
# Model M3460R

## Ride-Thru
## 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.

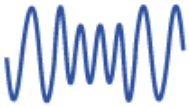
The Bonitron engineering team has the background and expertise necessary to design, develop, and manufacture the quality industrial electronic systems demanded in today's market. A strong academic background supported by continuing education is complemented by many years of hands-on field experience.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

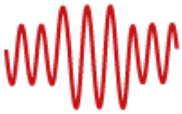
In 1975, Bonitron began working with AC inverter drive specialists at synthetic fiber plants to develop speed control systems that could be interfaced with their plant process computers. Ever since, Bonitron has developed AC drive options that solve application issues associated with modern AC variable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

**Power Quality Solutions**
12 and 18 Pulse Kits
Filtering
Noise and Transient Suppression
Power Factor Correction



**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 Sharing Diodes
Isolation Diodes
Bus Filter Capacitance

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

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

# 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 M3460R 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 VERSION

Rev 5 covers the M3460R Ride-Thru Voltage Regulator open chassis units only. The 3460 Cabinets are covered by a separate manual.
Rev 5a has minor formatting changes.
Jumper configurations were updated in Rev 5b.
Display Options were updated in Rev 05c.

**Figure 1-1: M3460R in the R11 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 M3460R Ride-Thru Voltage Regulator provides 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.

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 M3460R 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
- M3460R maintenance can be done while normal process is on-line
- Internal redundancy
- Easy retrofit installation
- Works with almost any fixed bus, variable frequency, PWM drive
- Only 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.

**M3460B SERIES RIDE-THRU MODULES**

Voltage regulators used to regulate battery storage banks for 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.

**M3628 ULTRACAPACITOR SAFETY DISCHARGERS**

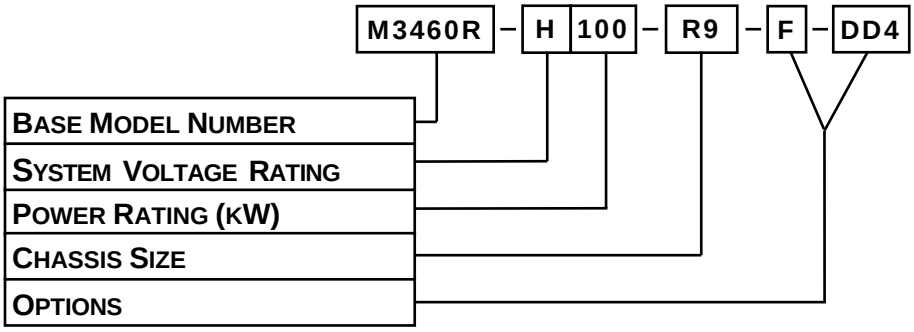
Automatic discharge for large capacitor storage banks for safety and quick maintenance entry.

### 2.1.2. OTHER REFERENCE MANUALS

Please refer to the ASM 3660DD4 manual when this unit is equipped with the Digital Display option. This manual is available from the Bonitron website, 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.**

**SYSTEM VOLTAGE RATING**

The M3460R is available in several input voltage ratings. This rating is indicated by a code number as shown in Table 2-1.

**Table 2-1: System Voltage Rating Codes**

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

**POWER RATING (KW)**

The Power Rating indicates the maximum power in kilowatts that can safely be handled by the M3460R and is represented by a 3-digit value based on the nominal DC system voltage rating and the maximum output current rating of the M3460R. For instance, the rating code for a 100kW M3460R is **100**.

**CHASSIS SIZE**

Three open-backplate chassis sizes are indicated by a code as shown in Table 2-2. This chassis size is determined by the power capacity of the unit.

**Table 2-2: Chassis Size Codes**

| CHASSIS SIZE CODE | DIMENSIONS (H X W X D) | DESCRIPTION |
|---|---|---|
| R10 | 28” x 16” x 14” | 2-stage (85 - 127A) |
| R9 | 34” x 16” x 14” | 4-stage (170A) |
| R11 | 44” x 16” x 14” | 4-stage (255 - 425A) |

**OPTIONS**

Options are indicated by codes as shown in Table 2-3 and are separated by a dash as shown in Figure 2-1. Option codes are omitted if not required.

**Table 2-3: Option Codes**

| OPTION CODE | DESCRIPTION |
|---|---|
| F | Integral Fusing (standard) |
| DP17 | Analog Metering and Event Counter |
| DP10 | Event Counter with Diagnostic indicators |
| DD4 | Digital Display and Diagnostic Panel |

## 2.3. GENERAL SPECIFICATIONS

**Table 2-4: General Specifications**

| PARAMETER | SPECIFICATION | |
|---|---|---|
| Input AC Voltage | 208 – 480 VAC | |
| Input DC Voltage | 200 – 650 VDC | |
| Output DC Voltage | 265 – 650 VDC | |
| DC Bus Current Rating | 85 – 425 ADC | |
| Power Rating | 25 – 250kW | |
| 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 | |
| Logic I/O | Inputs - 24VDC<br>• Enable/Disable<br>• Test | Outputs<br>• Ride-Thru Ready (RTR)<br>• Overtemperature (OT)<br>• Voltage Fault (VF)<br>• Precharge Complete (PCC)<br>• Ride-Thru Active (RTA)<br>• Input Undervoltage (IUV) |

## 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.**
- **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 M3460R 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 M3460R should not exceed 40°C. Temperatures above this can cause overheating during operation.

The standby heat production of the M3460R is quite low, but can generate significant heat during boosting. This is of little concern, as the 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 for damage.

Inspect the M3460R for shipping damage.

Check all equipment for shipping damage, broken terminals, loose screws, loose or missing IC's, unseated connectors, etc.

Notify the shipping carrier if damage is found.

## 3.3. MOUNTING

Mounting dimensions can be found in Section 6.

1. Remove the display panel from the M3460R, if applicable.
2. Unplug the wire harness from the M3460R to make display harness installation easier. The display panel can be installed later.
3. Lift M3460R backplate off of crate bottom using the 4 handles. Eyebolts may be installed in the mounting holes for lifting with hooks or chains.
4. Install the module to the backplate. Secure the M3460R backplate to the rack using the backplate's ½" diameter mounting holes. Mounting hardware is not supplied with the M3460R. The power input terminals will be at the top of the installation.
5. If supplied, install the display panel in an appropriate location. The analog display panel is provided with an 8 foot long interconnect harness. Take this into consideration when selecting the installation site.

## 3.4. WIRING AND USER CONNECTIONS

Review this entire section before attempting to wire the M3460R.

**CAUTION!**

***WIRING OF THIS PRODUCT SHOULD ONLY BE PERFORMED BY A QUALIFIED ELECTRICIAN IN ACCORDANCE WITH NATIONAL ELECTRICAL CODE OR LOCAL CODES AND REGULATIONS.***

### 3.4.1. POWER WIRING

**DANGER!**

***THE M3460R 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 M3460R. 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: Power Wiring Connections**

| TERMINAL DESIGNATION | FUNCTION | WIRING SPECIFICATION | CONNECTION | TORQUE |
|---|---|---|---|---|
| L1, L2, L3 | AC Input | 600VAC | 3/8" stud | 150 lb-in |
| DRIVE (+,-) | DC Output | 600VAC | 3/8" stud | 150 lb-in |
| ⏚ | Ground | 600VAC | 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.

These units can provide high surge 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 INPUT CONNECTIONS (L1, L2, L3)

The AC input to the M3460R can temporarily reach up to 200% of the normal input current for up to 2 seconds 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 up to twice 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 IR 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.

### 3.4.1.2. DC BUS INPUT CONNECTIONS

If a storage module is used (such as ultracapacitors), the input from this module can be attached directly to the diode bus bars as shown in Figure 3-1. Make sure the polarity is correct for the connection, 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. DC BUS OUTPUT CONNECTIONS (DRIVE +, DRIVE-)

The attached drives 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 M3460R 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 the connection, failure to do so can cause severe damage to the system.

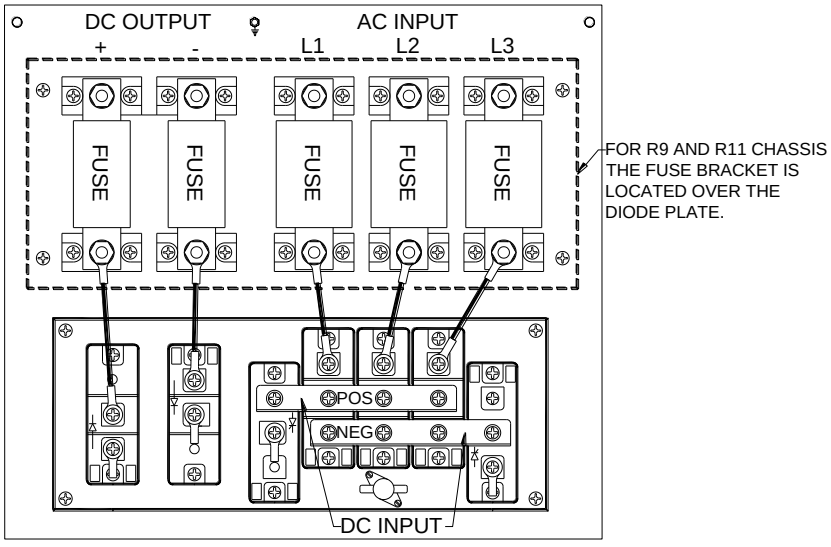
**DANGER!**

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

**Figure 3-1: Typical M3460R Connections**



## 3.4.2. CONTROL INTERFACE AND I/O WIRING

Control wiring allows for remote enabling, testing, and monitoring of the M3460R. 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

