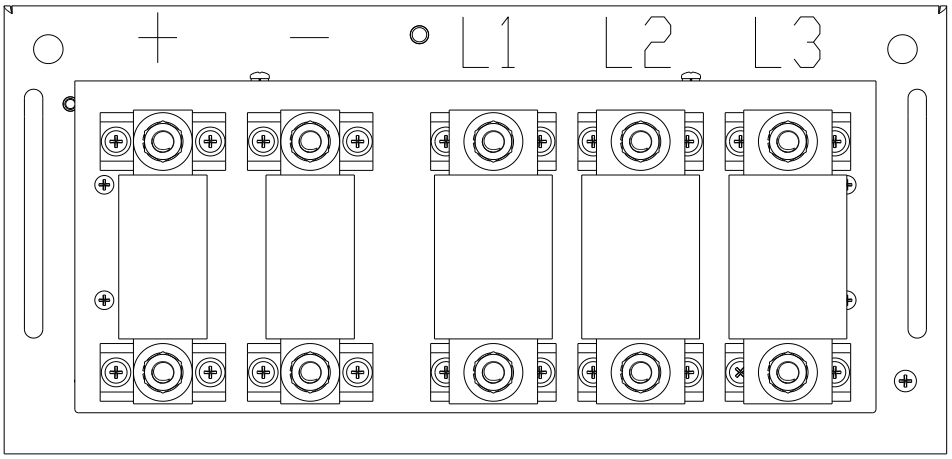
DANGER!

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.

Figure 3-1: M3460 Power Wiring Connections



3.4.2. CONTROL INTERFACE AND I/O WIRING

Control wiring allows for remote enabling, testing, and monitoring of the M3460. Some I/O is duplicated to allow for isolated monitoring; some have a mutual common.

When a display system is used, the system status outputs on 3460M6 TB6 are connected to the display. This leaves the outputs on 3460M6 TB5 available for remote monitoring.

3.4.2.1. CONNECTIONS FOR BASE CONFIGURATION

Table 3-3: User I/O Connections with 3460M6 Board

3460M6 TERMINAL	FUNCTION	ELECTRICAL SPECIFICATIONS	WIRE AWG	TORQUE
INPUTS				
TB7 – 1	Enable/Disable Input +	24VDC, 20mA	16-12	4.5 lb-in
TB7 – 2	Enable/Disable Input -			
TB7 – 3	Test Input +			
TB7 – 4	Test Input -			
ISOLATED OUTPUTS				
TB5 – 1 & 2	Ride-Thru Ready (RTR)	250V / 120mA	16-12	4.5 lb-in
TB5 – 3 & 4	Overtemperature (OT)			
TB5 – 5 & 6	Voltage Fault (VF)			
TB5 – 7 & 8	Fault (FLT)			
TB5 – 9 & 10	Precharge Complete (PCC)			
TB5 – 11 & 12	Ride-Thru Active (RTA)			
TB5 – 13 & 14	Input Undervoltage (IUV)			
COMMON OUTPUTS				
TB6 – 1	Local I/O Supply +	24 VDC, 500 mA	16-12	4.5 lb-in
TB6 – 9	Local I/O Supply -			
TB6 – 2	Precharge Complete (PCC)	250 V / 120 mA		
TB6 – 3	Voltage Fault (VF)			
TB6 – 4	Overtemperature (OT)			
TB6 – 5	Ride-Thru Ready (RTR)			
TB6 – 6	Ride-Thru Active (RTA)			
TB6 – 7	Input Undervoltage (IUV)			
TB6 – 8	Output Common			

3.4.2.2. CONNECTIONS WITH DD5 DIGITAL DISPLAY

When the KIT 3660DD5 digital display is used, some user connections to the digital display interface are made on a different module than the M3460. They are made to the 3660I4 interface module.

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

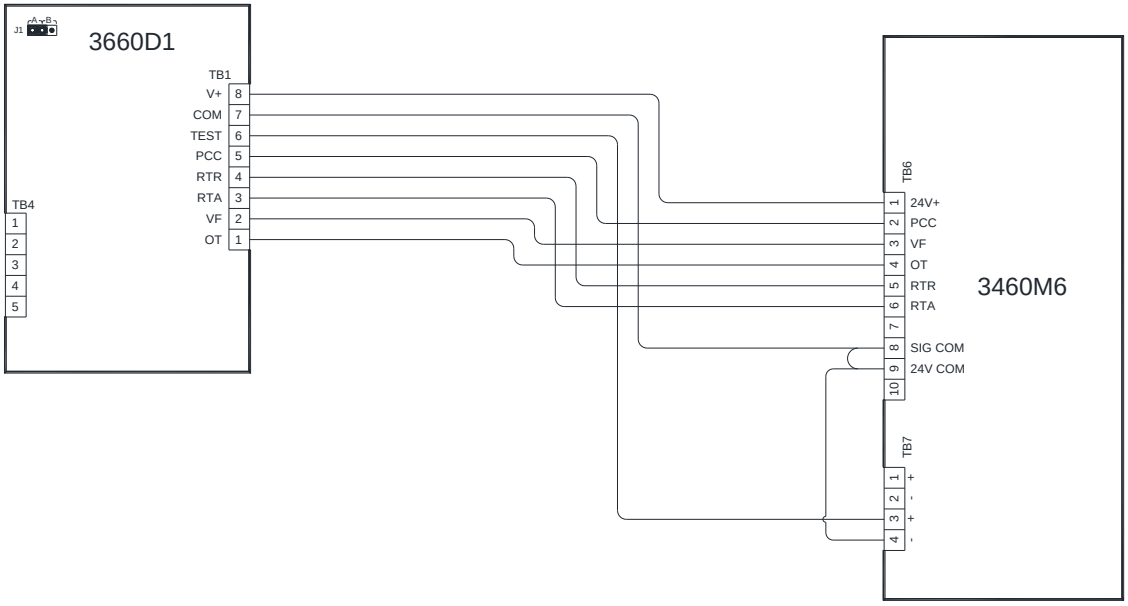
3.4.2.3. CONNECTIONS WITH DP10 ANALOG DISPLAY

When the M3460 is used with the DP10 analog display, the interconnections are made through TB6 and TB7 on the 3460M6 board and TB1 on the 3660D1 board.

Table 3-4: User I/O Connections with 3660D1 Board

3660D1 TERMINAL	FUNCTION	ELECTRICAL SPECIFICATIONS	WIRE AWG	TORQUE
TB1 – 1	Overtemperature (OT)	15 VDC, 15 mA	16	2.1 lb-in
TB1 – 2	Voltage Fault (VF)			
TB1 – 3	Ride-Thru Active (RTA)			
TB1 – 4	Ride-Thru Ready (RTR)			
TB1 – 5	Pre-Charge Complete (PCC)			
TB1 – 6	Test			
TB1 – 7	Local I/O Supply -	15 VDC, 50 mA		
TB1 – 8	Local I/O Supply +			

Figure 3-2: M3460 Interconnections with DP10



3.5. TYPICAL CONFIGURATIONS

Figure 3-3: M3460R Typical Configuration without Energy Storage

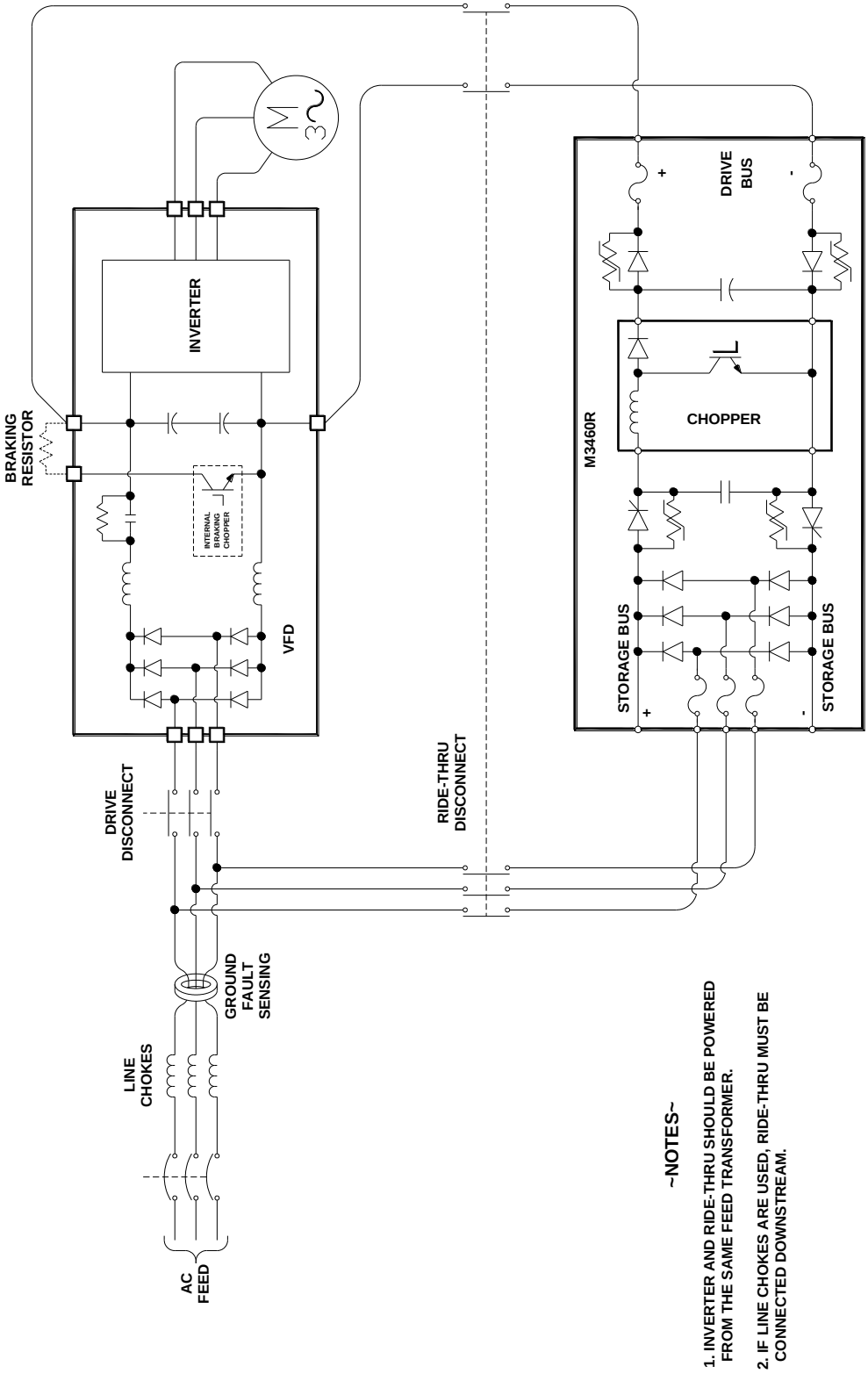


Figure 3-4: M3460R Typical Configuration with Electrolytic Capacitor Storage Bank

