BONITRON

Model M3460B

Battery Boost Regulator Module

Customer Reference Manual

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Bonitron, Inc.

An Industry Leader in AC Drive Systems and Industrial Electronics

OUR COMPANY

Bonitron is an international supplier of power controls designed to improve the performance and reliability of electronic systems and variable frequency drives. Located in Nashville, Tennessee, and founded in 1962, Bonitron has gained a reputation for designing and manufacturing products with the highest possible degree of quality and reliability.

Bonitron has all the necessary resources in-house for complete electronic product development and manufacturing. Engineering facilities include a CAD lab for circuit board design and engineering labs for prototype testing and evaluation. Production facilities include production areas for circuit board assembly, a machine tool and sheet metal shop for chassis fabrication, and a systems assembly and checkout area. With these assets, Bonitron is positioned to be a leader into the future while maintaining first class support for their current customer base.

Worldwide sales of equipment are generated mainly by reputation and referrals. Our customer base includes all of the major drive manufacturers, their distributors, OEMs, end users, and many other satisfied companies. Equipment is installed throughout the United States as well as in Canada, Mexico, Costa Rica, Argentina, Brazil, Chile, Venezuela, Northern Ireland, the Netherlands, Spain, Hungary, Israel, Turkey, China, India, Indonesia, Singapore, Taiwan, and the Philippines.

TALENTED PEOPLE MAKING GREAT PRODUCTS

The engineering team at Bonitron has the background and expertise needed to design, develop, and manufacture the quality industrial systems demanded by today's client. A strong academic background supported by continuing education is complemented by many years of hands-on field experience. Expertise encompasses a broad range of applications and engineering solutions such as modern power conversion design techniques and microprocessor-based controls. This insures a solution tailored to the specific needs of the client.

A clear advantage that Bonitron has over many competitors is combined on-site engineering labs and manufacturing facilities. This allows the engineering team to have immediate access to and response from testing and manufacturing. This not only saves time during prototype development, but also is essential to providing only the best quality products.

AC DRIVE OPTIONS

In 1975, Bonitron began working with the AC inverter drive specialists at synthetic fiber plants to develop speed control systems that could be interfaced to their plant process computers. Since that time, Bonitron has developed AC drive option modules that help overcome many of the problems encountered in applications of modern AC variable frequency drives.

Bonitron's Ride-Thru module provides protection from AC line voltage sags while the Line Regen and Resistive Braking modules provide DC Bus regulation for over-voltage due to regenerated voltage.

Bonitron AC drive modules are available to provide Undervoltage, Overvoltage, Line Side, Load Side, Maintenance, Power Quality, and Green / Sustainability solutions. These products are compatible with the drives of all major manufacturers and have become the standard in many industries including semiconductor, oil, and fiber.

WORLD CLASS PRODUCTS

Bonitron has developed over 3000 different modules and systems. Bonitron is willing and able to meet the unique specifications the client may request.

Some Bonitron products include:

- Power Sag Ride-Thru Modules
- Power Outage Ride-Thru Modules
- Line Regen Modules
- Resistive Braking Modules
- Modular High Speed Precision AC Inverter Systems
- Inverter Upgrade Modules
- Multi-motor, Multi-phase Current Sensors
- Battery Production Charging Systems
- Data Acquisition Systems
- Process Controllers
- Temperature Control Systems
- RMS True Reading Digital Voltmeters, Ammeters, and Frequency Meters

1. INTRODUCTION

1.1. WHO SHOULD USE

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

Please keep this manual for future reference.

1.2. PURPOSE AND SCOPE

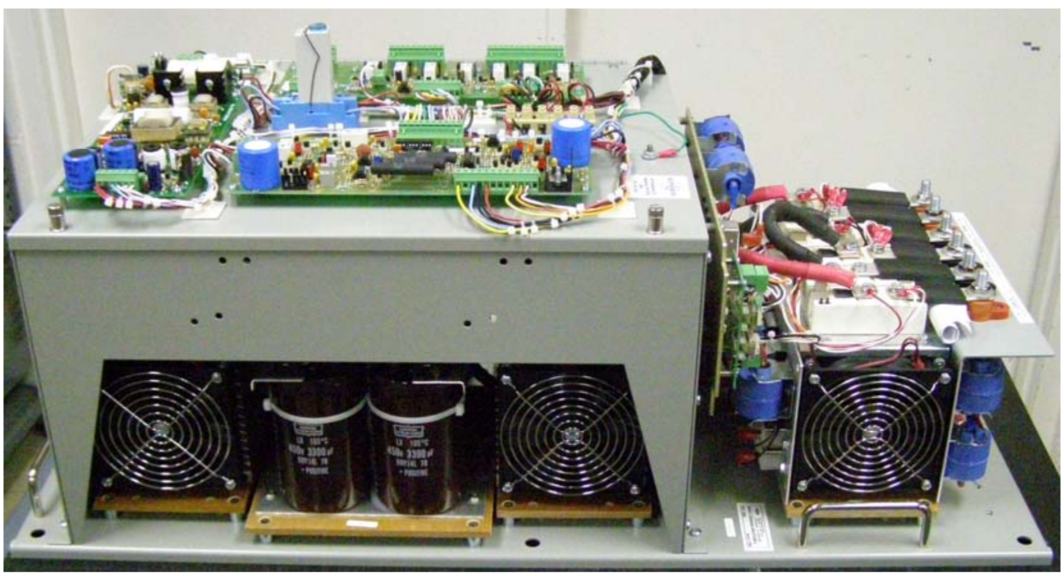
This manual describes a cabinet mountable Battery Regulator Ride-Thru Module, with single or dual DC bus outputs, used to regulate a battery bank, which provides DC bus power for AC PWM inverter drives during a power sag or loss situation.