**Figure 3-2: M3460R Board Locations**

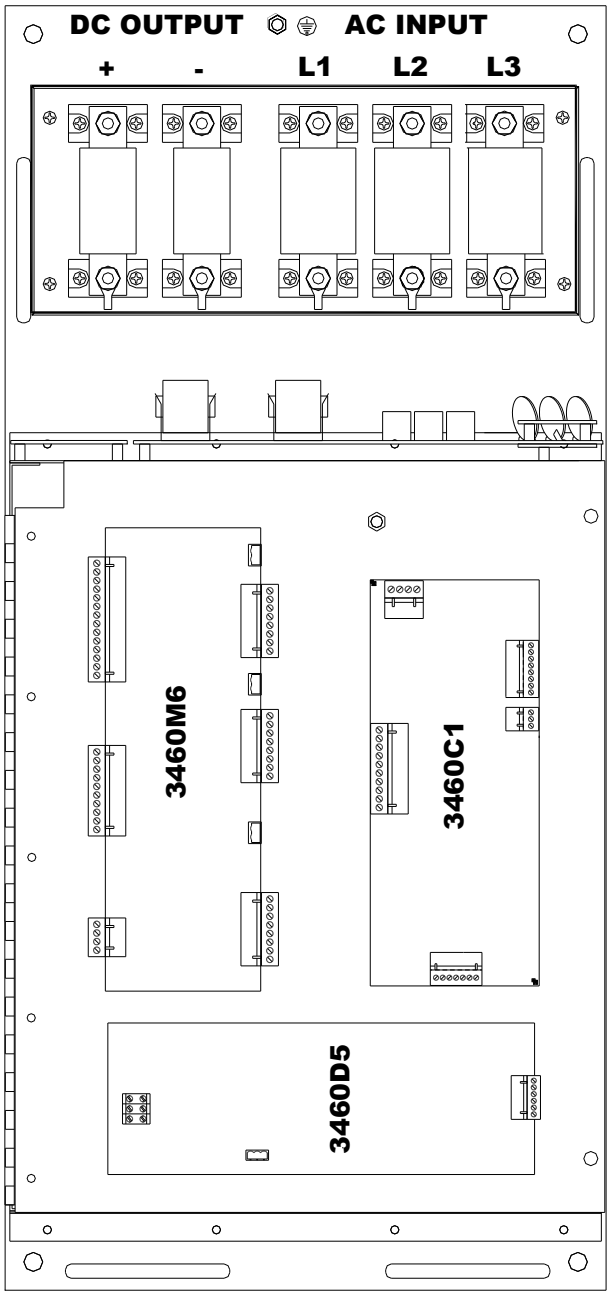


**Figure 3-3: 3460M6 Basic Interface Schematic**

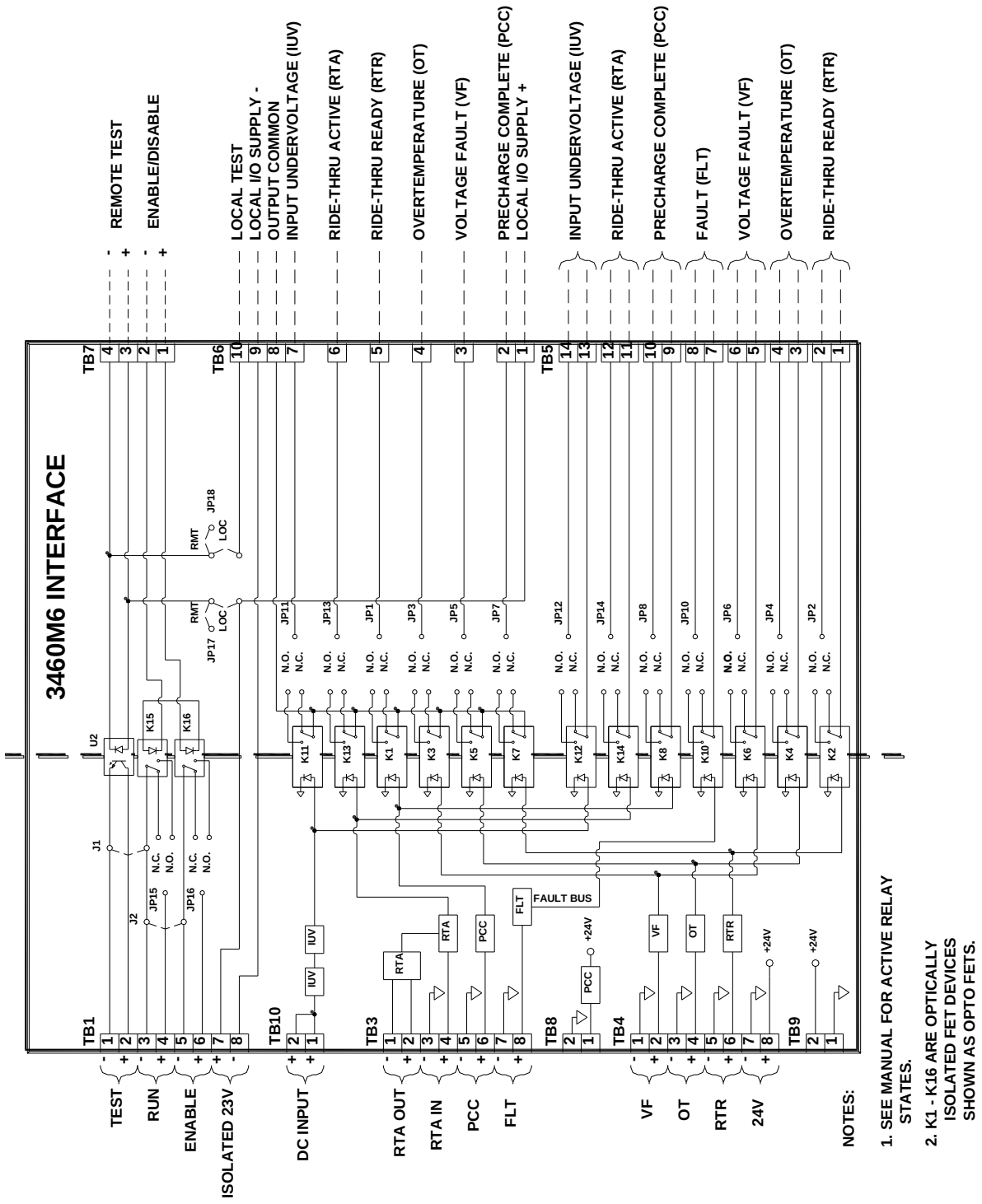


**Table 3-2: User I/O Connections with 3460M6 Board**

| TERMINAL | FUNCTION | ELECTRICAL SPECIFICATIONS | MIN WIRE | MAX WIRE | TORQUE |
|---|---|---|---|---|---|
| **INPUTS** | | | | | |
| TB7 - 1 | Enable/Disable Input + | 24VDC, 20mA | 16 | 12 | 4.5 lb-in |
| TB7 - 2 | Enable/Disable Input - | | | | |
| TB7 - 3 | Remote Test Input + | | | | |
| TB7 - 4 | Remote Test Input - | | | | |
| TB6 - 10 | Local 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 + | 24VDC, 500mA | 16 | 12 | 4.5 lb-in |
| TB6 - 9 | Local I/O Supply - | | | | |
| TB6 - 2 | Precharge Complete (PCC) | 250V / 120mA | | | |
| 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 ANALOG DISPLAY

When the M3460R is ordered with an analog display (DP10 or DP17), the interconnections are prewired with a harness and the power and control signals for the 3660D1 board come through the TB6 terminals on the 3460M6 board.

When the DP17 analog display is used, there is an extra interface board installed that allows the analog meters to show the current and voltages. This board is marked 3534I2.

The base I/O connections are still available on the 3460M6 board.

**Figure 3-4: 3534I2 Interface Board Location**

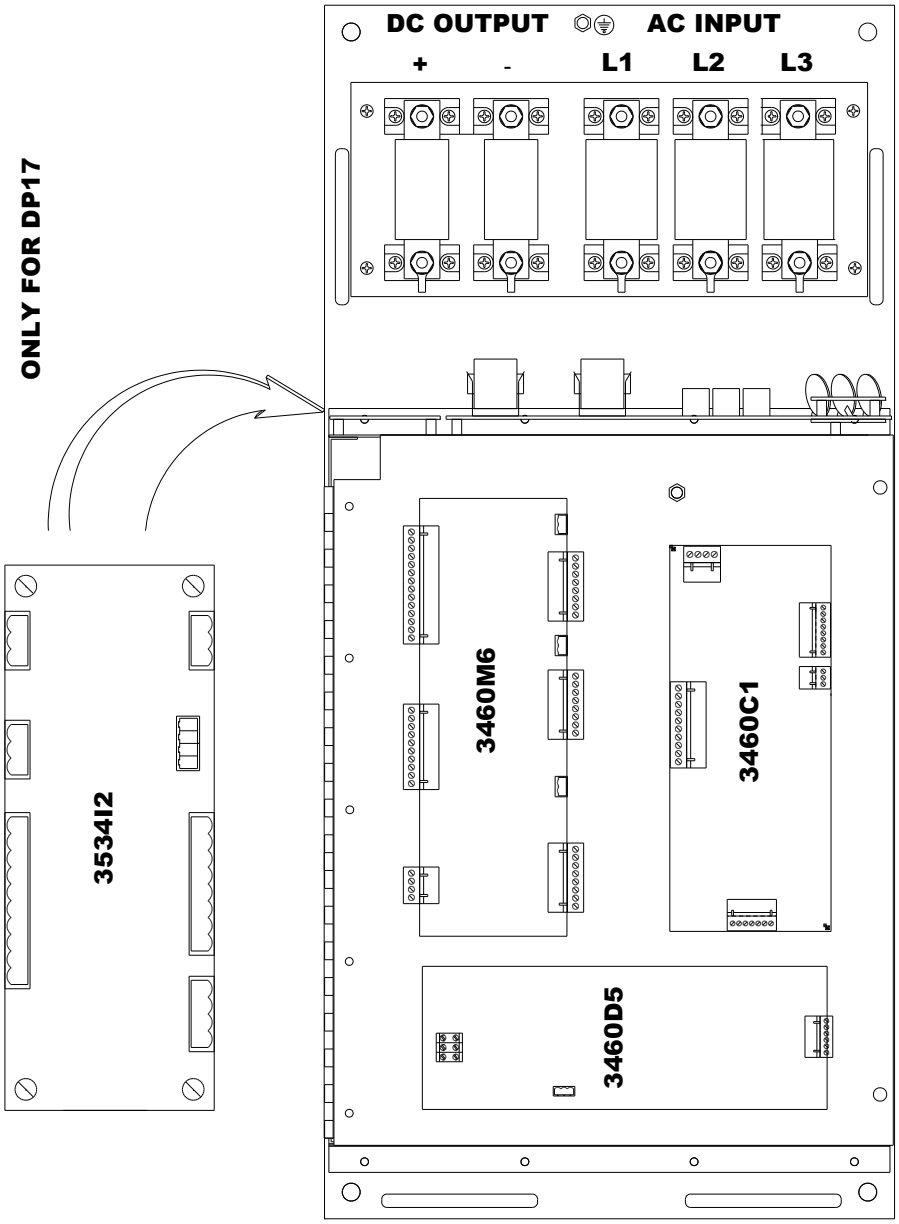


**Figure 3-5: M3460R Interconnections with DP17**

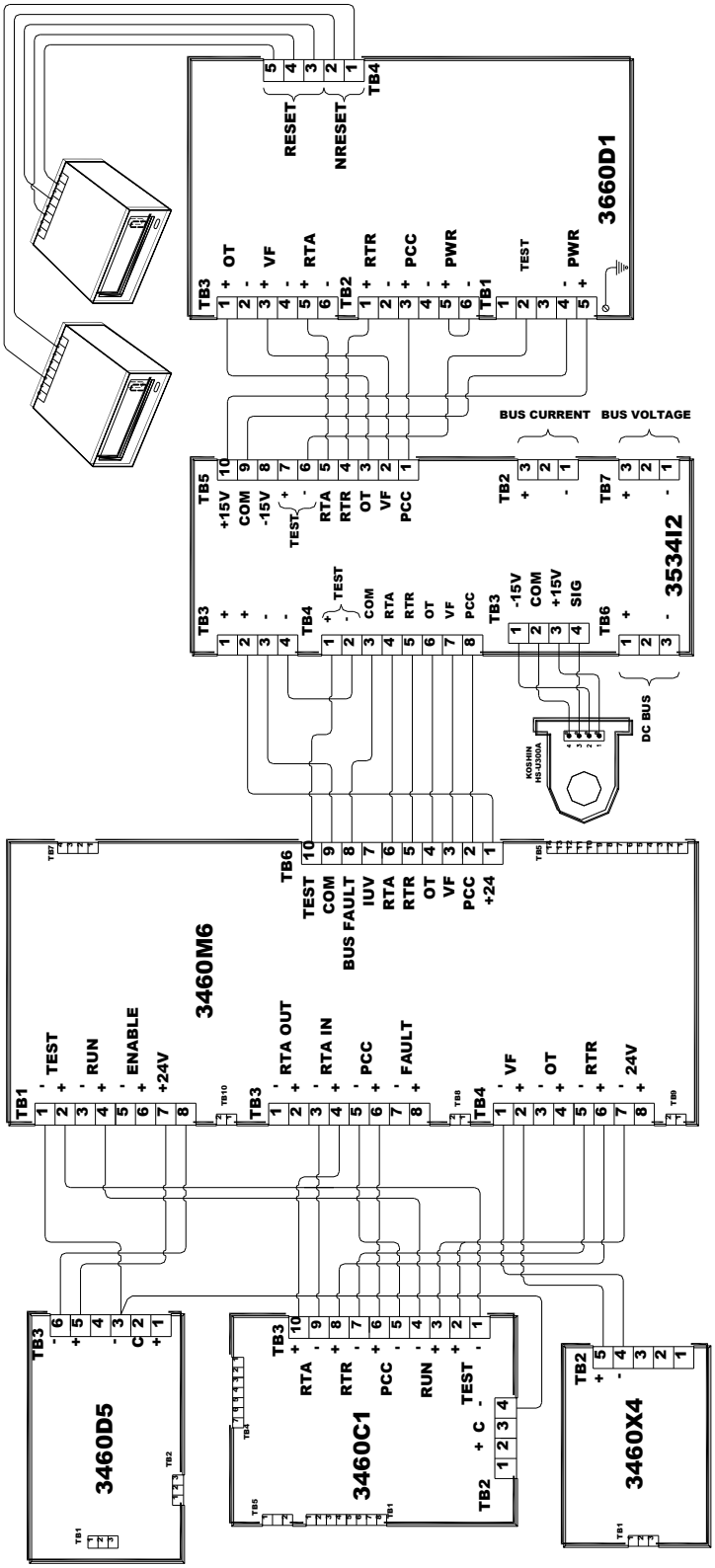
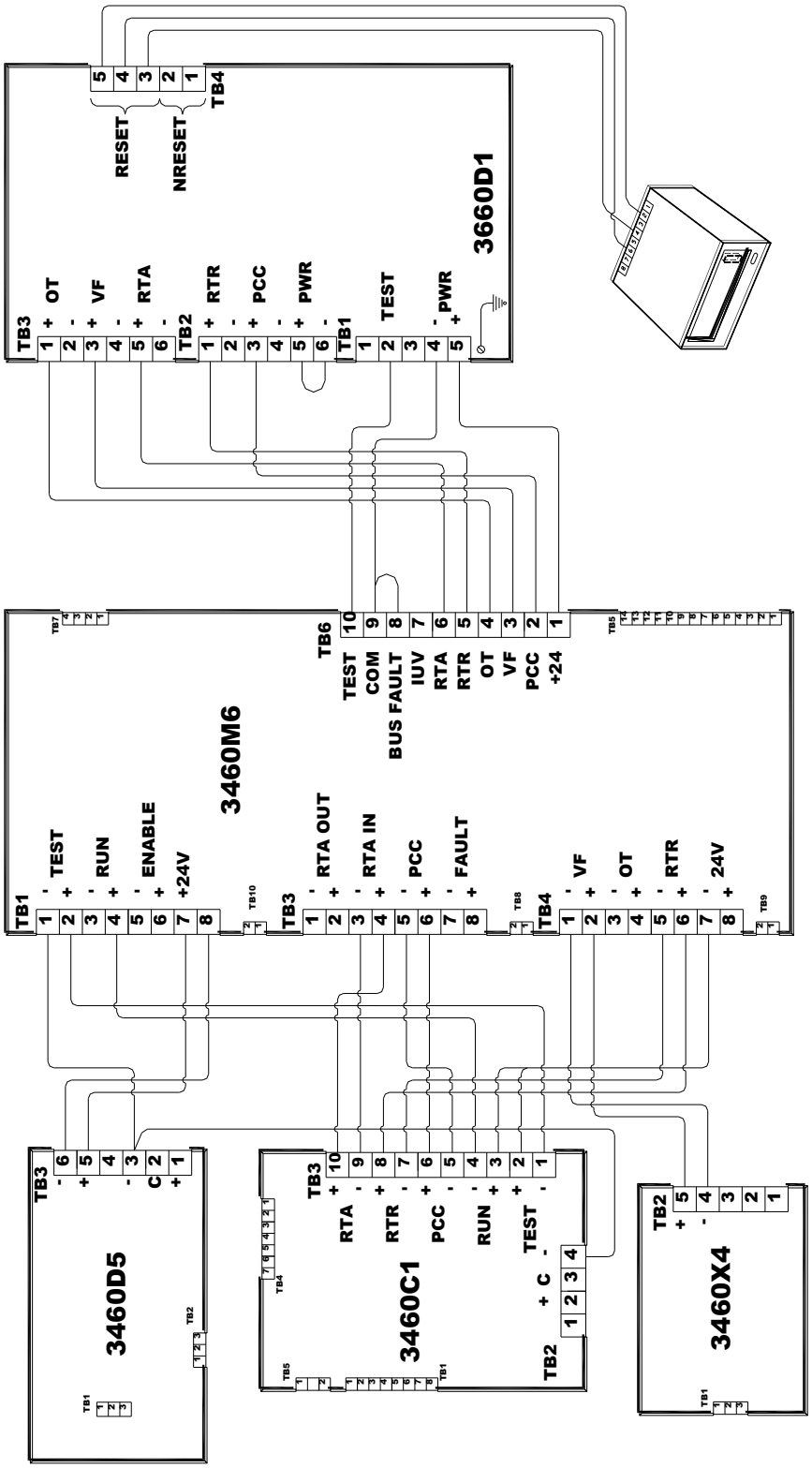