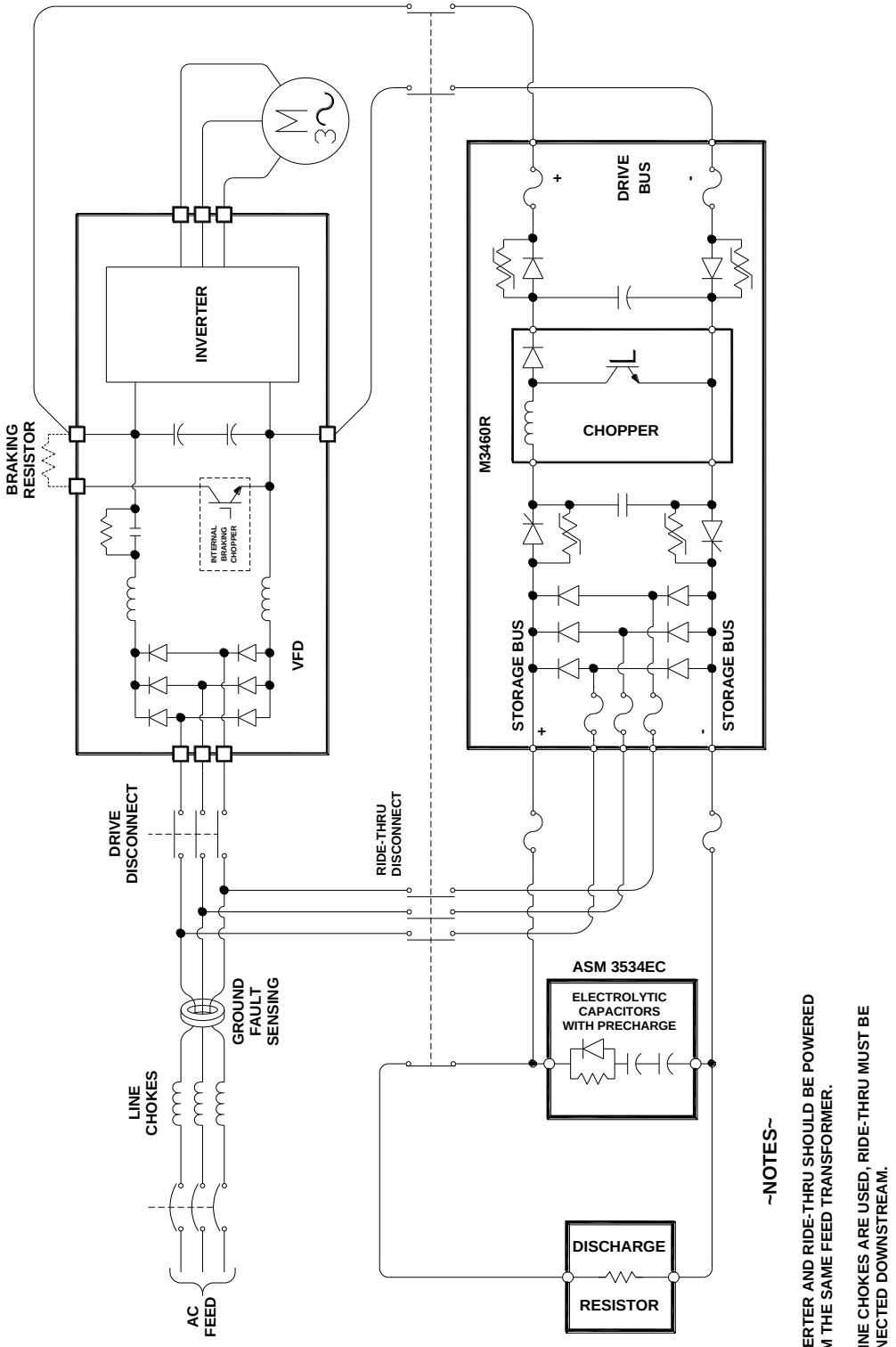


Figure 3-5: M3460R Typical Configuration with Ultracapacitor Storage Bank and M3528 Charger

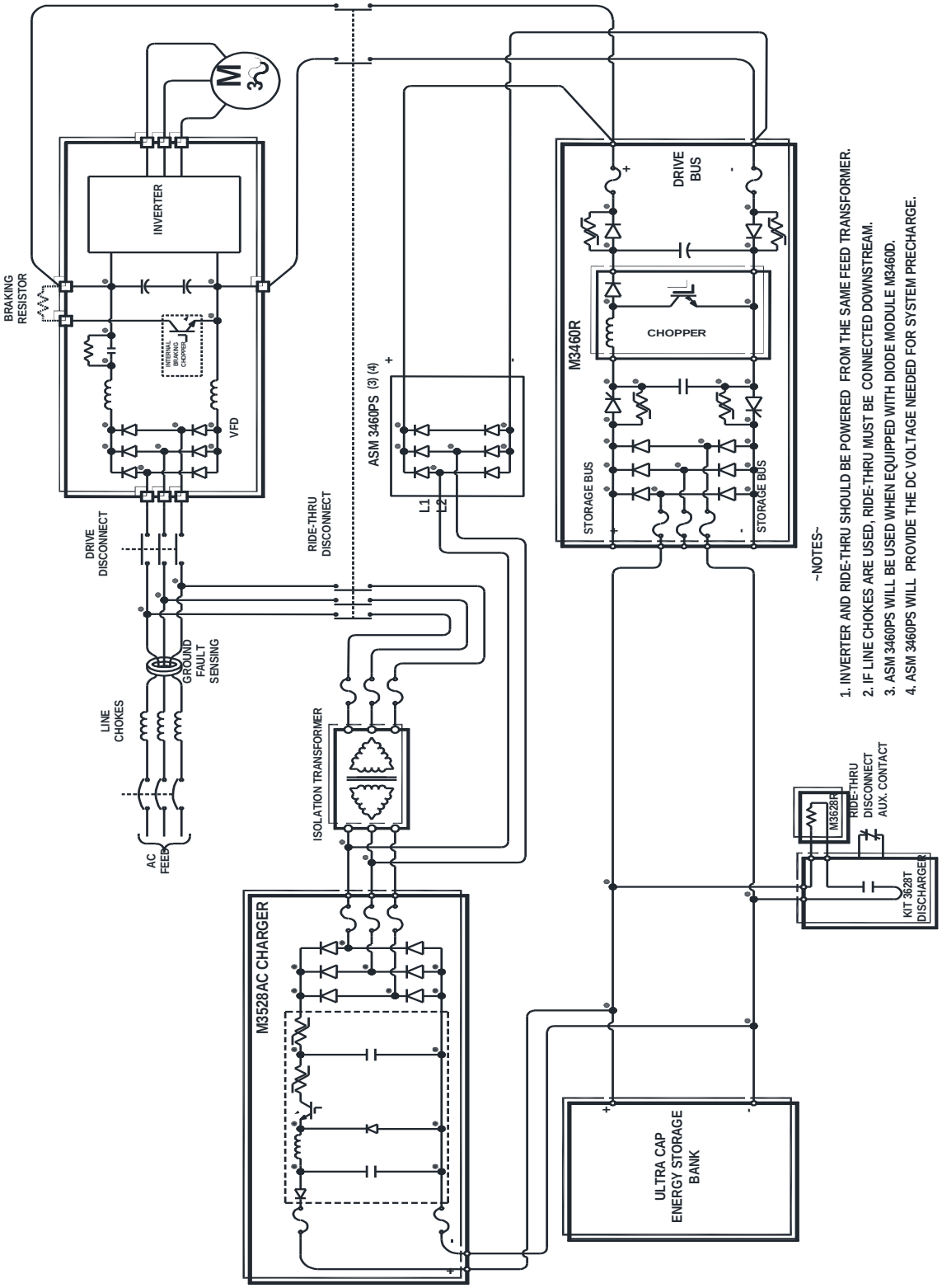


Figure 3-6: M3460R Typical Configuration with Ultracapacitor Storage Bank and M5628 Charger

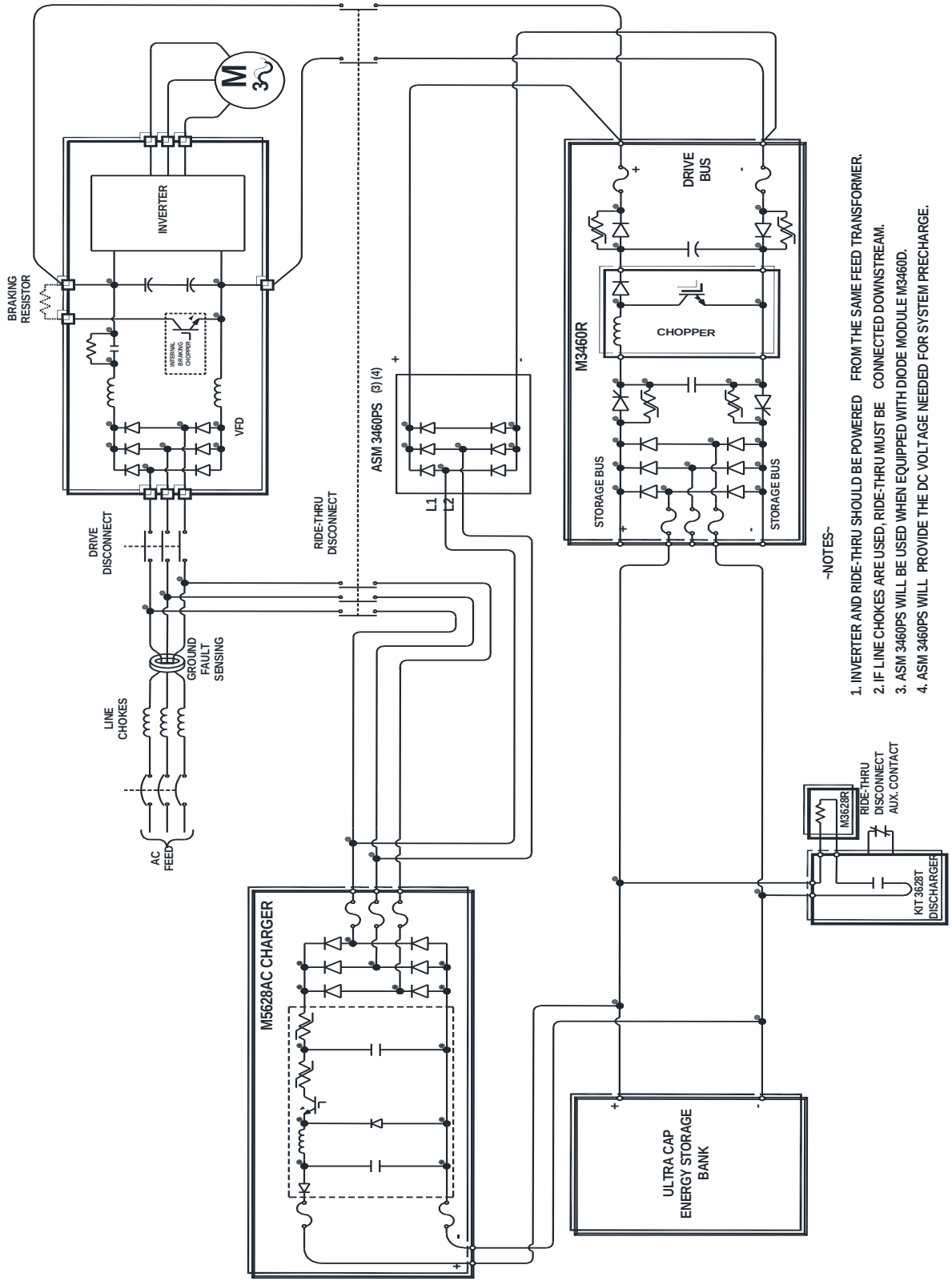


Figure 3-7: M3460B Typical Configuration with Battery Storage Bank and M3528 Charger