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

1.3. MANUAL VERSION AND CHANGE RECORD

Digital display and start-up information was expanded in Rev 02b and clarifications were made in Rev 02c.

Figure 1-1: M3460B-H100-240-R9-D



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2. PRODUCT DESCRIPTION

Bonitron's Model M3460B Battery Regulator Ride-Thru Module (RTM), in conjunction with a back-up battery bank, provides protection from AC line voltage sags and/or outages for AC drive systems that use a fixed bus, as with AC PWM variable frequency drives (VFDs). VFDs are commonly used in industry to improve control over continuous processes where highly accurate motor speed control is required. Unfortunately, VFDs are quite susceptible to problems when fluctuations in incoming power occur.

One solution to this problem is to support the drive system's fixed DC bus with a string or bank of back-up batteries. However, this solution is not without its own problems. When using batteries for back-up in this fashion, the charge voltage of the battery bank cannot exceed the DC bus voltage. Then, when the batteries are loaded supporting the DC bus, their voltage drops and quickly becomes too low to be useful.

Bonitron's M3460B Battery Regulator Ride-Thru Module solves the voltage drop problem associated with battery banks in back-up situations. The Ride-Thru module regulates the battery bank voltage, boosting it as it drops. This is done by temporarily storing energy in specialized boost circuits and releasing it into the DC bus as needed.

By compensating for the short-term discharge voltage drop problem and also for long term degradation of the batteries themselves, the M3460B will allow for extended usage of existing battery banks. For new systems, the design engineer will be able to spec fewer of the costly batteries to accomplish the same task. When used with a battery bank, the M3460B Battery Regulator Ride-Thru Module will provide DC bus support for up to 15 minutes during a 100% power outage. This would allow ample time for a controlled shut down of the process thus preventing unnecessary loss of product and revenue.

ADVANTAGES

1. Reliability
   - Connects parallel to existing system
   - Ride-Thru failure does not affect normal process
   - Ride-Thru maintenance can be done while normal process is on-line
   - Open battery bypass option available
   - Open battery detection option available
   - AC input option available
2. Redundancy
   - Battery bypass option means one bad battery does not spoil the bunch
   - Some Ride -Thru modules use multiple stages
     Single stage failure only means reduced capability
3. Additional AC input option voltage sag protection
   - Increases battery life by using energy from AC line for small voltage sags
   - Allows sag protection during battery maintenance
4. Easy retrofit installation
   - Works with most any fixed bus PWM drive
   - Only 2 parallel connections to existing system for DC battery regulator
   - Only 3 parallel connections for AC option
     - Can use existing AC feed wiring
     - Can use existing AC feed breakers

5. Installed Cost
   - $300 to $500 per kW
   - Less expensive than other options
     Traditional UPS
     Flywheel technology
     Capacitive energy storage
6. Easy testing
   - Can test system on-line or off-line
   - Can take off-line for repair or testing without disrupting the process
7. Instant response
   - No switchover time
   - Maintains control of motor speed and torque
8. Easy commissioning
   - No programming
   - Can power up/down with system on-line
   - Single fine tune level adjustment
9. No RF interference
   - Slow switching speeds internally filtered
   - Feeds DC to inverter bus
10. Remote communications
    - Single fault contact
    - Detailed I/O signals
11. System monitoring
    - LEDs
    - Voltage and current
    - Activity counter
12. Custom options available
    - Ability to adapt for custom configurations

2.1. Related Documents and Products

M3528DB Diode Bypass

For a failsafe battery system, the RTM allows bypassing an open battery cell while under load. A typical series battery string is only as good as the worst battery. When any battery gets weak or opens the whole string is ruined. If Bonitron’s Open Battery Bypass Option is used and a battery opens during discharge, the Battery Monitor will show which battery is open, and a diode will automatically bypass that battery. The RTM will make up the lost voltage and maintain the drive bus at threshold. Batteries can now be replaced on a one by one basis. See Figure 7-1 480VDC Battery Bypass System.