**Figure 3-6: M3460R Interconnections with DP10**



### 3.4.2.3. CONNECTIONS WITH DIGITAL DISPLAY

When the ASM 3660DD4 digital display is used, some user connections to the digital display interface are made on a different module than the M3460R. They are made to the 3660I3 interface module. When the M3460R is ordered with the digital display, the interconnections between the M3460R and the interface module are prewired with a harness.

The ASM 3660DD4 digital display monitors and controls operation of the system through the TB6 and TB7 terminals on the 3460M6 board. The power supply at TB9 of the 3460M6 board is used to power the digital display. The ASM 3660DD4 supply should not be connected to earth ground.

Refer to the ASM 3660DD4 manual for operational and functional details.

**Table 3-3: User I/O Connections with ASM 3660DD4**

| TERMINAL | FUNCTION | ELECTRICAL SPECIFICATIONS | MIN WIRE | MAX WIRE | TORQUE |
|---|---|---|---|---|---|
| **STATUS OUTPUTS** | | | | | |
| TB9 - 1 | Output COM | 250V, 170 mA | 16 | 12 | 4.5 lb-in |
| TB9 - 2 | Ride-Thru Active (RTA) | | | | |
| TB9 - 3 | Fault 2 | | | | |
| TB9 - 4 | Fault 1 | | | | |
| TB9 - 5 | Spare 2 | | | | |
| TB9 - 6 | Spare 1 | | | | |
| **CONTROL INPUTS** | | | | | |
| TB10 - 1 | Local I/O Supply - | 24VDC, 125mA | 16 | 12 | 4.5 lb-in |
| TB10 - 8 | Local I/O Supply + | | | | |
| TB10 - 2 | Input COM | 24VDC, 10mA | | | |
| TB10 - 3 | Spare | | | | |
| TB10 - 4 | Ride-Thru Test | | | | |
| TB10 - 5 | Ride-Thru Enable | | | | |
| TB10 - 6 | Charger Equalize | | | | |
| TB10 - 7 | Charger Enable | | | | |

**Figure 3-7: 3660I3 Board Layout**

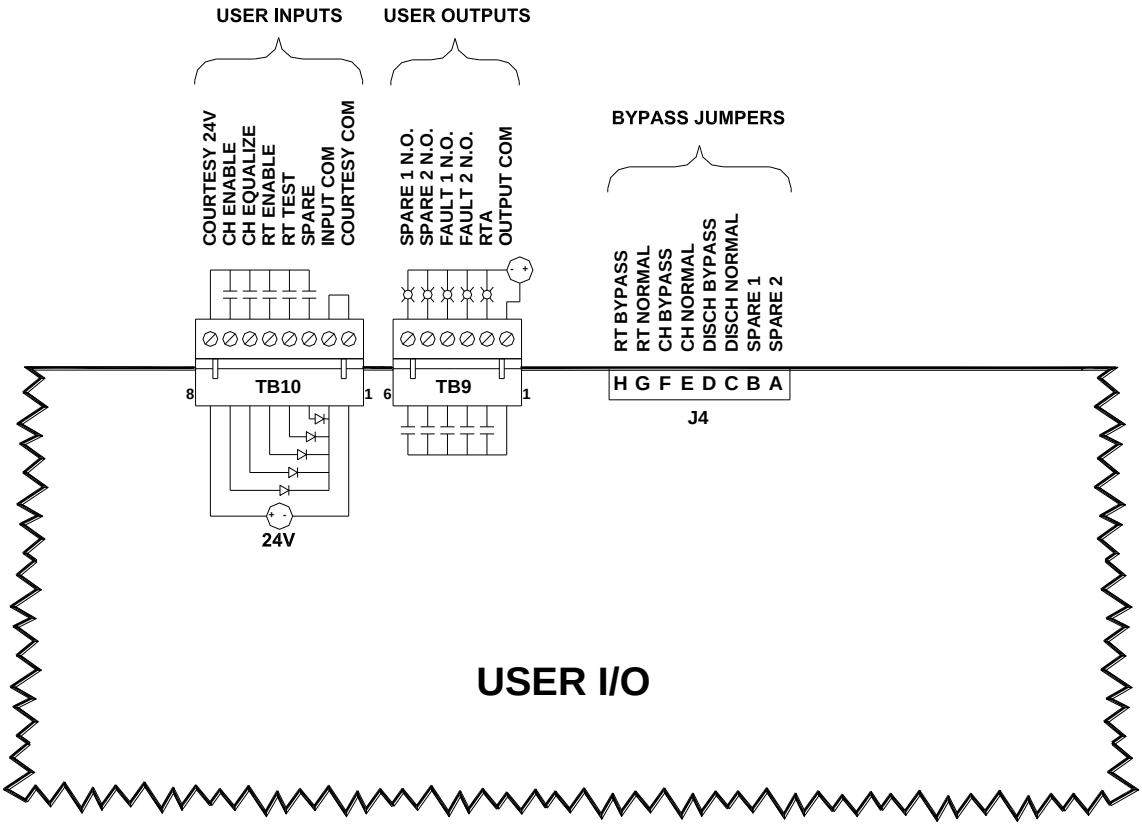


**Figure 3-8: M3460R Connections with 3660I3 Board**

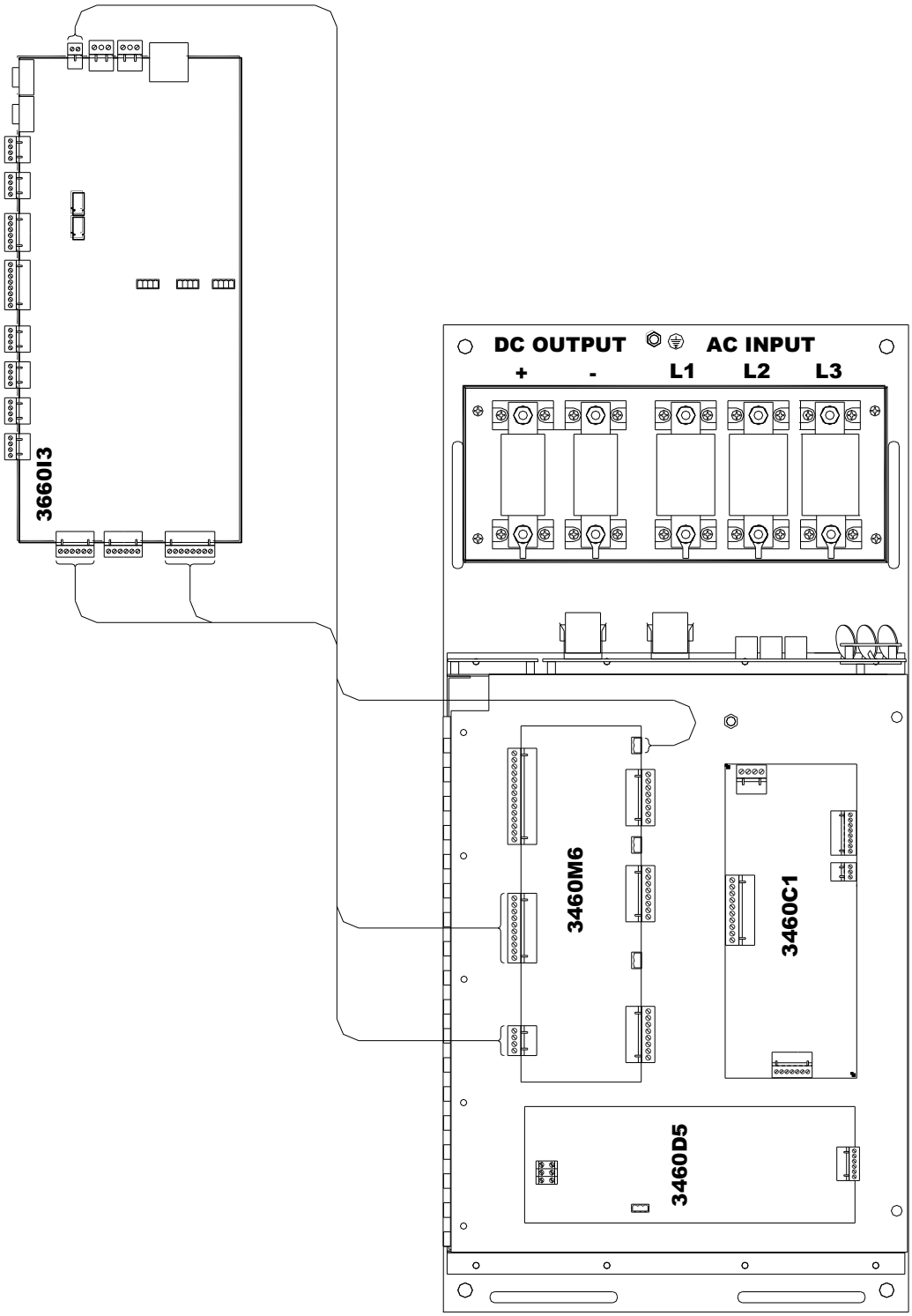
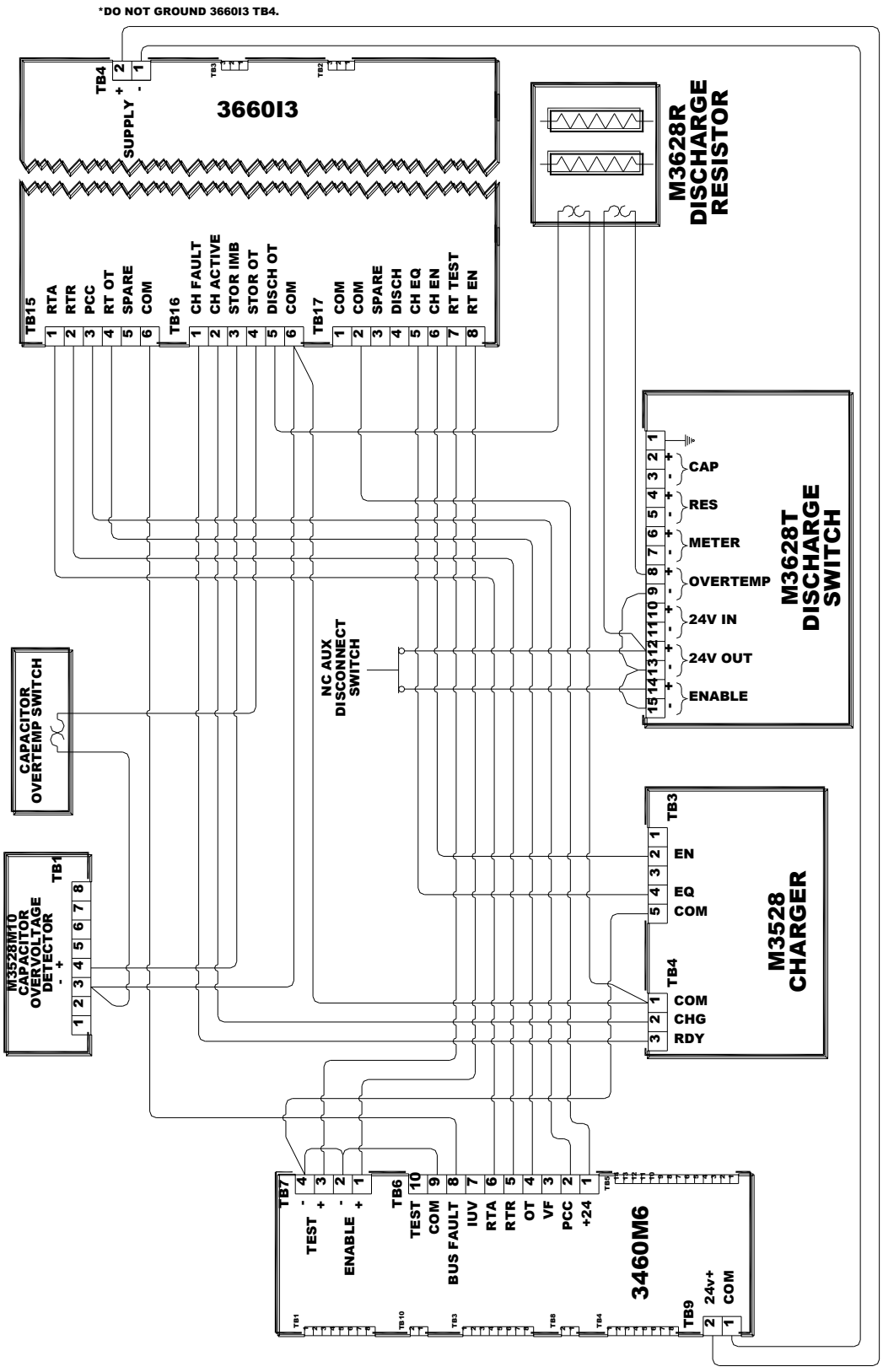