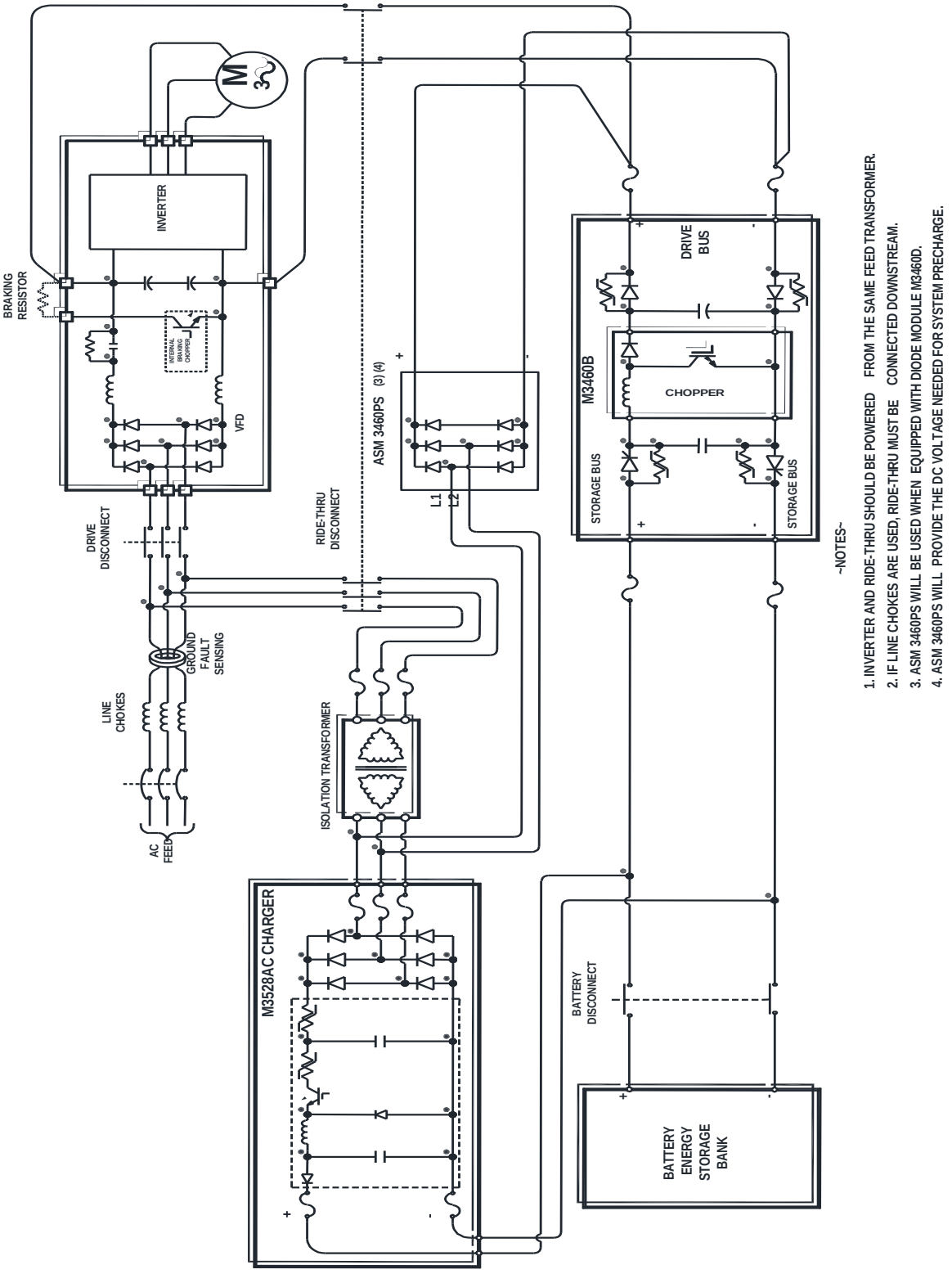
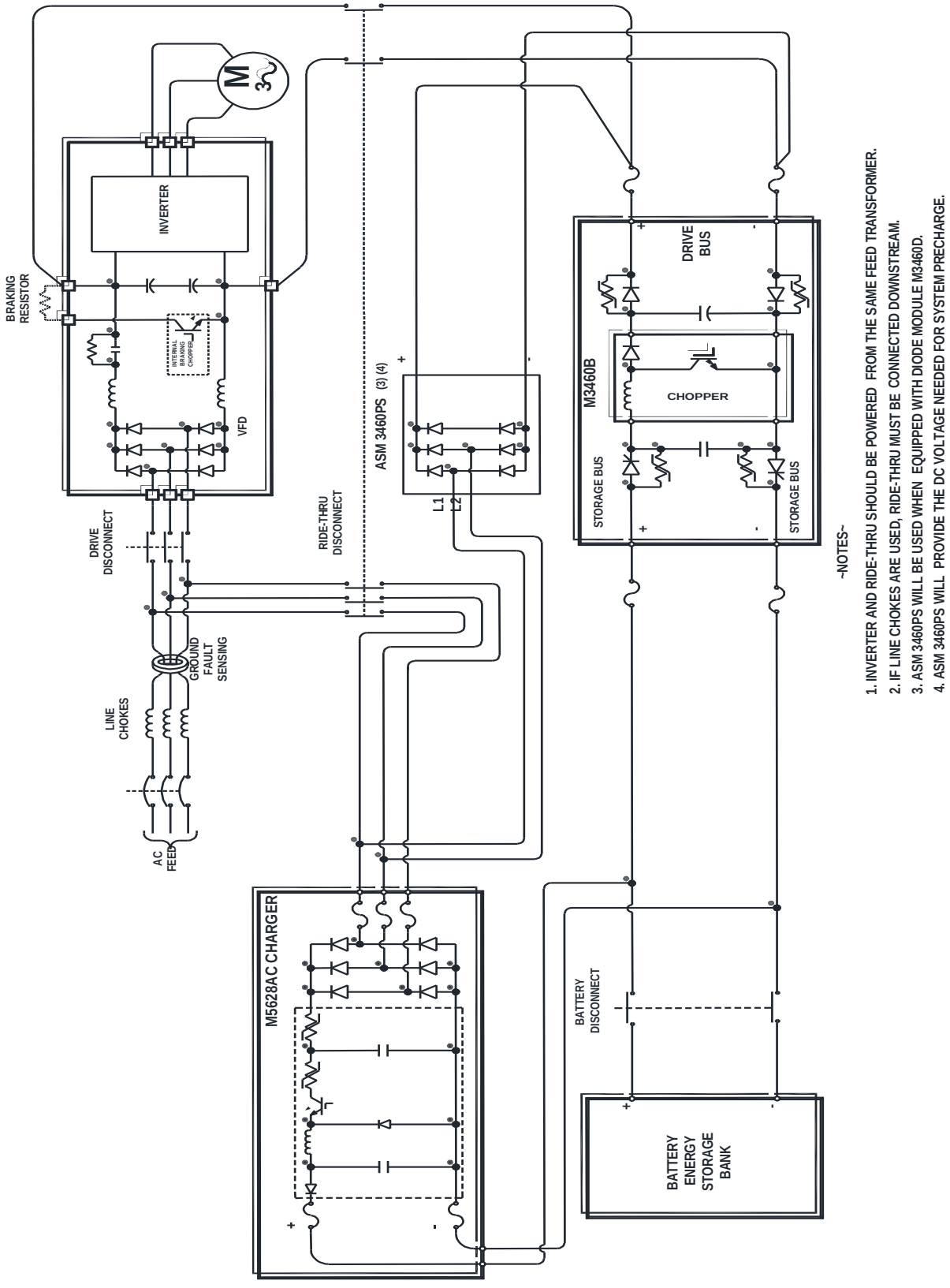


Figure 3-8: M3460B Typical Configuration with Battery Storage Bank and M5628 Charger



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.

The duration that the unit operates is determined by the Run Timeout selection, described in Section 4.4.4

This mode is activated by the Enable input. Refer to Section 4.4.1.1 for details on configuring this 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.

The duration that the unit operates is determined by the Test Timer selection, described in Section 4.4.5.

This mode is activated by the Test input. Refer to Section 4.4.1.2 for details on configuring this input.

4.4. I/O, FEATURES, AND DISPLAYS

Full status monitoring is available through discrete I/O points located on the 3460M6 board. Most of the I/O can be configured for different modes of operation with jumpers. This allows flexibility in the installation for remote control and monitoring of the system.

Figure 4-1: 3460M6 Status Interface Board Layout

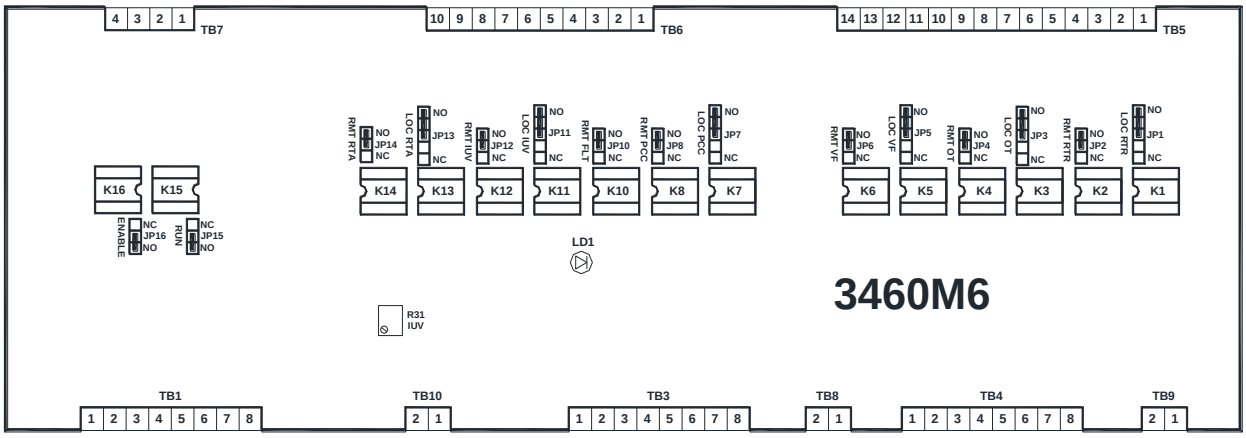


Figure 4-2: 3460C1 Control Board Layout

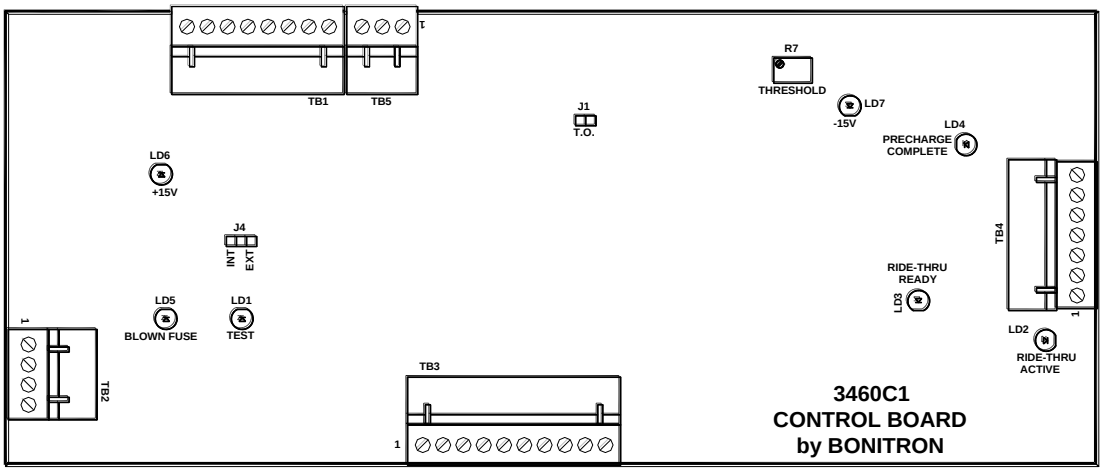


Figure 4-3: 3460D5 Power Supply Board Layout (for 380V and 460V)

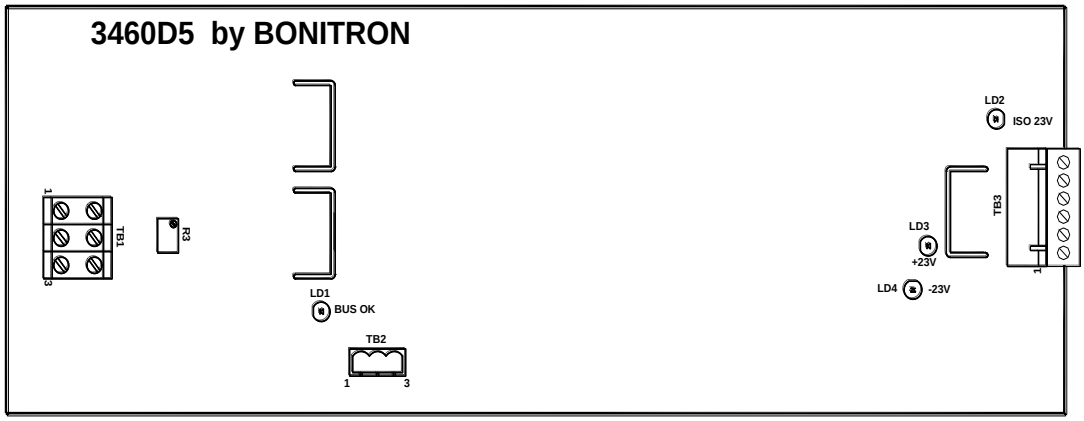
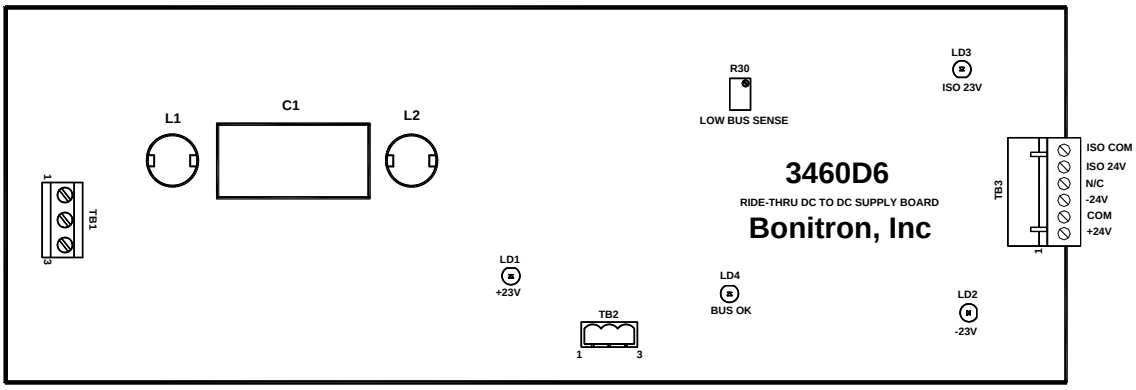


Figure 4-4: 3460D6 Power Supply Board Layout (for 575V)



4.4.1. INPUT TERMINALS – 3460M6 TB7

The input terminals are located on TB7 of the 3460M6 board. They can use an internal supply with a dry contact or an external 24VDC.