**Figure 3-9: M3460R Interconnections with DD4**



## 3.5. TYPICAL CONFIGURATIONS

**Figure 3-10: M3460R Typical Configuration without Energy Storage**

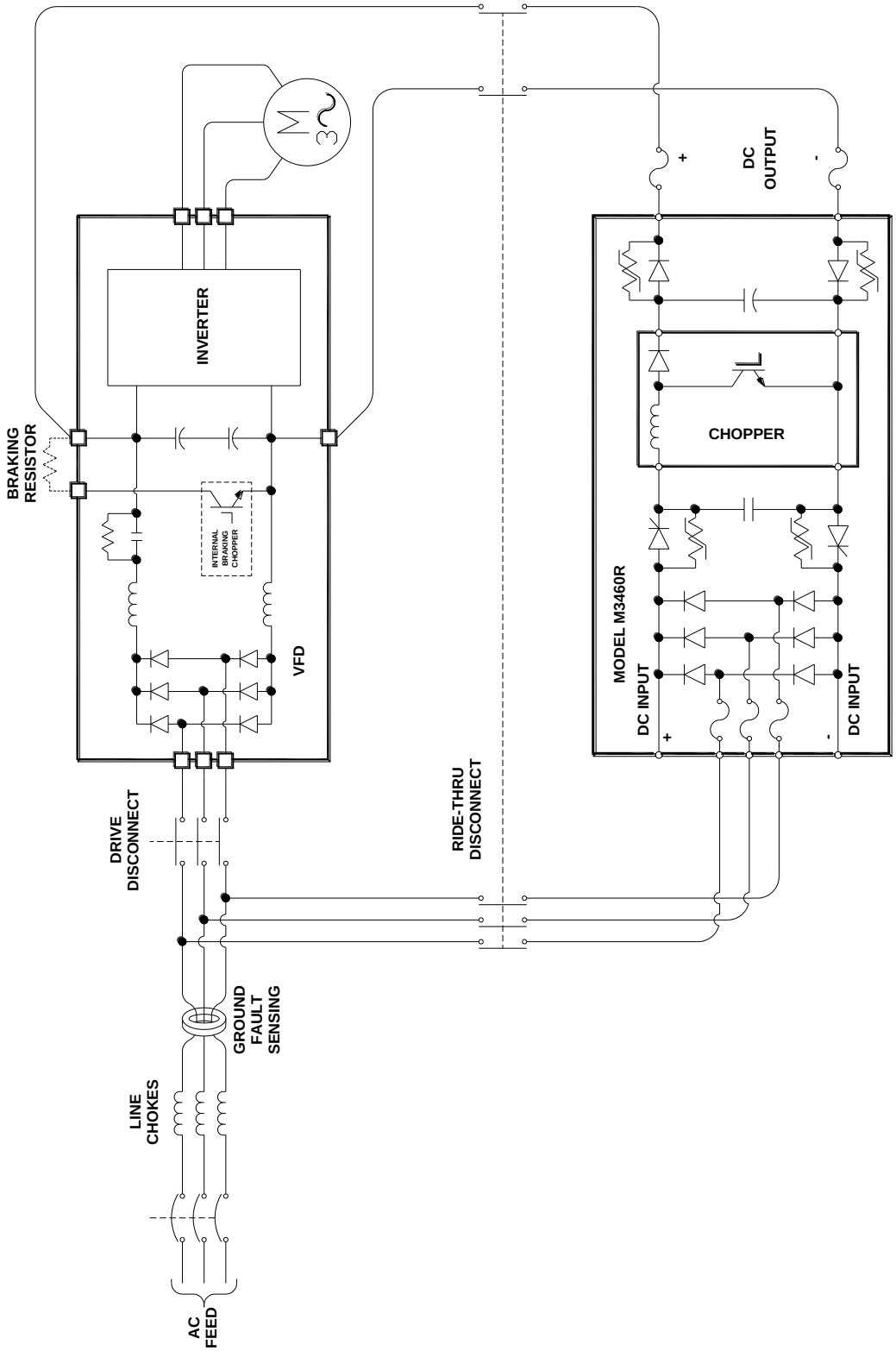


**Figure 3-11: M3460R Typical Configuration with Electrolytic Capacitor Storage Bank**

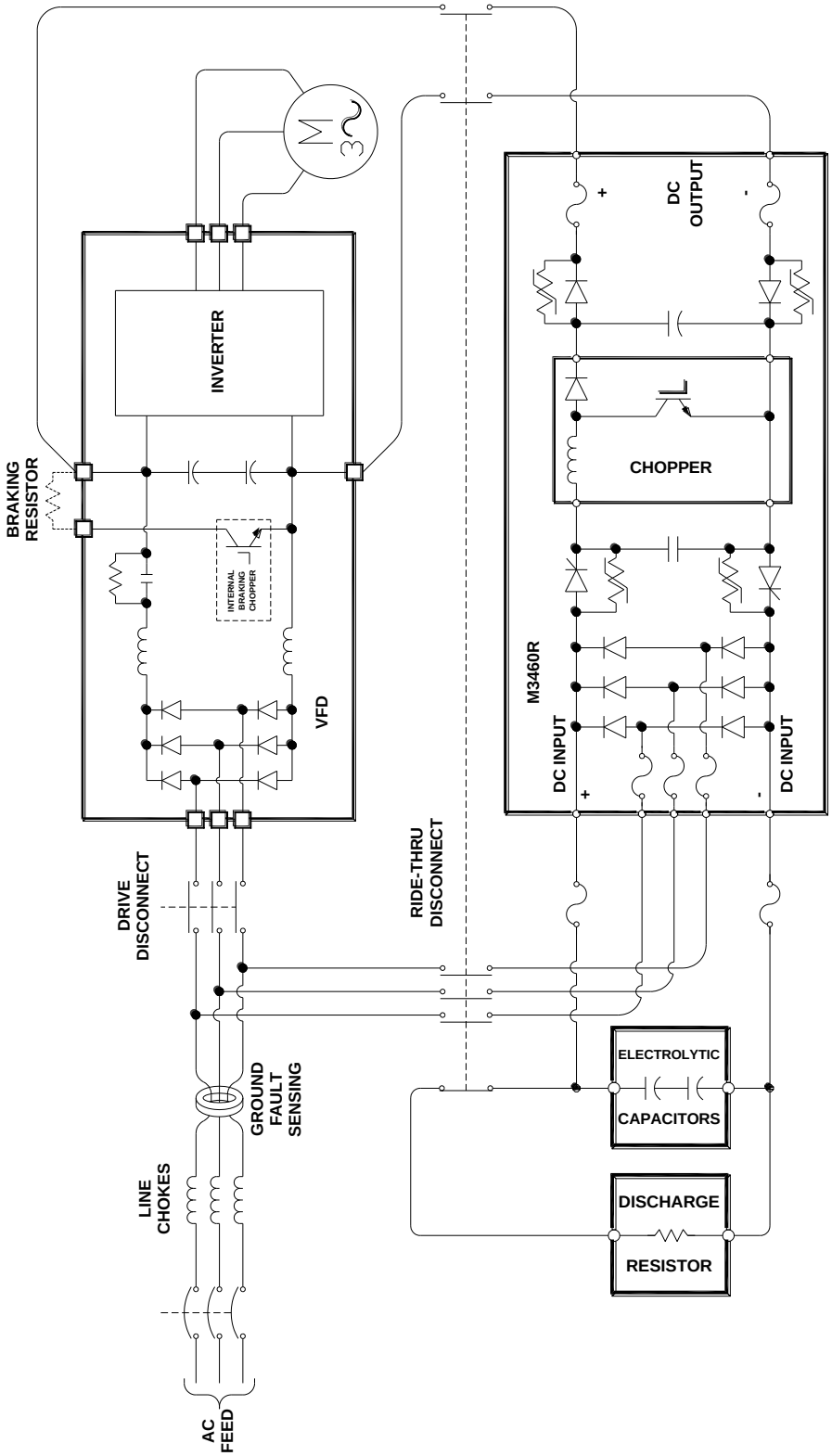
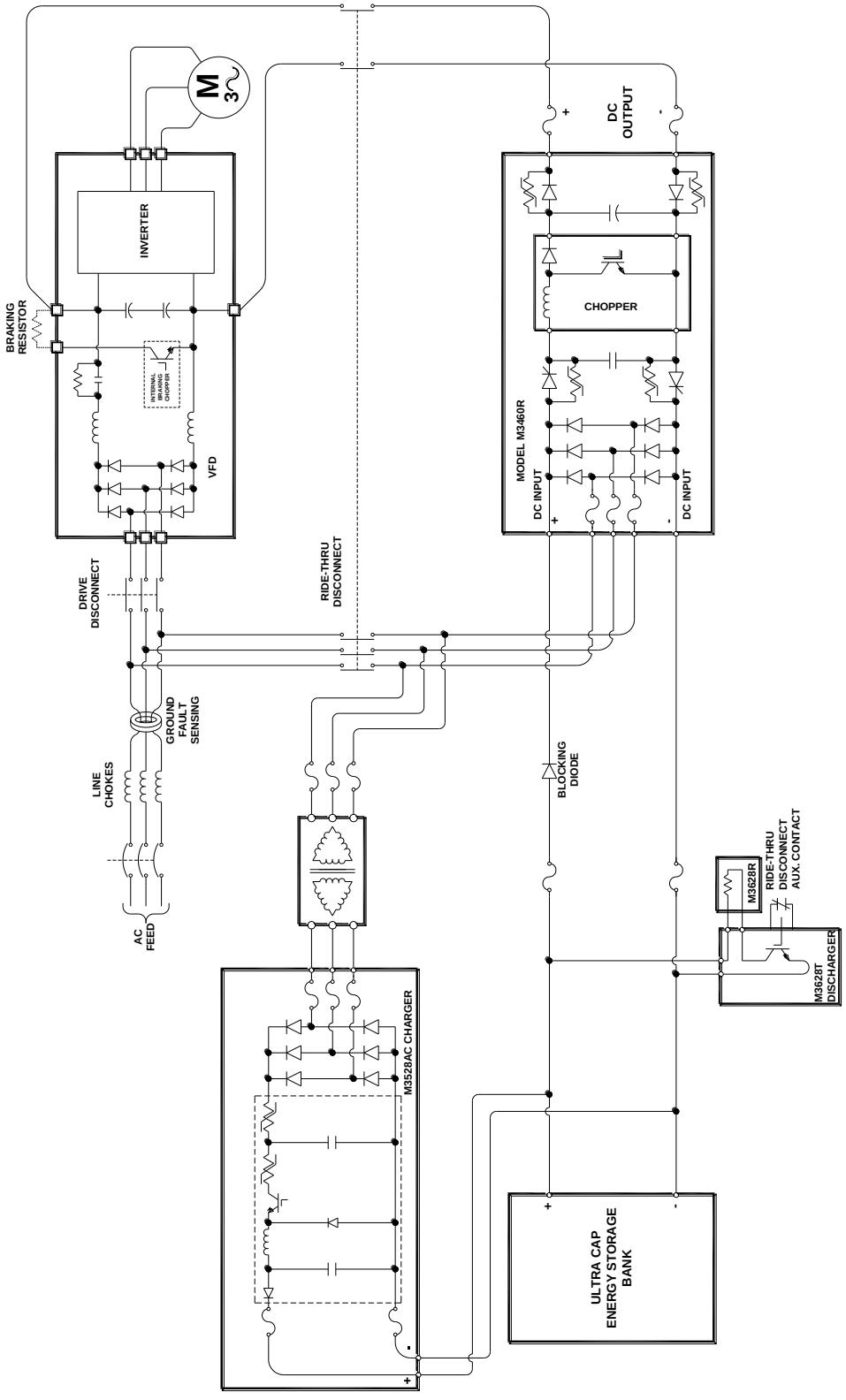


**Figure 3-12: M3460R Typical Configuration with Ultracapacitor Storage Bank**



# 4. OPERATION

## 4.1. FUNCTIONAL DESCRIPTION

The M3460R 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 M3460R, power is delivered through blocking diodes to hold up the voltage in the VFD bus. The M3460R regulates and boosts the input voltage to the drive at a constant voltage.

In standby mode, when the incoming AC power is normal, the M3460R power consumption is minimal.

## 4.2. 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.

When a storage bank is used, the M3460R will power the DC bus from the AC line until it drops below the storage bank voltage. At this point, power will be drawn from the storage bank until the M3460R reaches its input current limit.

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 M3460R does not have charging capabilities. The capacitor bank must also have a blocking diode in the DC link to allow for proper charging of the capacitor bank.

Refer to Section 7 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 M3460R will monitor the output DC bus. When the output DC bus voltage goes below the DC bus threshold voltage, the M3460R 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 M3460R 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 M3460R to be tested during normal power conditions. In this mode, the M3460R adjusts the DC bus threshold above the normal DC bus threshold setpoint. This forces the M3460R 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 Basic Interface Schematic**

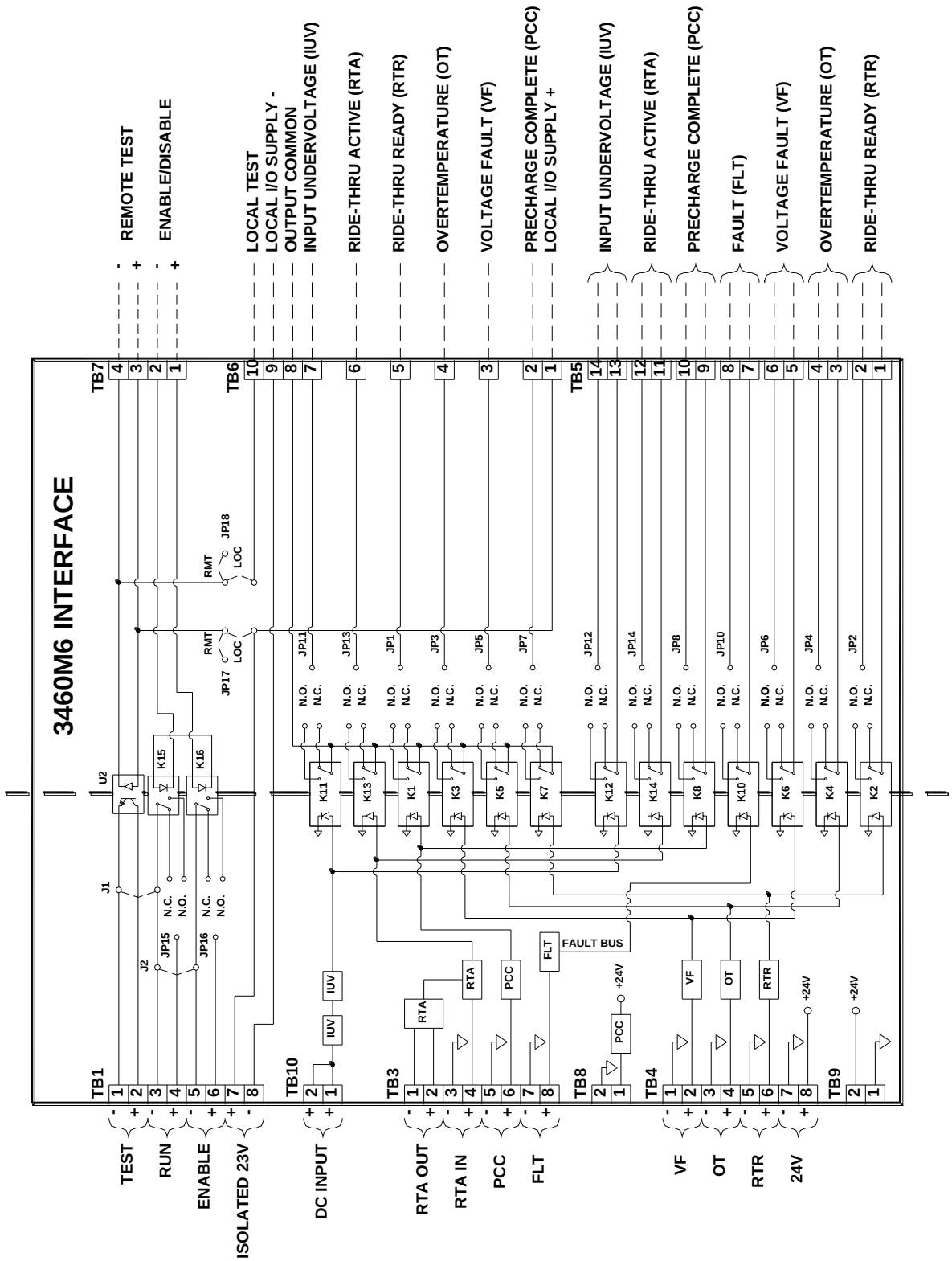


**Figure 4-2: 3460M6 Status Interface Board Layout**

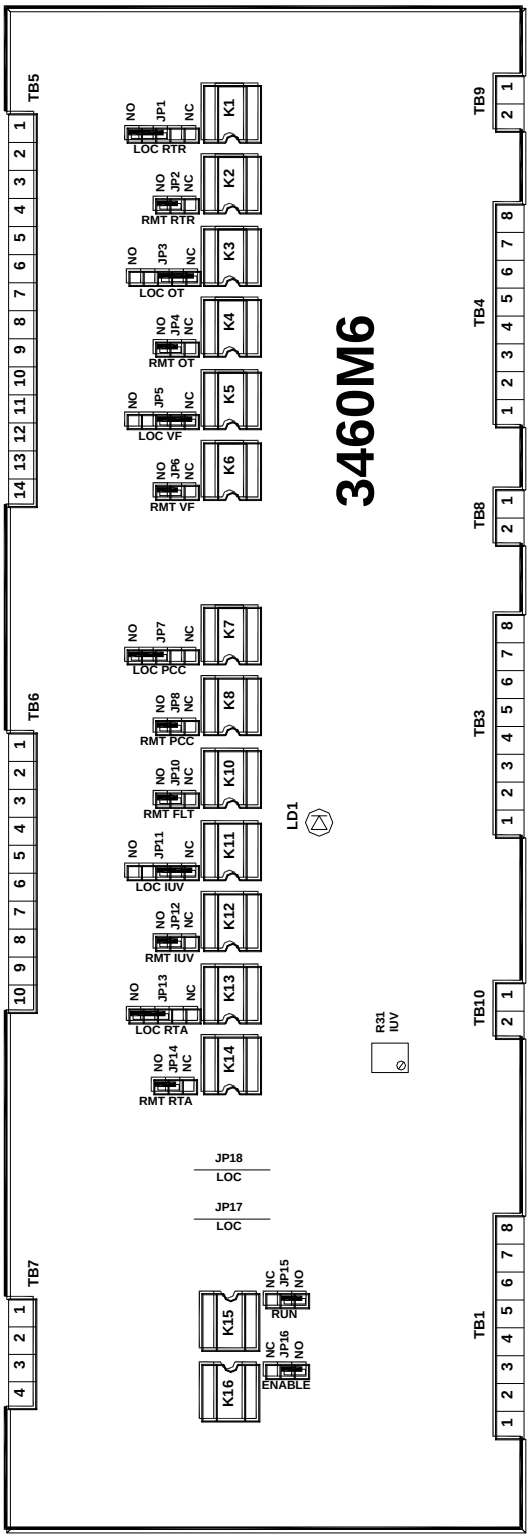


**Figure 4-3: 3460C1 Control Board Layout**

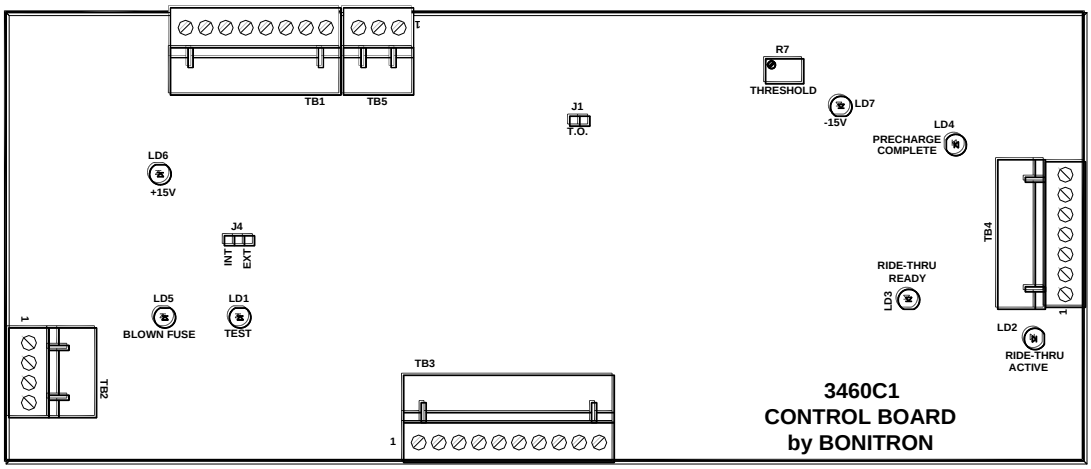
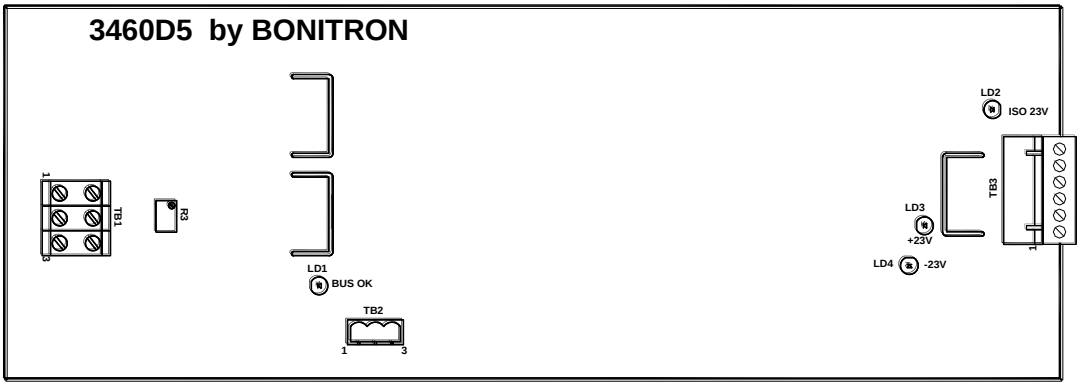



**Figure 4-4: 3460D5 Power Supply Board Layout**




## 4.4.1. INPUT TERMINALS – 3460M6 TB6, TB7

The input terminals are located on TB6 & 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 M3460R 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 M3460R will operate when 24VDC is applied to the input.

The input operation is set to "Disable" with JP15 set to "NC", and the M3460R 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.

The Overtemperature output status contact should be used to disable the M3460R.

The factory default setting is to have the internal power supply interlocked with the Overtemperature output status contact and 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 M3460R 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 - TB6 - 9, 10 & TB7 - 3, 4

The Test input is used to make the M3460R go into Test mode.

If JP17 and JP18 are installed, close a contact between TB6-9 and TB6-10 to force the M3460R into Test Mode.

If JP17 and JP18 are removed, connect 24V positive to TB7-3 and 24V common to TB7-4 to force the M3460R into Test Mode.

The Test function should only be connected on one set of terminals.

The default setting is to leave JP17 and JP18 installed.

**Table 4-2: 3460M6 Test Input Logic Jumper Details**

| JUMPERS | POSITION | FUNCTION | 3460M6 FIELD TERMINALS | FACTORY SETTING |
|---|---|---|---|---|
| JP17, JP18 | Installed | Internal 24V | TB6 - 9, 10 | Installed (Remote) |
| | Removed | External 24V | TB7 - 3, 4 | |

### 4.4.2. OUTPUT TERMINALS - 3460M6 TB5, TB6

The status of the M3460R 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 DP17 display panel, but is not restricted to that use.

All of 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 M3460R 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 within the M3460R is above 160°F . The contact will close again when the temperature goes below 140°F. This does not stop the M3460R from operating, and care must be taken so that the M3460R 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

This output opens when any phase from the input AC line is missing.

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 M3460R 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 M3460R is currently 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 come on when the unit is put into Test mode with the Test input.

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 M3460R 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 M3460R 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.

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

**Table 4-3: 3460M6 Status Output Signal Logic Jumper Details**

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

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

The I/O points for the M3460R can be supplied by the internal supply available on TB6-1, 9. TB6-1 supplies 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 an analog display is installed with the M3460R, 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 during a power quality event or test cycle.

If J1 is OFF the M3460R will operate for 2 seconds and then stop operating. Once the power quality event ends or Test input is removed the M3460R can operate again after a 4 second delay.

If J1 is ON the M3460R 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.

**Table 4-4: Run Timeout Jumper Configurations**

| JUMPER | POSITION | FUNCTION | FACTORY SETTING |
|---|---|---|---|
| J1 | ON | No Run Timeout | OFF |
| | OFF | Run Timeout set to 2 seconds | |

**DANGER!**

***IF J1 IS LEFT ON, THE M3460R 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, 2-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 4-5: 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 M3460R. These are found on the 3460C1, 3460M6, and 3460D5 boards. See Figures 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 M3460R 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 M3460R 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 M3460R is regulating the DC bus or when the M3460R is put into Test mode. If the M3460R is unloaded or lightly loaded, this light may not illuminate.