4.4.1.1. ENABLE INPUT - TB7-1, 2

The Enable input is used to allow the M3460 to operate. This signal can be configured for either enable or disable operation.

This input operation is configured with jumper JP15.

The input operation is set to "Enable" with JP15 set to "**NO**", and the M3460 will operate when 24VDC is applied to the input.

The input operation is set to "Disable" with JP15 set to "**NC**", and the M3460 will be inhibited and not operate when 24VDC is applied to the input.

Connect the 24V positive to TB7-1 and the 24V common to TB7-2.

JP16 is a spare enable input that is not currently used and should be left in the same position as JP15 to avoid any confusion.

With the M3460R, the Overtemperature output status contact at TB5 should be used to disable the M3460R. This can be done by connecting 24V positive to TB5-3, connecting TB5-4 to TB7-1, and connecting the 24V common to TB7-2.

With the M3460B, the Overtemperature and Input Undervoltage output status contacts should be used to disable the M3460B. This can be done by connecting 24V positive to TB5-3, connecting TB5-4 to TB5-13, connecting TB5-14 to TB7-1, & connecting the 24V common to TB7-2.

The factory default setting is to have the operation set to "Enable".

Table 4-1: 3460M6 Enable Input Logic Jumper Details

JUMPER	POSITION	FUNCTION	3460M6 FIELD TERMINALS	FACTORY SETTING
JP15	NO	Enable	TB7 - 1, 2	NO (Enable)
	NC	Disable		

CAUTION!

THE M3460 MAY NOT OPERATE CORRECTLY IF THE UNIT IS NOT PROPERLY CONFIGURED. PAY SPECIAL ATTENTION TO THIS CONFIGURATION, AS THIS CAN CAUSE THE UNIT TO NOT PROTECT THE DRIVE IN THE CASE OF A POWER SAG OR OUTAGE.

4.4.1.2. TEST INPUT - TB7 - 3, 4

The Test input is used to make the M3460 go into Test mode.

Connect 24V positive to TB7-3 and 24V common to TB7-4 to force the M3460 into Test mode.

When the DP10 display is used, pressing the test button on the display will put the M3460 into Test mode.

4.4.2. OUTPUT TERMINALS - 3460M6 TB5, TB6

The status of the M3460 can be monitored from two locations.

TB5 has individual isolated contacts for indication and TB6 has indicators that have a single common on TB6-8. In general, TB6 is used to connect the DP10 or DD5 display panel, but is not restricted to that use.

All the status outputs can be configured with jumpers to be normally open (**NO**) or normally closed (**NC**). In the descriptions below, the operation is described for the jumpers to be set in the normally open position.

The outputs are not polarized.

4.4.2.1. RIDE-THRU READY - TB5 - 1, 2 & TB6 - 5

This output closes when the M3460 is ready to operate and has no faults. This indicates the Enable input is active, the precharge is complete, and all the stage fuses are intact. This can be used as a general status indication.

The output configuration can be set to normally open or normally closed with Jumper JP2 for TB5-1, 2 and with JP1 for TB6-5.

4.4.2.2. OVERTEMPERATURE - TB5 - 3, 4 & TB6 - 4

This output opens when the temperature of any heatsink in the M3460 is above 160°F. The contact will close again when the temperature goes below 140°F. This does not stop the M3460 from operating, and care must be taken so that the M3460 is turned off before damage can occur to the internal power stages.

The output configuration can be set to normally open or normally closed with Jumper JP4 for TB5-3, 4 and with JP3 for TB6-4.

4.4.2.3. VOLTAGE FAULT - TB5 - 5, 6 & TB6 - 3

On M3460R models, this output opens when any phase from the input AC line is missing.

On M3460B models, this output opens when the output DC Bus drops below a preset threshold level. This is an indication the M3460B is not holding the DC Bus up and an Undervoltage Fault on the attached drive is possible. The default setting for this output is approximately 35V below the threshold level. This level can be adjusted in the field as described in Section 4.7.

The output configuration can be set to normally open or normally closed with Jumper JP6 for TB5-5, 6 and with JP5 for TB6-3.

4.4.2.4. GENERAL FAULT - TB5 - 7, 8

This output is a combination of the Voltage Fault, Overtemperature, and Ride-Thru Ready status contacts. It will open if any of these faults open, after a 3 second delay.

The output configuration can be set to normally open or normally closed with Jumper JP10 for TB5-7, 8. This output is not on TB6.

4.4.2.5. PRECHARGE COMPLETE - TB5 - 9, 10 & TB6 - 2

This output will close when the M3460 has been enabled and gone through the precharge cycle.

The output configuration can be set to normally open or normally closed with Jumper JP8 for TB5-9, 10 and with JP7 for TB6-2.

4.4.2.6. RIDE-THRU ACTIVE - TB5 - 11, 12 & TB6 - 6

This output will close when the M3460 is regulating the output DC bus of the system. This indicates that the power input on the connected equipment has sagged or failed. This output will also close when the unit is put into Test mode with the Test input, assuming the attached drive is loaded.

This output will latch on for 3 seconds after activity has stopped. The 3 second pulse allows a monitoring system to ensure capture of the event, or to indicate when the M3460 is being forced into operation when the power feed may be normal.

The output configuration can be set to normally open or normally closed with Jumper JP14 for TB5-11, 12 and with JP13 for TB6-6.

4.4.2.7. INPUT UNDERVOLTAGE - TB5 - 13, 14 & TB6 - 7

This output indicates that the input voltage to the M3460 has dropped below a preset threshold. This is generally used when a storage device must be protected from over discharge. The default level for this output is dependent on the nominal system voltage, and is listed in Tables 6-3 and 6-4.

This level can be adjusted in the field as described in Section 4.6.

Table 4-2: 3460M6 Status Output Signal Logic Jumper Details

OUTPUT	ABBREVIATION	3460M6 FIELD TERMINALS	JUMPER	FACTORY SETTING
Voltage Fault	VF	TB6 – 3	JP5	Normally Open (N.O.)
		TB5 – 5, 6	JP6	
Over Temperature	OT	TB6 – 4	JP3	
		TB5 – 3, 4	JP4	
Precharge Complete	PCC	TB6 – 2	JP7	
		TB5 – 9, 10	JP8	
Ride-Thru Active	RTA	TB6 – 6	JP13	
		TB5 – 11, 12	JP14	
Ride-Thru Ready	RTR	TB6 – 5	JP1	
		TB5 – 1, 2	JP2	
General Fault	FLT	TB5 – 7, 8	JP10	
Input Undervoltage	IUV	TB6 – 7	JP11	
		TB5 – 13, 14	JP12	

4.4.3. LOCAL I/O POWER SUPPLY - TB6 - 1, 9

The I/O contacts for the M3460 can be supplied by the internal supply available on TB6 – 1, 9. TB6 – 1 is 24VDC+ and the common is on TB6 – 9.

It is not recommended to use an external power supply connected in parallel to the internal supply. If an external supply is used, terminals TB6 – 1 and TB6 – 9 should not be used.

When the DP10 analog display is installed with the M3460, this internal power supply is used to drive the I/O on the display panel.

4.4.4. RUN TIMEOUT SELECTION

The ride-thru operation can be timed out automatically during a power quality event or testing. This allows internal monitoring of operation to prevent overheating of the unit. Jumper J1 on the 3460C1 control board can be used to limit the operation time to 2 seconds.

If jumper J1 is **OFF** the M3460 will operate for 2 seconds and then stop operating. Once the power quality event ends or Test input is removed the M3460 can operate again after a 4 second delay.

If jumper J1 is **ON** the M3460 will operate as long as the DC bus is below the DC Bus Threshold voltage during a power quality event, or as long as the "Test" input is active.

The default setting for M3460R is placing J1 in the “**OFF**” position.

The default setting for M3460B is placing J1 in the “**ON**” position.

Table 4-3: Run Timeout Jumper Configurations

JUMPER	POSITION	FUNCTION	M3460R SETTING	M3460B SETTING
J1	ON	No Run Timeout	OFF	ON
	OFF	Run Timeout set to 2 seconds		

DANGER!

IF J1 IS LEFT ON, THE M3460 WILL RUN CONTINUOUSLY AND CAN OVERHEAT. DAMAGE CAN OCCUR IF THE UNIT IS OPERATED BEYOND ITS RATINGS FOR DURATION OR TEMPERATURE.

4.4.5. TEST TIMER SELECTION

The Test operation can be selected to be "real time" or a pre-determined, two second pulse.

Jumper J4 located on the 3460C1 control board is used for this selection.

If J4 is in the "**INT**" position, the DC Bus will rise for 2 seconds every time the Test input is active.

If J4 is in the "**EXT**" position, the DC Bus will rise for as long as the Test input is active, unless J1 is selected to time out after 2 seconds.

The default setting is the "**EXT**" position.

Table 4-4: Test Timer Jumper Configurations

JUMPER	POSITION	FUNCTION	FACTORY SETTING
J4	INT	Sets test timer to 2 seconds	EXT
	EXT	Test timer is real time	

4.4.6. INDICATORS

There are several light-emitting diodes (LEDs) used to indicate the status of the M3460. These are found on the 3460C1, 3460M6, 3460D5 and 3460D6 boards. See Figures 4-1, 4-2, & 4-3, 4-4.

4.4.6.1. POWER – 3460C1 - LD6, LD7

The +15V and -15V lights will illuminate when the internal power supply is operating properly.

4.4.6.2. RIDE-THRU READY (RTR) – 3460C1 - LD3

The Ride-Thru Ready light will illuminate when the M3460 has been enabled and there are no faults. This can be used as a general status indication.

4.4.6.3. PRECHARGE COMPLETE (PCC) – 3460C1 - LD4

The Precharge Complete light will illuminate when the M3460 internal bus capacitors have been precharged.

4.4.6.4. BLOWN FUSE (BF) – 3460C1 - LD5

The Blown Fuse light will illuminate when an internal IGBT stage fuse has blown.

4.4.6.5. RIDE-THRU ACTIVE (RTA) – 3460C1 - LD2

The Ride-Thru Active light will illuminate while the M3460 is regulating the DC bus or when the M3460 is put into Test mode. If the M3460 is unloaded or lightly loaded, this light may not illuminate.

4.4.6.6. TEST – 3460C1 - LD1

The Test light will illuminate when the M3460 is put into Test mode. If the M3460 is unloaded or lightly loaded, this light may not illuminate.

4.4.6.7. NO FAULT (NFLT) – 3460M6 - LD1

The No Fault light will illuminate during normal operation. It will go out with a Ride-Thru Ready, Overtemperature, or Voltage Fault, after a three second delay.

4.4.6.8. OUTPUT UNDERVOLTAGE (OUV) –3460D5 – LD1, 3460D6-LD4

The Output Undervoltage fault will happen if the DC bus is approximately 35V below the threshold setting. If the DC bus drops 35V below the threshold setting, the light will go out. This is an indication the M3460 is not regulating the DC bus and an undervoltage fault on the attached equipment is possible. This light is also indicated as “BUS OK”.

4.4.7. FAN TIMER

The M3460B is equipped with fans to keep the heatsinks cool while the unit is active. These fans are controlled by a timer relay on the front of the unit. This timer relay is set at the factory to run for approximately 2 hours after the M3460B module becomes active. This setting should not be adjusted as it may affect the ability of the M3460B module to operate properly for its time specification.