#### 4.4.6.6. TEST – 3460C1 - LD1

The Test light will illuminate when the M3460R is put into Test mode. If the M3460R is unloaded or lightly loaded, this light may not illuminate.

#### 4.4.6.7. FAULT (FLT) – 3460M6 - LD1

The Fault light will illuminate as long as there are no faults. It will go out with a Ride-Thru Ready, Overtemperature, or Voltage Fault, after a 3 second delay.

#### 4.4.6.8. OUTPUT UNDERVOLTAGE (OUV) – 3460D5 – LD1

The Output Undervoltage light will illuminate as long as the DC bus is approximately 35V below the threshold setting or higher. If the DC bus drops below this, the light will go out. This is an indication the M3460R is not regulating the DC bus and an undervoltage fault on the attached equipment is possible.

### 4.4.7. DISPLAY OPTIONS

There are display options available for local indication. They are designed to be mounted to the door or deadfront of a drive cabinet. They can be wired to the I/O points on TB6, leaving the outputs on TB5 available for remote monitoring. The displays show the M3460R module's operating status and also permit a system test to be performed.

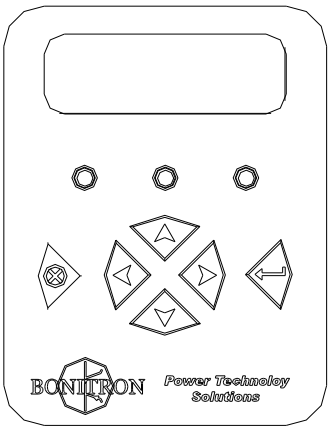
Currently, there are two analog and one digital display panel. The digital display system has many more features than the analog displays, including outage and fault logging. Please refer to the ASM 3660DD4 manual for a full description of the features.

**Table 4-6: Display Panel Configurations**

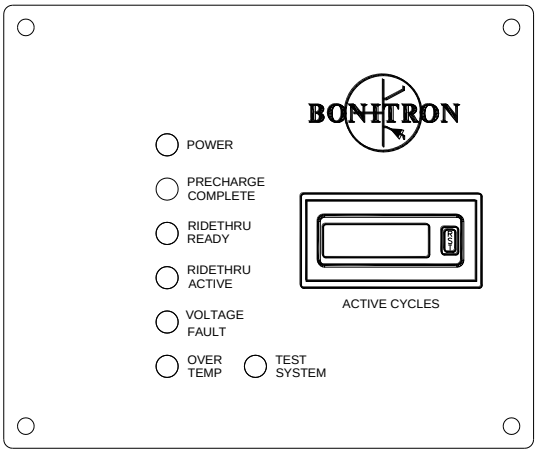
| DISPLAY MODEL | LOCAL INDICATORS | VOLTMETER | AMMETER | TOTAL COUNTER | RESETTABLE COUNTER | ACTIVITY LOGGING | LOCAL TEST INITIATION |
|---|---|---|---|---|---|---|---|
| DP10 | ✓ | | | | ✓ | | ✓ |
| DP17 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| DD4 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

**Figure 4-5: Display Panels**

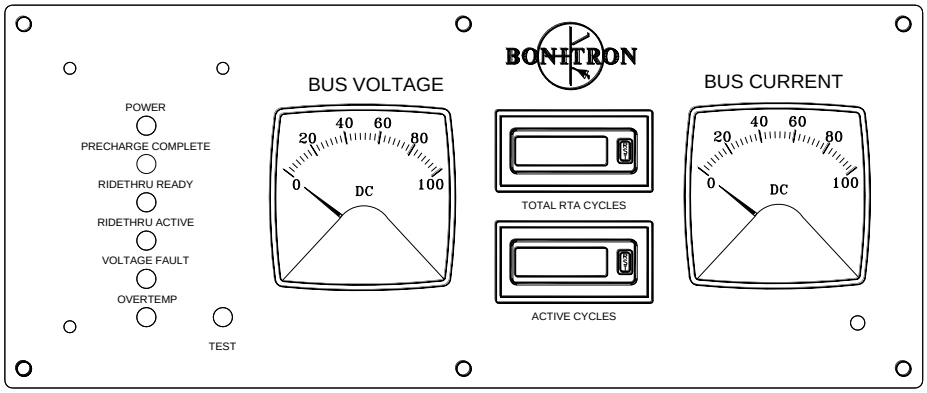
**DD4**




**DP10**




**DP17**




### 4.4.7.1. 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 M3460R is 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.

### 4.4.7.2. DP17 ANALOG DISPLAY

The DP17 has LED indicators for the following status outputs:

- Power
- Precharge Complete

- Ride-Thru Ready
- Ride-Thru Active
- Voltage Fault
- Overtemperature

There are two counters: a Total Cycle counter that cannot be reset, and an Active Cycle counter that can be reset. These indicate the number of times the M3460R is active. These numbers will increase when there is a power quality event, or when the system is tested.

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

There are also two meters. The DC Bus Voltmeter that indicates the voltage in the output bus voltage to the attached drive. The Bus Current meter indicates the current being supplied to the drive. If the M3460R is not active, this current should read zero.

#### 4.4.7.3. DD4 DIGITAL DISPLAY

The ASM 3660DD4 digital display has many features and control modes that can be used to monitor, test and log information about the M3460R and its activity.

Below are very basic operation instructions. Please refer to the ASM 3660DD4 manual for detailed instructions and configuration information.

The ASM 3660DD4 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.

Like the analog displays, full diagnostic output information is available on the isolated outputs on TB5 of the 3460M6 board.

**DIGITAL DISPLAY INPUTS**

There are two remote inputs to control the activity of the M3460R, Enable and Test. They allow remote initiation of these inputs, but the digital display system allows the M3460R 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 M3460R is ordered with the ASM 3660DD4 digital display, the factory settings are for Automatic Control mode, meaning the M3460R will be disabled locally under the following conditions:

- Overtemperature
- Runtime Exceeded

This allows for the most protection for the M3460R. This can be reconfigured if these warnings should be ignored.

**CAUTION!**

***DISABLING THESE FAULTS CAN DAMAGE THE M3460R BY FORCING IT TO OPERATE OUTSIDE OF DESIGN PARAMETERS!***

## 4.5. DC BUS THRESHOLD VOLTAGE SETTING

The DC bus threshold voltage is the voltage at which the M3460R maintains the DC bus at during a power quality event. Whenever the output DC bus voltage drops below the DC bus threshold voltage setting, the M3460R 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 M3460R to become active when there is no need. If this is a constant or frequent occurrence, the M3460R may overheat and not be available in the event of an actual sag or outage.

The M3460R 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 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 M3460R may become active when not needed. In this case, the DC bus threshold voltage setting should be lowered to allow the M3460R to only be active during a true power quality event. The M3460R should not become active during normal everyday operation.

The DC bus threshold voltage is factory preset on all M3460R modules according to Table 6-4 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

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 USING THE TEST MODE

The DC bus threshold voltage setting may be checked with the drive connected using the test input to put the M3460R 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 M3460R 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 M3460R, thus providing an inaccurate result.

The M3460R may shutdown from the timeout feature, depending on the load.

1. Monitor the output DC bus of the M3460R, 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 M3460R 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 M3460R 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.

### 4.5.3. ADJUSTING THE DC BUS THRESHOLD VOLTAGE SETTING

Adjustment of R7 on the 3460C1 control board (see Figure 4-3) 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 M3460R 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.

Adjustment of pot R31 on the 3460M6 interface board (see Figure 4-2) 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 M3460R 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 (see Figure 4-4) 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.

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# 5. START-UP, MAINTENANCE AND TROUBLESHOOTING

## 5.1. 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 ON
   - Output Undervoltage light on 3460D5 board should be ON
   - 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
   - Fault light on 3460M6 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 M3460R with either the enable input or the digital display.
   - Ride-Thru Ready light on 3460C1 board should turn ON
   - 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 M3460R and the attached drive.
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 SHUTDOWN 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. MAINTENANCE ITEMS

The M3460R 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.

### 5.2.1. CAPACITOR REPLACEMENT RECOMMENDATIONS

The M3460R 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 M3460R 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!***

### 5.2.2. CAPACITOR TESTING PROCEDURE

1. Open the panel door to expose the capacitor bank.
2. Measure voltage across each cap and make note for future reference.
3. 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
   - Remove power and replace both capacitors if the difference is more than 15%.

### 5.2.3. 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. 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 LEDs | ▪ Check incoming power. |
| No Ride-Thru Ready Output | ▪ Check Enable Input.<br>▪ Check IGBT fuses – look for blown fuse light on 3460C1.<br>▪ Check 3460M6 interface for proper connection. |
| No Precharge Complete | ▪ Check DC bus level – if not OK check pre-charge circuits or bus caps.<br>▪ Check Enable Input.<br>▪ Check IGBT fuses – look for blown fuse light on 3460C1. |
| Voltage Fault Always On | ▪ Check input fuses.<br>▪ Check 3460M6 interface. |
| Test Mode Does Not Raise Output Voltage | ▪ Check Enable Input.<br>▪ Check Test Input.<br>▪ Check incoming and outgoing fuses.<br>▪ Check normal DC bus voltage. If the DC bus is normally too high, the DC bus test setpoint may not raise the output voltage. |
| Ride-Thru Active Output Always On | ▪ Check DC bus threshold voltage setting. |
| Ride-Thru Active Output Never Comes On or Attached Drive Trips On Outages | ▪ Check Enable Input.<br>▪ Check DC link to attached drive.<br>▪ Initiate Test Mode. If the Test does not raise the DC bus and/or the Ride-Thru Active output does not activate, there could be internal damage.<br>▪ Check power quality data to confirm sag events should have caused activity to occur. |
| Overtemp | ▪ Check for constant current on the negative and positive DC bus links to the drive. Circulating currents may be overheating the unit in standby.<br>▪ Check activity record –too much activity causes overtemp. |
| Blown Fuse LED On | ▪ Check IGBT fuses – Blown Fuse light on 3460C1 control board will be ON if an IGBT fuse is blown. |

| SYMPTOM | ACTION |
|---|---|
| Voltage Fluctuates During Test Mode | ▪ Check DC bus threshold voltage setting and test boost level. Overvoltage shutdown can occur if settings are too high, causing an oscillation effect. Lower threshold level and retry. |
| Stays in Test Mode | ▪ Check to make sure Enable input is properly configured and not active. |
| Precharge Overheated | ▪ Not enough time between powerup and powerdown during testing. Precharge can only be done 3 consecutive times before overheating can occur.<br>▪ Check DC bus ripple voltage. Too much ripple can cause the precharge circuit to overheat. |

**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.***

## 5.4. 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 CHARTS

**Table 6-1: M3460R kW Ratings**

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

**Table 6-2: Model Specifications**

| DC BUS CURRENT ① | BACKPLATE SIZE | CIRCUIT CONFIGURATION. | RECOMMENDED FUSE RATING ② | | SCCR RATINGS |
|---|---|---|---|---|---|
| | | | DC BUS (F1 /F2) | AC LINE (F3 / F4 / F5) | |
| 85A | R10 | 2-stage | 80A, 700V | 125A, 600V | 10kA③ |
| 127A | R10 | 2-stage | 125A, 700V | 200A, 600V | |
| 170A | R9 | 4-stage | 175A, 700V | 250A, 600V | |
| 255A | R11 | 4-stage | 250A, 700V | 400A, 600V | |
| 340A | R11 | 4-stage | 350A, 700V | 500A, 600V | 18kA④ |
| 425A | R11 | 4-stage | 450A, 700V | 600A, 600V | |

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 6-3: Minimum Input Voltages for Full Power Output**

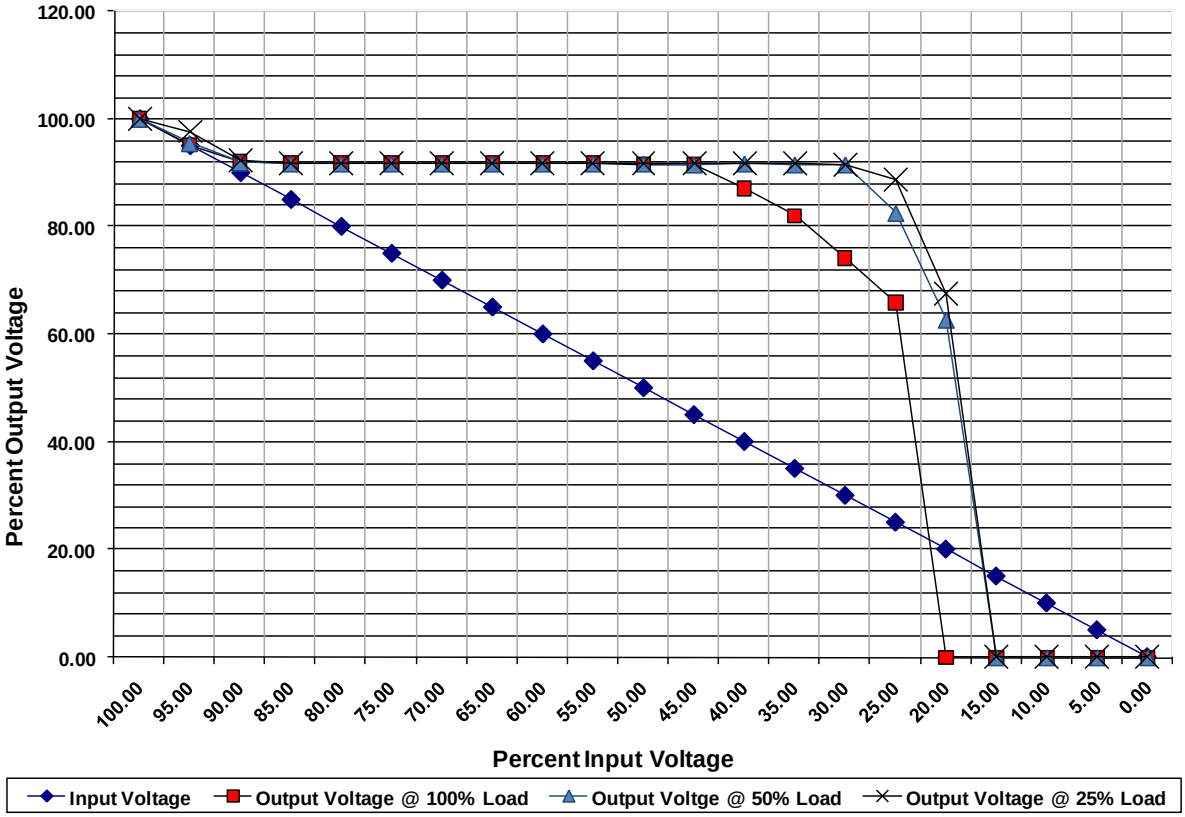
| SYSTEM VOLTAGE | MINIMUM AC INPUT VOLTAGE ① | MINIMUM DC INPUT VOLTAGE ② (IUV LEVEL) |
|---|---|---|
| 230VAC | 115VAC | 160VDC |
| 380-415VAC | 190VAC | 265VDC |
| 460VAC | 230VAC | 320VDC |

① Minimum AC input for full power operation without energy storage
② Minimum DC input for full power operation with energy storage

**Table 6-4: Factory Setpoints for DC Bus Threshold and Test Boost Voltages**

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

**Figure 6-1: Typical M3460R Output Voltage vs. Input Voltage**




## 6.2. EFFICIENCY / POWER CONSUMPTION

All M3460R modules are 93% efficient or better @ full load. Power consumption in standby mode is less than 100W for modules rated for 170A or less and less than 200W for modules rated for more than 170A.

## 6.3. CERTIFICATIONS

### 6.3.1. UNDERWRITERS LABORATORIES LISTING

Standard M3460R models 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 M3460R Ride-Thru Voltage Regulators 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 M3460R:

- 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 M3460R 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. The recommended minimum current rating for the power source fusing is listed in Table 6-5, based on the DC bus current rating of the M3460R.
- The field wiring sizes listed in Table 6-5 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 M3460R should be equal to or greater than that listed in Table 6-5.
- Use copper wiring rated 75°C or equivalent for field wiring terminals.
- These devices do not provide motor overload protection.