4.4.8. DISPLAY OPTIONS

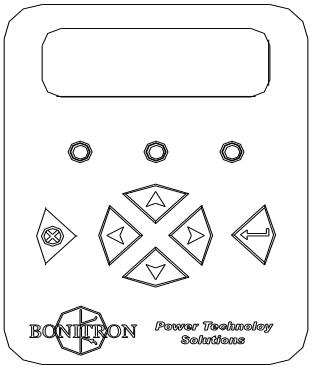
There are two display options available for local indication. They are designed to be mounted to the door or deadfront of a drive cabinet or system. The displays show the M3460 operating status and also permit a system test to be performed. The DD5 digital display system has many more features than the DP10 analog display, including outage and fault logging. Please refer to the KIT 3660DD5 manual for a full description of the features.

Table 4-5: Display Panel Configurations

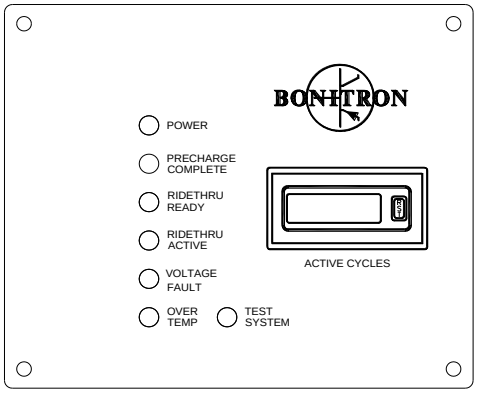
DISPLAY MODEL	LOCAL INDICATORS	VOLTMETER	AMMETER	TOTAL COUNTER	RESETTABLE COUNTER	ACTIVITY LOGGING	LOCAL TEST INITIATION
DD5	✓	✓	✓	✓	✓	✓	✓
DP10	✓				✓		✓

Figure 4-5: Display Panels

DD5



DP10



4.4.8.1. DD5 DIGITAL DISPLAY

The KIT 3660DD5 digital display has many features and control modes that can be used to monitor, test and log information about the M3460 and its activity.

Below are basic operation instructions. Please refer to the KIT 3660DD5 manual for detailed instructions and configuration information.

The KIT 3660DD5 power supply should not be connected to earth ground.

The digital display can also be used to monitor charging and storage modules for Ride-Thru systems.

DIGITAL DISPLAY INPUTS

There are two remote inputs to control the activity of the M3460, Enable and Test. They allow remote initiation of these inputs, but the digital display system allows the M3460 to be tested locally.

DIGITAL DISPLAY OUTPUTS

There are two outputs that can be configured for various indications on the digital display.

DEFAULT OPERATION

When the M3460 is ordered with the KIT 3660DD5 digital display, the factory settings are for Automatic Control mode.

The M3460R will be disabled locally under the following conditions:

- Overtemperature
- Runtime Exceeded

The M3460B will be disabled locally under the following conditions:

- Input Undervoltage
- Overtemperature
- Runtime Exceeded

The default operation allows for the most complete protection for the M3460 but these can be reconfigured if required.

CAUTION!

DISABLING THESE FAULTS CAN DAMAGE THE M3460 BY FORCING IT TO OPERATE OUTSIDE OF DESIGN PARAMETERS!

4.4.8.2. DP10 ANALOG DISPLAY

The DP10 has LED indicators for the following status outputs:

- Power
- Precharge Complete
- Ride-Thru Ready
- Ride-Thru Active
- Voltage Fault
- Overtemperature

In addition, there is a total cycle counter that can be reset. It indicates the number of times the M3460 has been active since the last reset. This number will increase when there is a power quality event, or when the system is tested.

There is also a local test button that can be used to initiate a system test.

4.5. 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!**

4.5.1. 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.

4.5.2. 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.

4.5.3. 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. Enable the Test input, or 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.

4.5.4. 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.

4.6. INPUT UNDERVOLTAGE (IUV) LEVEL ADJUSTMENT

This output indicates that the input voltage to the M3460 has dropped below a preset threshold. This is generally used when a storage device must be protected from over discharge. The default level for this output is dependent on the nominal system voltage, and is listed in Table 6-3 and Table 6-4.

Adjustment of pot R31 on the 3460M6 interface board (see Figure 4-1) is used to set the input undervoltage level. Adjusting the pot in a clockwise direction will raise the setpoint level and a counter-clockwise adjustment of the pot will lower the setpoint level.

4.7. OUTPUT UNDERVOLTAGE LEVEL ADJUSTMENT

This output indicates that the output voltage to the Drive DC Bus has dropped below a preset threshold. This generally means the M3460 is not maintaining the DC Bus and an Undervoltage fault is possible on the attached Drive. The default level for this output is approximately 35V below the threshold level.

Adjustment of pot R3 on the 3460D5 board or pot R30 on 3460D6 board is used to set the "Low DC Bus" voltage level. Adjusting the pot in a clockwise direction will raise the setpoint level and a counter-clockwise adjustment of the pot will lower the setpoint level (see Figure 4-3, 4-4).

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:

- DC bus voltage should rise
- +15V light on 3460C1 board should be ON
- -15V light on 3460C1 board should be ON
- Precharge Complete light on 3460C1 board should be OFF
- Ride-Thru Ready light on 3460C1 board should be OFF
- Ride-Thru Active light on 3460C1 board should be OFF
- Blown Fuse light on 3460C1 board should be OFF
- Test light on 3460C1 board should be OFF
- No Fault light on 3460M6 board should be OFF
- Bus OK light on 3460D5 / 3460D6 board should be ON
- All status outputs are in the expected state. If there are faults on the system, check the configuration of the status output jumpers.

5. Enable the M3460R with either the enable input or the digital display.

- Ride-Thru Ready and Precharge Complete lights on 3460C1 board should turn ON
- No Fault light on 3460M6 board should turn ON

6. Initiate the test mode with the Test input or display panel.

- The DC bus should rise for as long as the test is performed. A timeout may occur, depending on the state of J1 and J4 on the 3460C1 board and the load on the M3460R.

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, **the drive must be ON before applying power to the Ride-Thru**. 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. 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 drive is operating properly with the M3460B disconnected.
4. Apply battery bank power to the input of the M3460B and observe the following conditions:

   DC bus voltage should rise to approximately the battery bank voltage

   +15V light on 3460C1 board should be ON

   -15V light on 3460C1 board should be ON

   Precharge Complete light on 3460C1 board should be OFF

   Ride-Thru Ready light on 3460C1 board should be OFF

   Ride-Thru Active light on 3460C1 board should be OFF

   Blown Fuse light on 3460C1 board should be OFF

   Test light on 3460C1 board should be OFF

   No Fault light on 3460M6 board should be OFF

   Bus OK light on 3460D5 /3460D6 board should be OFF

   All status outputs are in the expected state. If there are faults on the system, check the configuration of the status output jumpers.
5. Enable the M3460B with either the enable input or the digital display.
   - Ride-Thru Ready and Precharge Complete lights on 3460C1 board should turn ON
   - No Fault light on 3460M6 board should turn ON
   - Bus OK light on 3460D5 /3460D6 board should turn ON
   - Ride-Thru Active light should turn ON and M3460B should start to operate
   - The DC bus will hold at the DC bus threshold voltage setting
6. Initiate the test mode with the Test input or display panel.

   The DC bus should rise for as long as the test is performed. A timeout may occur, depending on the state of J1 and J4 on the 3460C1 board and the load on the M3460B.
7. Turn off the battery bank power to the M3460B and connect the DC bus of the M3460B to the DC bus of the drive.
8. 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**.
9. Monitor the DC bus voltage and current with the display or with separate meters. Also, monitor the AC input current to the attached drive.
10. Load the drive as much as practical and put the M3460B 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 M3460B to drive.

    Drive input current should decrease.

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.***

5.3. 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.

5.3.1. 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!***

5.3.2. 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%.

5.3.3. 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.

5.3.4. 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.

5.3.5. 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.

5.4. 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. See Section 4.4.1.1 ▪ Check input and output fuses.
Test Mode Does Not Raise Output Voltage	▪ Check Enable Input. See Section 4.4.1.1 ▪ Check Test Input. See Section 4.4.1.2 ▪ Check input and output fuses. ▪ Check threshold voltage setting. See Section 4.5.4.
Stays in Test Mode	▪ Check Test Input. See Section 4.4.1.2
Ride-Thru Ready light is OFF or Ride-Thru Ready output is open	▪ Check Enable Input. See Section 4.4.1.1 ▪ Check IGBT fuses. ▪ Check 3460M6 jumpers. See Table 4-2
Precharge Complete light is OFF or Precharge Complete output is open	▪ Check Enable Input. See Section 4.4.1.2 ▪ Check 3460M6 jumpers. See Table 4-2 ▪ Check Drive Bus voltage level.
Voltage Fault output is open	▪ Check input fuses (for M3460R models) ▪ Check Drive Bus level and see Section 4.7 (for M3460B models) ▪ Check jumpers on 3460M6 board. See Table 4-2
Overtemperature output is open	▪ Check jumpers on 3460M6 board. See Table 4-2 ▪ Check threshold voltage setting. See Section 0
General Fault output is open	▪ Check Ride-Thru Ready output ▪ Check Voltage Fault output ▪ Check Overtemperature output ▪ Check jumpers on 3460M6 board. See Table 4-2
Ride-Thru Active output is closed when Ride-Thru is not active	▪ Check Drive Bus voltage. ▪ Check threshold voltage setting. See Section 4.5.4 ▪ Check jumpers on 3460M6 board. See Table 4-2

SYMPTOM	ACTION
Ride-Thru Active output does not close or Attached Drive Trips during power quality events	▪ Check Enable Input. See Sec. 4.4.1.1 ▪ 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. See Section 4.6 ▪ Check jumpers on the 3460M6 board. See Table 4-2
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. See KIT 3660DD5 manual, Table 3-1 and Section 4.5.1.6.

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.

5.5. 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	575VAC SYSTEM VOLTAGE
85 A	25 kW	43 kW	50 kW	60 kW
127 A	38 kW	65 kW	75 kW	90kW
170 A	50 kW	87 kW	100 kW	125 kW
255 A	75 kW	130 kW	150 kW	185 kW
340 A	100 kW	175 kW	200 kW	245 kW
425 A	125 kW	215 kW	250 kW	305 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
575 VAC	720 VDC	+150 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
575 VAC	287 VAC	400 VDC	675 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
575 VAC	500 VDC	600 VDC	675 VDC	692 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.

Table 6-7: M3460R Model Specifications for 575 - 600 VAC Systems

DC BUS CURRENT ①	BACKPLATE SIZE	CIRCUIT CONFIGURATION	RECOMMENDED FUSE RATING		SCCR RATINGS
			DRIVE BUS	AC LINE ②	
85 A	R10	2-stage	80 A, 1000 V	125 A, 600 V	10 kA③
127 A	R10	2-stage	125 A, 1000 V	200 A, 600 V	
170 A	R9	4-stage	175 A, 1000 V	250 A, 600 V	
255 A	R11	4-stage	250 A, 1000 V	400 A, 600 V	
340 A	R11	4-stage	350 A, 1000 V	500 A, 600 V	18 kA④
425 A	R11	4-stage	400 A, 1000 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.
③ Suitable for use on a circuit capable of delivering not more than 10,000 RMS symmetrical amperes, 1000 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, 1000 volts maximum when protected by recommended fuses.

Table 6-8: M3460B Model Specifications for 575 - 600 VAC Systems

DC BUS CURRENT ①	BACKPLATE SIZE	CIRCUIT CONFIGURATION	RECOMMENDED FUSE RATING		SCCR RATINGS
			DRIVE BUS	STORAGE BUS②	
85 A	R10	1-stage	80 A, 1000 V	125 A, 700 V	10 kA③
127 A	R9	2-stage	125 A, 1000 V	175 A, 700 V	
170 A	R9	2-stage	175 A, 1000 V	250 A, 700 V	
255 A	R2	4-stage	250 A, 1000 V	350 A, 700 V	
340 A	R2	4-stage	350 A, 1000 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.
③ Suitable for use on a circuit capable of delivering not more than 10,000 RMS symmetrical amperes, 1000 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, 1000 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. CERTIFICATIONS

6.3.1. UNDERWRITERS LABORATORIES LISTING

Standard M3460 models with L, E, and H voltage ratings are UL listed under file E204386.

6.3.2. CE CONFORMITY

Compliance with the Low Voltage Directive and Electromagnetic Compatibility Directive has been demonstrated using harmonized European Norm (EN) standards published in the Official Journal of the European Communities. Bonitron M3460 ride-thru voltage regulators that are L, E, and H voltage class comply with the EN standards listed below when installed according to this manual.