**Table 6-5: 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 |

## 6.5. DIMENSIONS AND MECHANICAL DRAWINGS

**Figure 6-2: M3460-R10 Chassis Dimensional Outline**

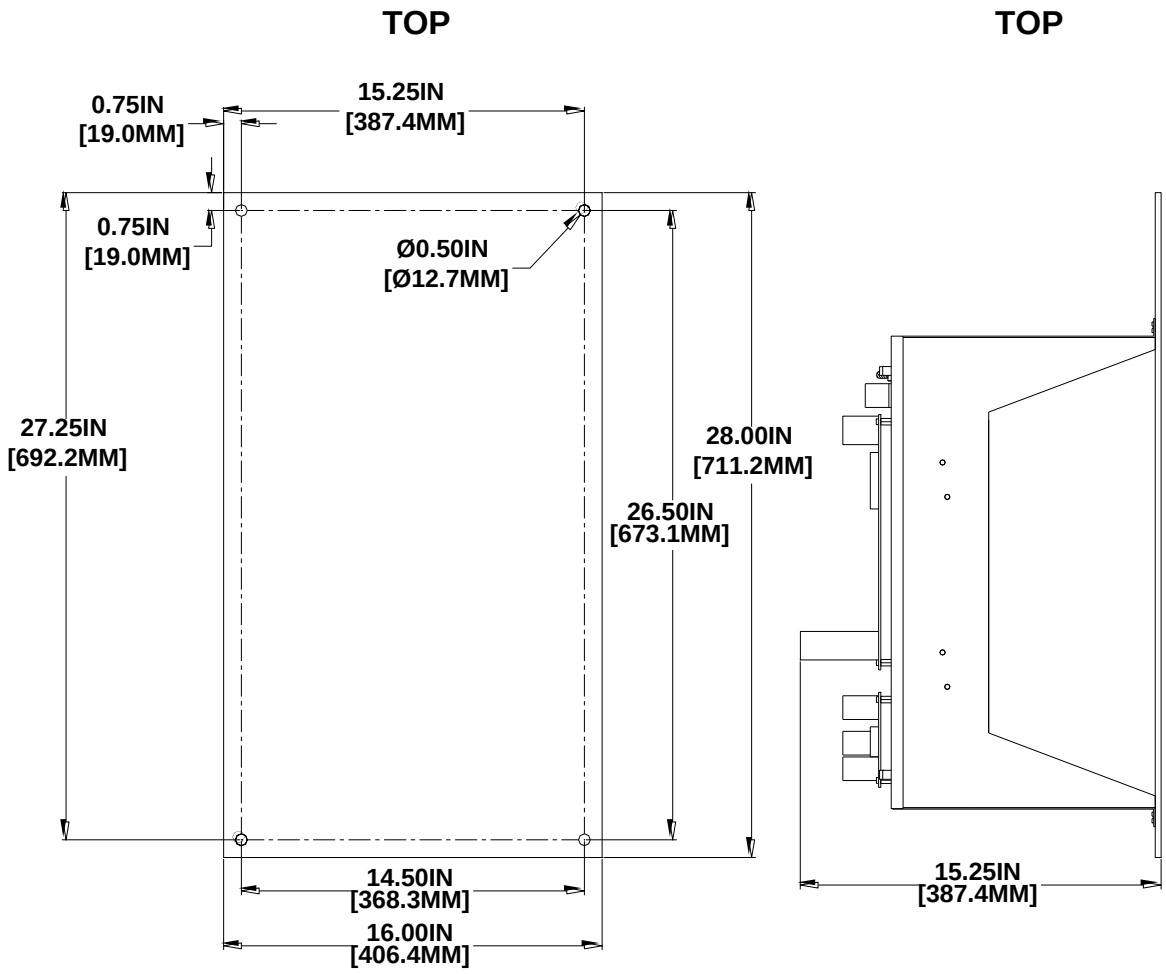


**Figure 6-3: M3460-R9 Chassis Dimensional Outline**

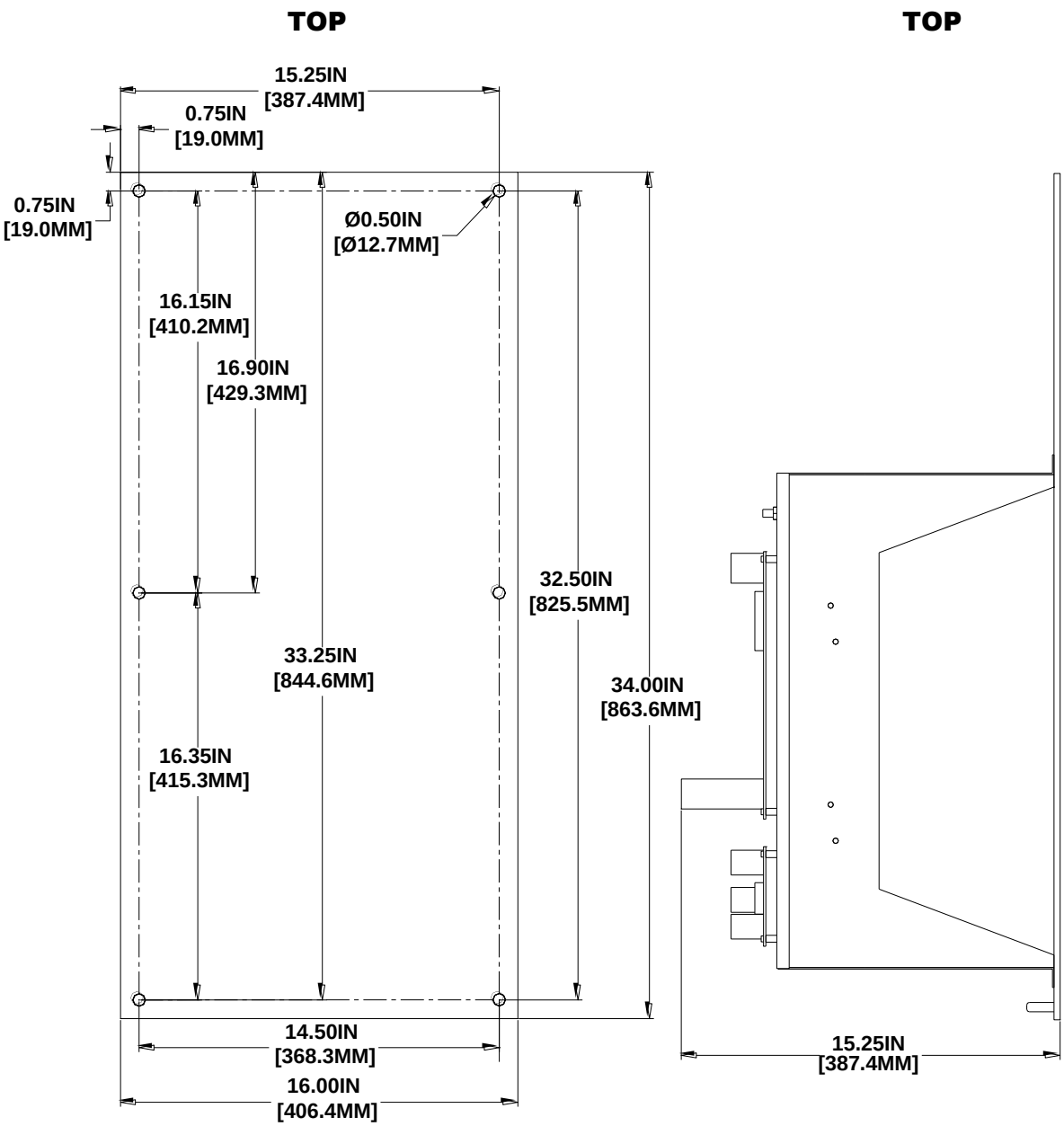


**Figure 6-4: M3460-R11 Chassis Dimensional Outline**

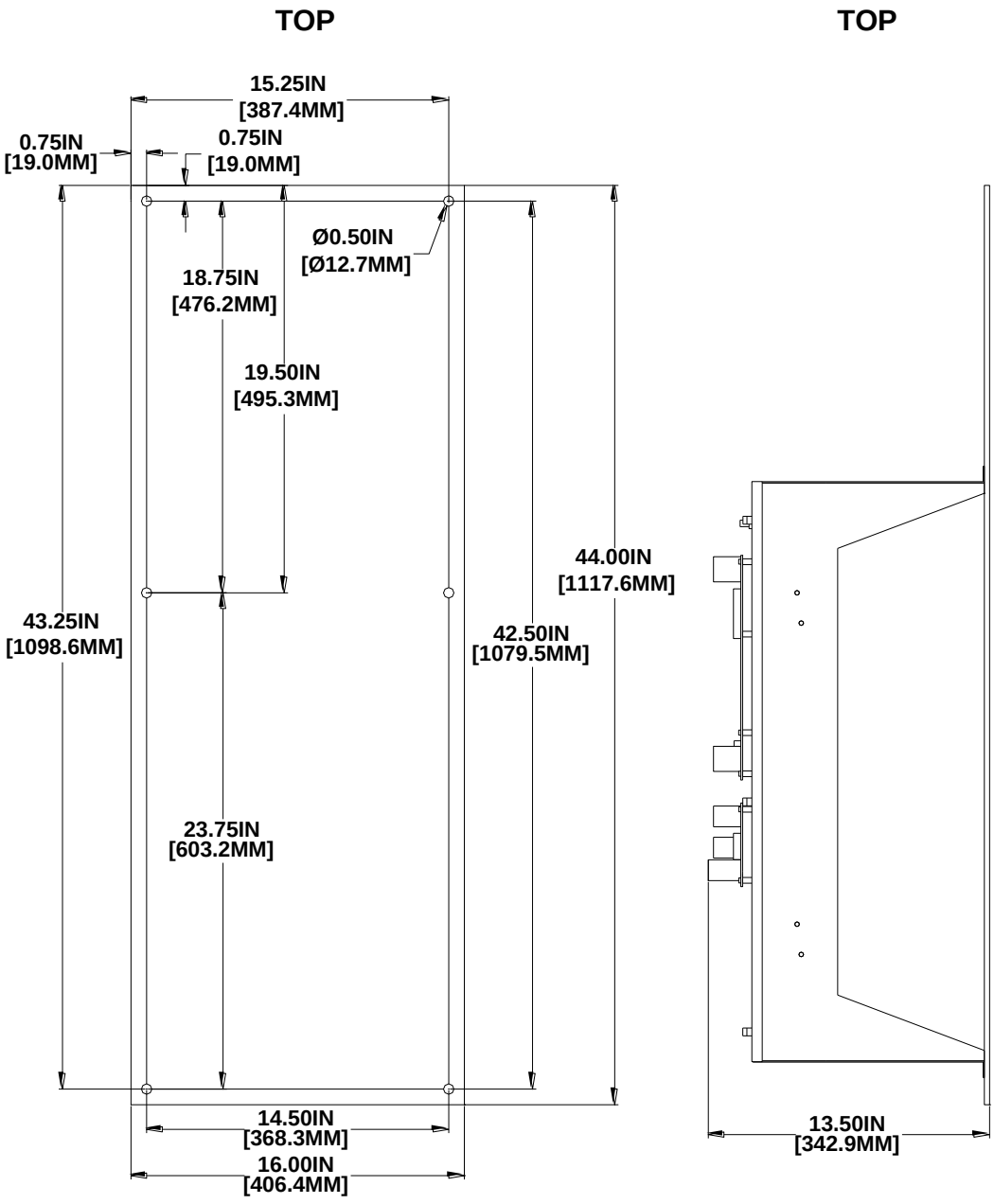


**Figure 6-5: DD4 Digital Display Cutout and Mounting Dimensions**

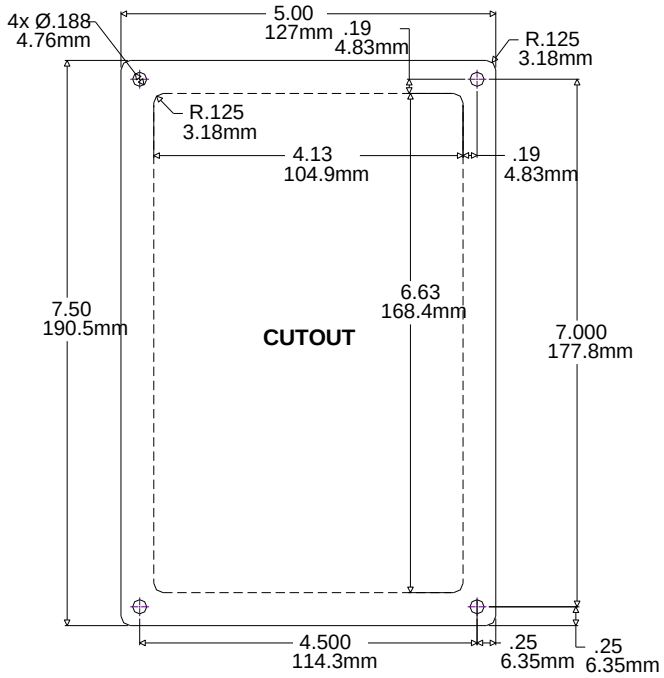



**Figure 6-6: DP10 Display Cutout and Mounting Dimensions**

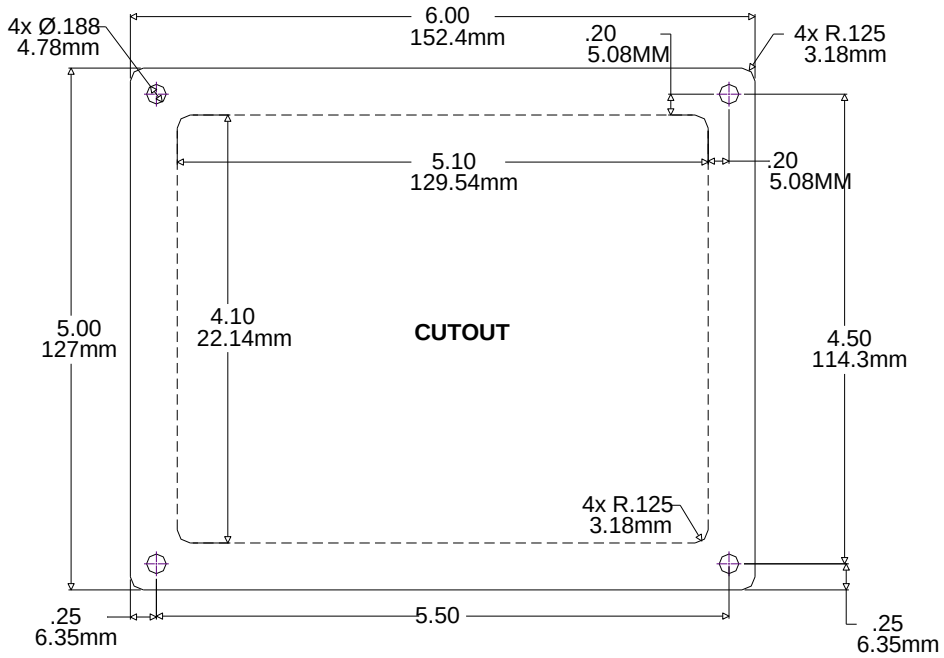
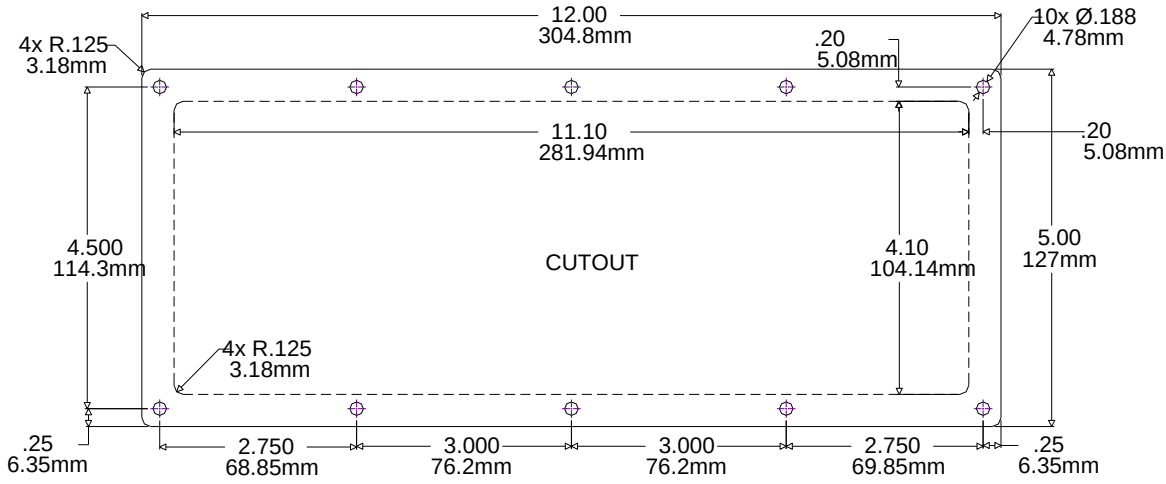


**Figure 6-7: DP17 Display Cutout and Mounting Dimensions**




## 6.6. RECOMMENDED SPARE PARTS

The part numbers listed in Table 6-6 represent the recommended spare parts and the quantities of each used in the M3460R modules.

This list is intended for use as a reference if ordering spare parts for the M3460R Ride-Thru modules becomes necessary. Please remember to refer to the complete Bonitron part number when ordering parts.

**Table 6-6: Spare Parts List**

| | | QUANTITY PER MODULE | | | | | |
|---|---|---|---|---|---|---|---|
| PART NUMBER | PART DESCRIPTION | 85A | 127A | 170A | 255A | 340A | 425A |
| FS FWP-80A | Buss FWP Type 80A Fuse | 2 | * | * | * | * | * |
| FS FWP-125A | Buss FWP Type 125A Fuse | 3 | 2 | * | * | * | * |
| FS FWP-200A | Buss FWP Type 200A Fuse | * | 3 | * | * | * | * |
| FS A70QS175-4 | Gould A70QS Type 175A Semicon Fuse | * | * | 2 | * | * | * |
| FS A70QS250-4 | Gould A70QS Type 250A Semicon Fuse | * | * | 3 | 2 | * | * |
| FS A70QS350-4 | Gould A70QS Type 350A Semicon Fuse | * | * | * | * | 2 | * |
| FS A70QS400-4 | Gould A70QS Type 400A Semicon Fuse | * | * | * | 3 | * | * |
| FS A70QS450-4 | Gould A70QS Type 450A Semicon Fuse | * | * | * | * | * | 2 |
| FS A70QS500-4 | Gould A70QS Type 500A Semicon Fuse | * | * | * | * | 3 | * |
| FS A70QS600-4 | Gould A70QS Type 600A Semicon Fuse | * | * | * | * | * | 3 |

# 7. APPENDICES

## 7.1. M3460R INSTALLATION CONSIDERATIONS

There are several things to take in to account when backing up a drive system. The M3460R 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 ELECTROLYTIC CAPACITORS OR ULTRACAPACITORS, THE M3460R 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 M3460R 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 M3460R 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 M3460R. 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 M3460R.
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

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. 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

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

The total number of joules required is:

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

### 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,

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

### 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. DIODE SHARING WITH A BONITRON M3460R RIDE-THRU

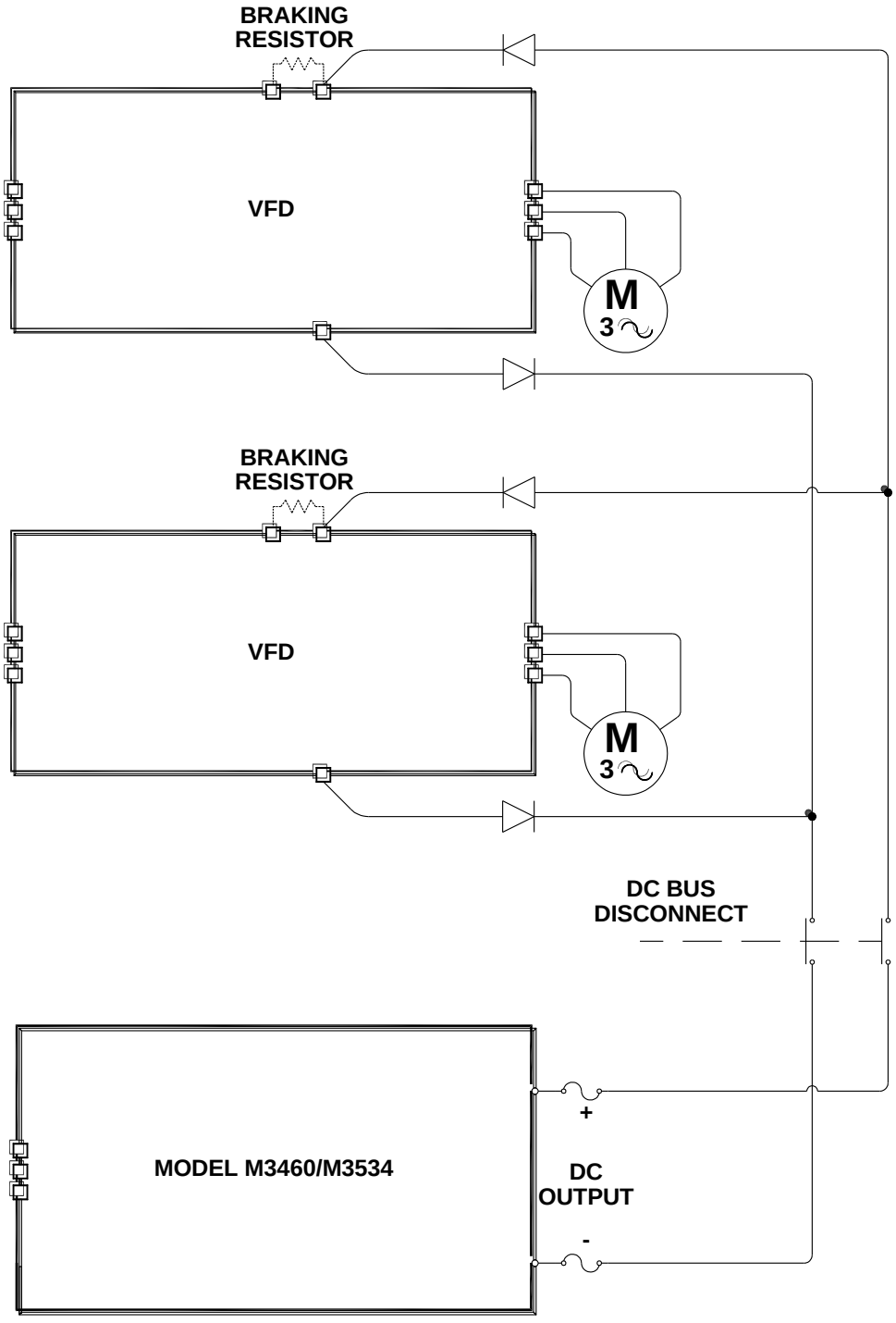
Diode sharing is used to decrease the cost of implementing M3460 modules to existing drive systems that are not common bussed. The use of diodes will prevent drive busses from "back feeding" each other, by allowing energy to pass one way only.

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. Drives should have equivalent DC bus levels as would be found on equal size drives of a common manufacturer.
2. Drives should 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. 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, upstream of line filter, if used.

**Figure 7-1: Diode Sharing Example**



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