CE Declarations of Conformity are available online at www.bonitron.com.

LOW VOLTAGE DIRECTIVE (2006/95/EC)

- EN 61010-1:2001 2nd Edition - Electrical Equipment for Measurement Control and Laboratory Use; Part 1: General Requirements.

EMC DIRECTIVE (2004/108/EC)

- EN 61000-4-2, 1995 Edition, Electromagnetic Compatibility – Part 4: testing and measurement techniques - Section 2: Electrostatic discharge immunity test.
- EN 61000-4-3, 2002 Edition, Electromagnetic Compatibility - Part 4: Testing and measurement techniques - Section 3: Radiated, radio-frequency, electromagnetic field immunity test.
- EN 61000-4-4, 2004 Edition, Electromagnetic Compatibility - Part 4: Testing and measurement techniques - Section 4: Electrical fast transient/burst immunity test.
- EN 61000-4-5, 1995 Edition, Electromagnetic Compatibility - Part 4: Testing and measurement techniques - Section 5: Surge immunity test.
- EN 61000-4-11, 2004 Edition, Electromagnetic Compatibility - Part 4: Testing and measurement techniques - Section 11: Voltage dips and interruptions immunity test.

6.3.3. THIRD PARTY CERTIFICATIONS

Tested by EPRI to exceed Semi-F47 specs.

6.4. 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 6-9 & 6-10, based on the DC bus current rating of the M3460.
- The field wiring sizes listed in Tables 6-9 & 6-10 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 6-9: M3460R Input Power Wiring Sizes and Fusing

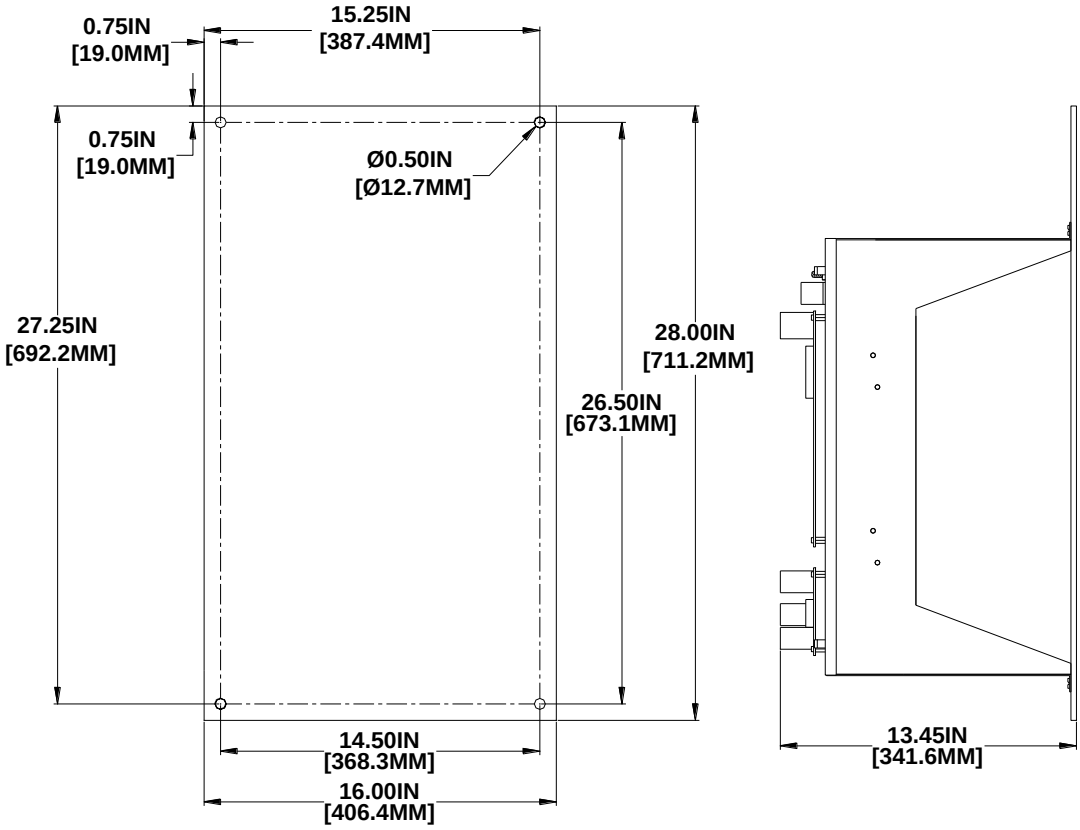
M3460R DC Bus Current Rating	Minimum Circuit Branch Protection Fusing (Class J Time Delay)	Recommended Field Wiring Sizes
85 Amps	70 Amps	4 AWG
127 Amps	100 Amps	2 AWG
170 Amps	125 Amps	1/0 AWG
255 Amps	175 Amps	2/0 AWG
340 Amps	225 Amps	3/0 AWG
425 Amps	225 Amps	4/0 AWG

Table 6-10: 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

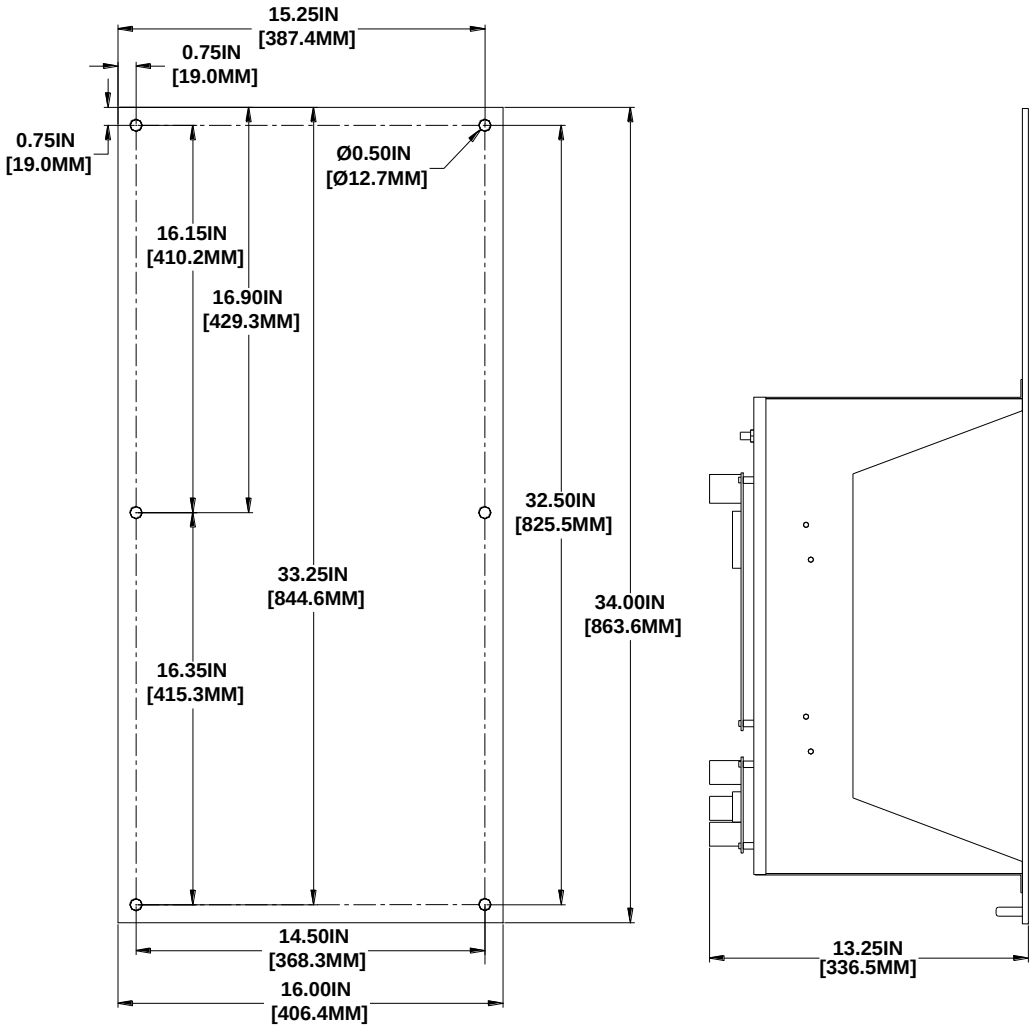
6.5. DIMENSIONS AND MECHANICAL DRAWINGS

Figure 6-1: M3460-R10 Chassis Dimensional Outline



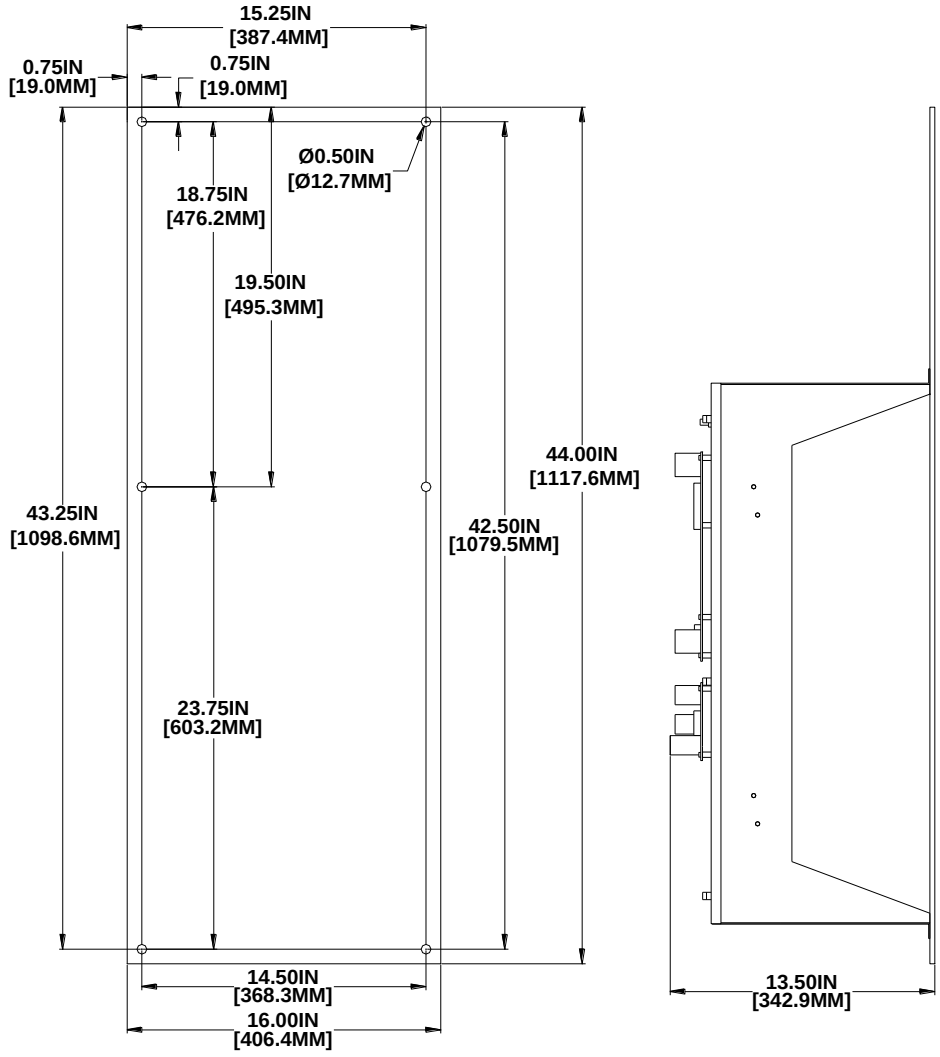
MOUNTING FOOTPRINT

Figure 6-2: M3460-R9 Chassis Dimensional Outline



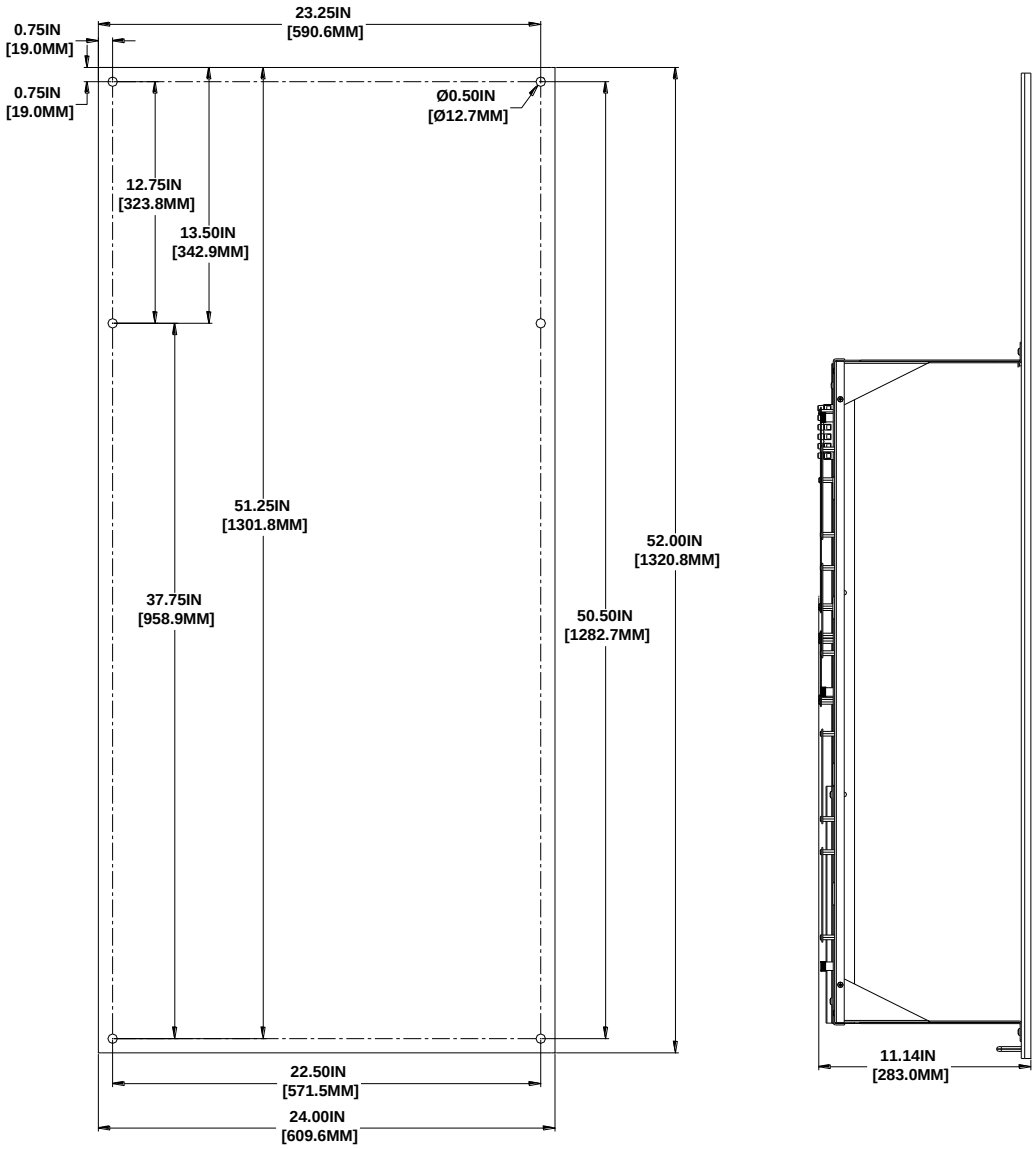
MOUNTING FOOTPRINT

Figure 6-3: M3460-R11 Chassis Dimensional Outline



MOUNTING FOOTPRINT

Figure 6-4: M3460-R2 Chassis Dimensional Outline



MOUNTING FOOTPRINT

Figure 6-5: DD5 Digital Display Cutout and Mounting Dimensions

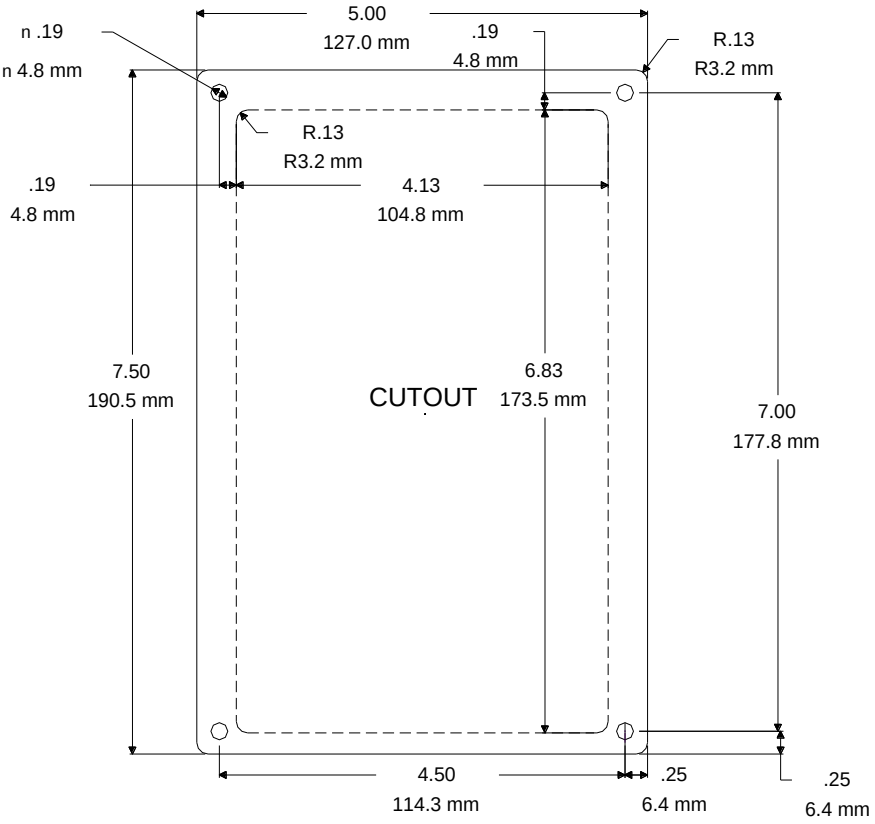
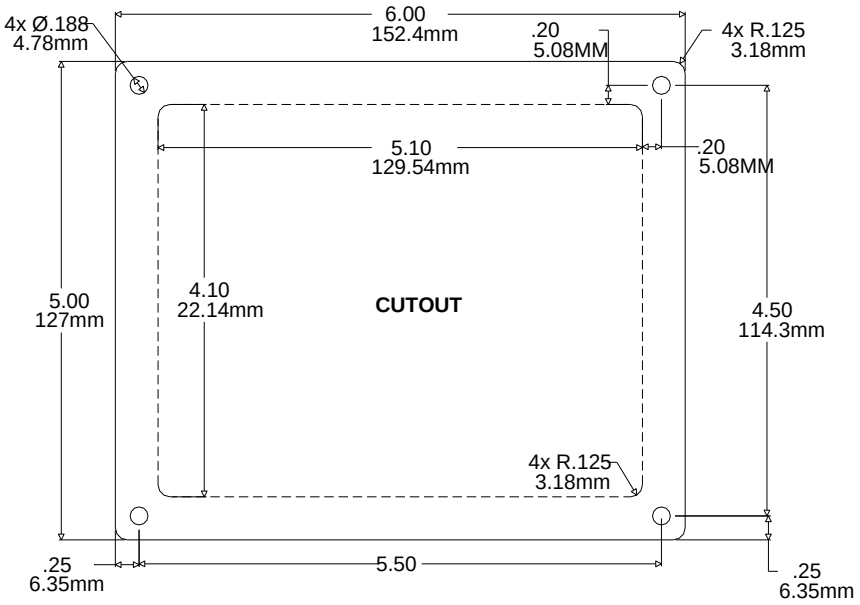


Figure 6-6: DP10 Display Cutout and Mounting Dimensions



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 system is equipped with Ultracapacitors or battery storage bank and M3460D diode module, the power supply will provide the DC voltage needed to complete pre-charge.

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.

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

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

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:

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

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

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

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

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

The equivalent Esr of the string is given by

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

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

The total extraction losses of the string is given by

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

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

Now the total required energy can be compared.

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

$$150\mathrm{kJ} + 9\mathrm{kJ} < 175kJ$$

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 7.3.1. 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.

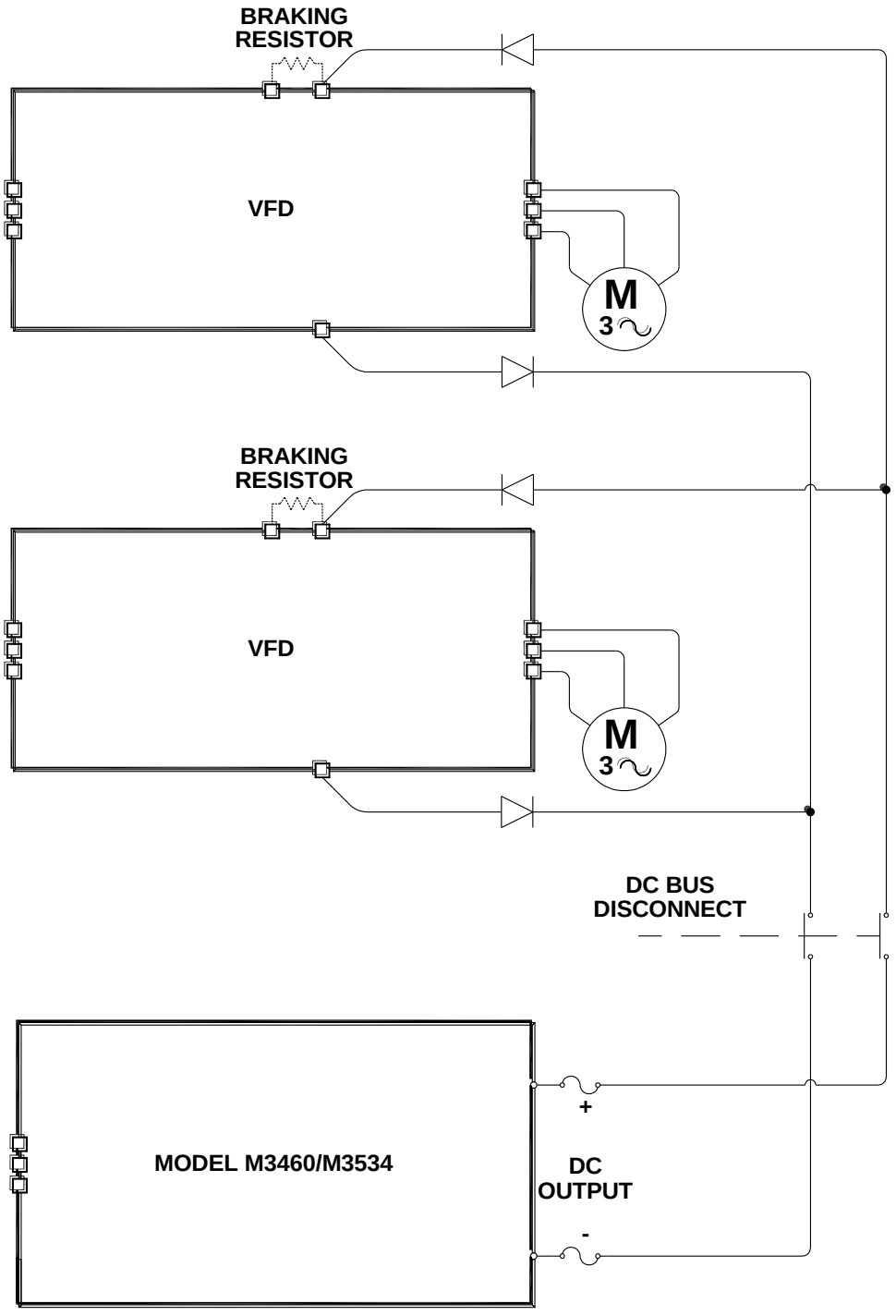
For Ride-Thru applications, the energy is allowed to pass from the M3460 to the drives, but is blocked from the drives to the M3460. Figure 7-1 is a block diagram of a diode sharing example.

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.

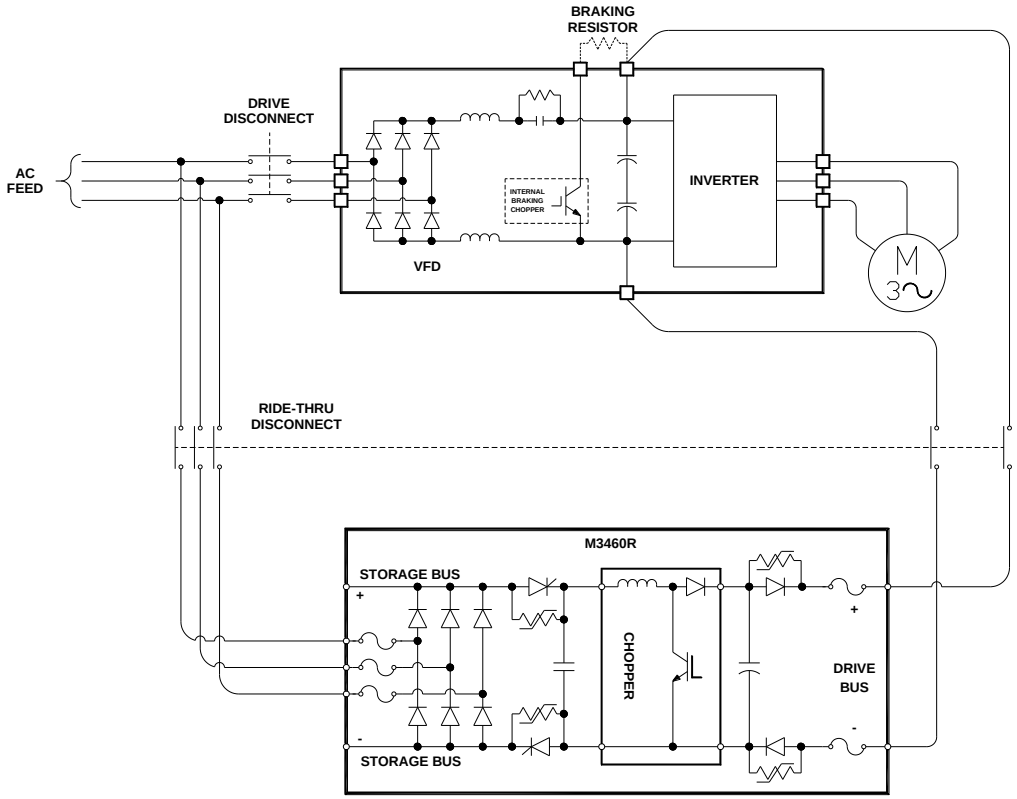
Figure 7-1: Diode Sharing Example



7.4. SAG ONLY INSTALLATIONS & CIRCULATING CURRENTS

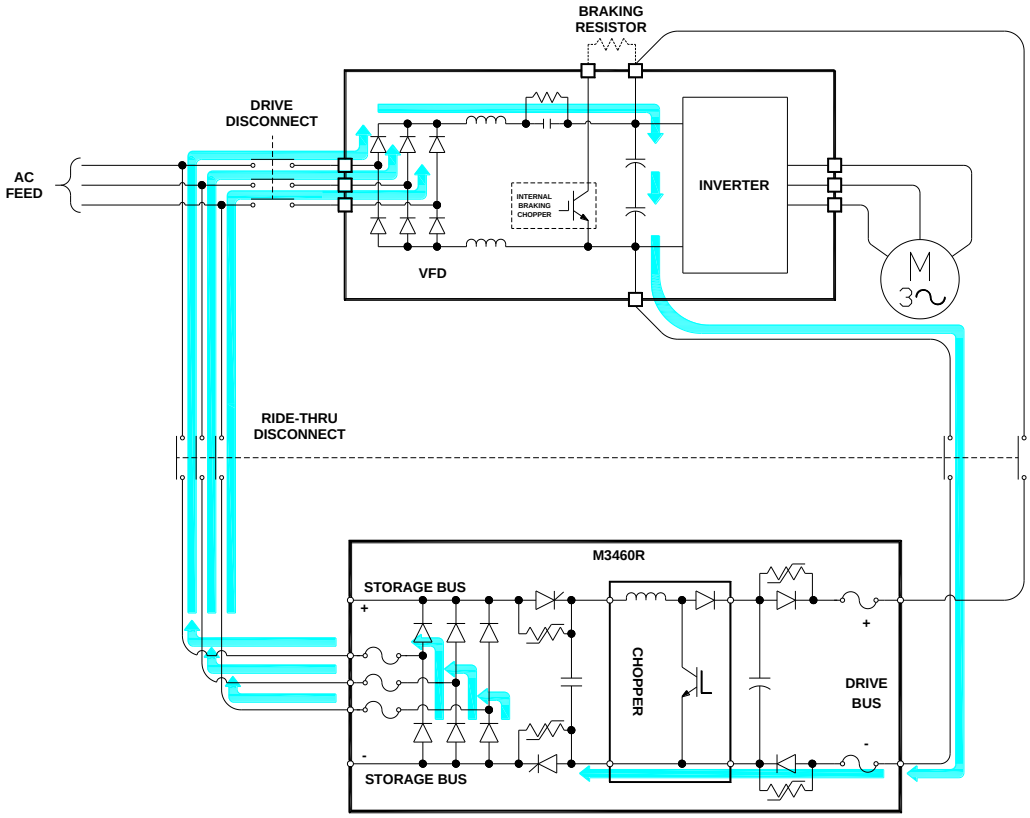
The topology of the M3460R voltage boost module incorporates a six diode full wave three phase rectifier bridge. When the M3460R is connected to the DC bus of the variable frequency drive, the input rectifier bridge of the variable frequency drive is in parallel with the M3460R input rectifier bridge. 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



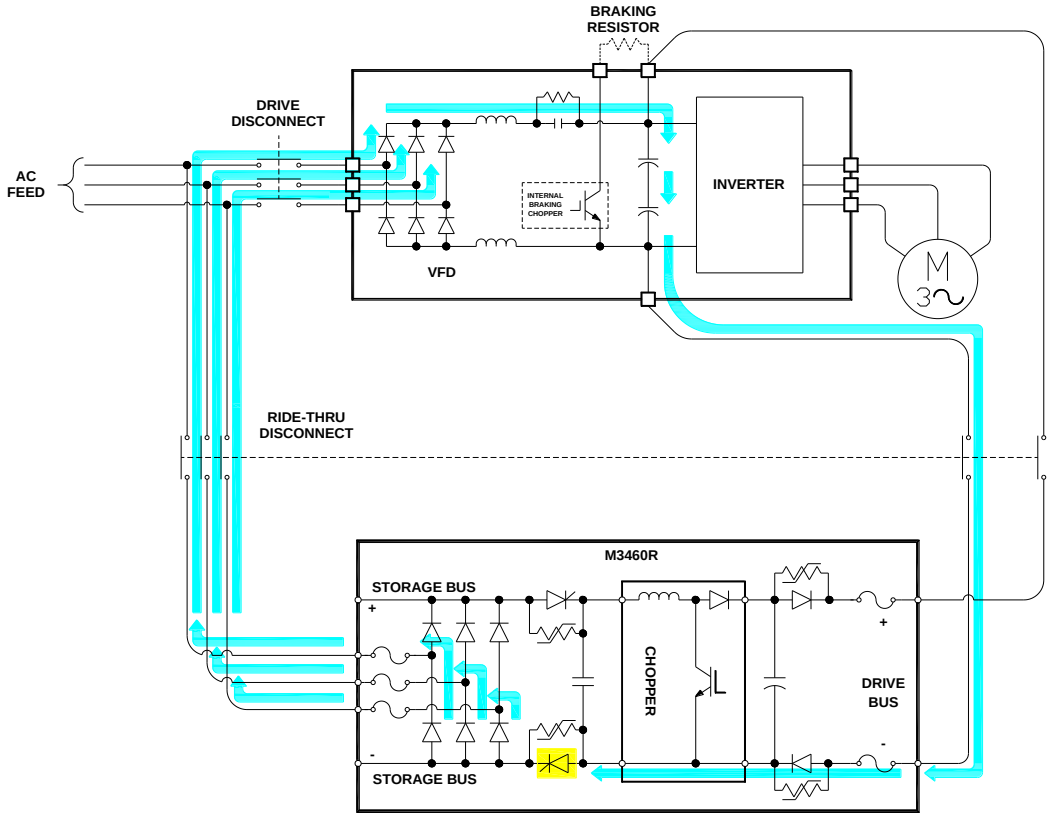
The current will follow the path with the least resistance, this can cause “circulation currents”, or currents that may enter the DC bus of the M3460R through one bridge and return to the AC source through the other bridge.

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.

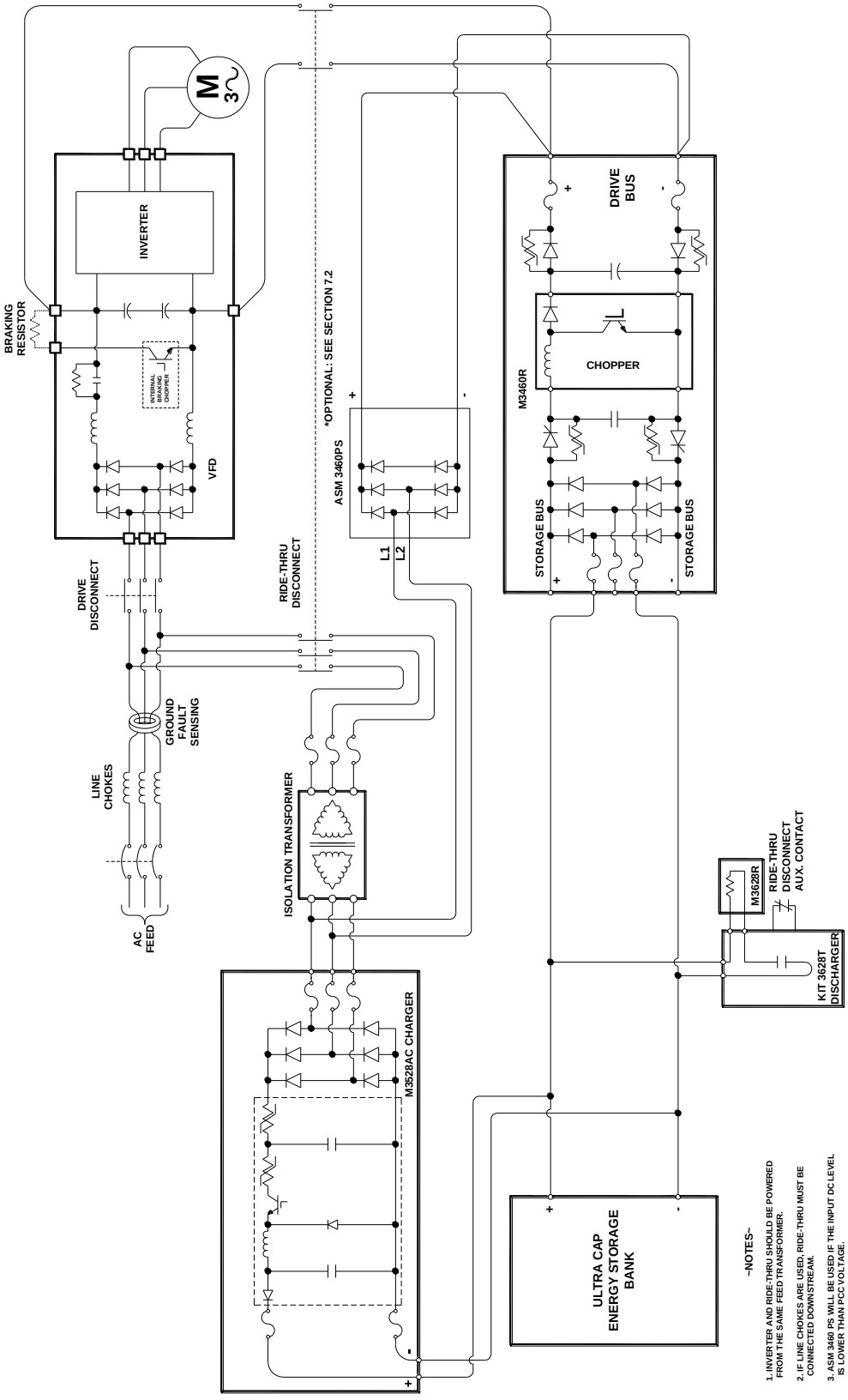
Figure 7-3: M3460R Typical Configuration with Current Flow with affected SCR Highlighted



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



NOTES

This page intentionally left blank

This page intentionally left blank

521 Fairground Court ● Nashville, TN 37211 ● USA
Tel: (615) 244-2825 ● Fax: (615) 244-2833 ● Web: www.bonitron.com ● Email: info@bonitron.com