ASB 3528M4 Battery Monitor Board (up to 10 Batteries):

The ASB 3528M4 Board monitors the individual cell voltage within the battery bank and will alert the user of any voltage above or below the respective setpoints. Therefore if one of the batteries within the bank is faulty the user will be able to pinpoint and replace the defective cell.

M3528M2 BATTERY BANK MONITOR:

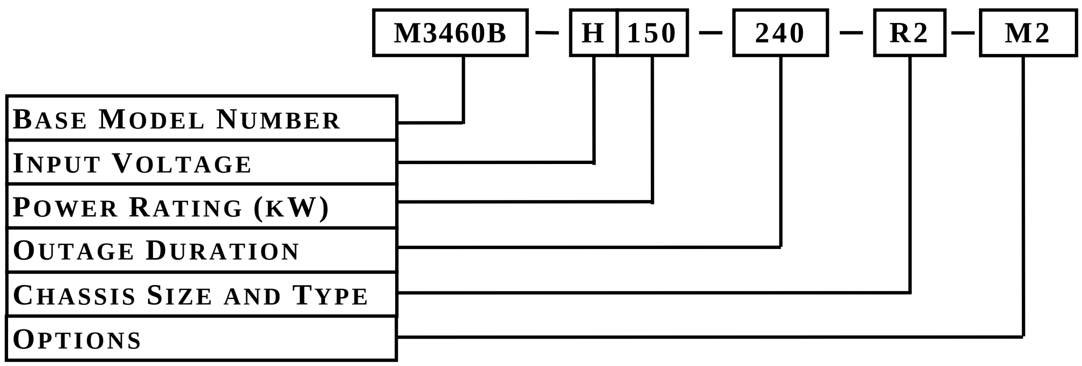
The M3528M2 monitors DC levels and changes the relay states if voltage drops below or rises above preset levels. This can be used to stop overcharging or discharging of batteries to increase life.

DP SERIES AND DDM SERIES DISPLAY

The Ride-Thru Diagnostic Display Panel provides visual indication of the Ride-Thru module's operating status and also permits a system test to be performed. Currently, there are several display panel configurations available with various combinations of features.

2.2. PART NUMBER BREAKDOWN

Figure 2-1: Example of Part Number Breakdown



BASE MODEL NUMBER

The Base Model Number for all Battery Regulator Ride-Thru Modules is **M3460B.**

INPUT VOLTAGE RATING

The Model M3460B Ride-Thru is available in several input voltage ranges. The rating is indicated by a code letter.

Table 2-1: System Voltage Rating Codes

RATING CODE	VOLTAGES (NOMINAL AC LINE / DC BUS)
L	230VAC Line / 320VDC
E	400VAC Line / 565VDC
H	460VAC Line / 640VDC
C	575VAC Line / 805VDC

POWER RATING

The Model M3460B Battery Regulator Ride-Thru is available in several power ratings for each source voltage level. This rating is indicated by a 3-digit number which directly corresponds to the system's power (kW) rating. For the unit's power rating, refer to Section 6 of this manual.

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.

CHASSIS SIZE

The M3460B Battery Regulator Ride-Thru is available in three open-chassis backplate sizes. Size is dependent on the module's boost configuration.

Table 2-2: Chassis Codes for 4-Minute Modules

CHASSIS CODE	UNIT SIZE	DESCRIPTION
R10	42-85 Amp	28" x 16" x 14" open chassis backplate (1-stage)
R9	127-170 Amp	34" x 16" x 14" open chassis backplate (2-stage)
R2	155-340 Amp	52" x 24" x 14" open chassis backplate (4-stage)

OPTIONS

Table 2-3: Option Codes

OPTION CODE	DESCRIPTION
M2	Battery Bank Voltage Monitor
M4	Individual Battery Voltage Monitor
D	Dual Output
DP17	Diagnostic Display Panel for Booster Modules
DP18	Diagnostic Display Panel for Storage Systems
DDM	Digital Diagnostic Display Panel
P3	Internal 300W DC bus power supply

Option Codes are separated by a comma, and are omitted when not required. Contact Bonitron if other special options are required.

2.3. GENERAL SPECIFICATIONS

Table 2-4: General Specifications Table

PARAMETER	SPECIFICATION
Input DC Voltage	Table 2-5
Output DC Voltage	Table 2-5
DC Bus Current Rating (Max)	Tables 6-1 and 6-2
Power Rating (Max)	Tables 6-1 and 6-2
Duty Cycle (Full Load)	Maximum allowed Duty Cycle is 1%
Inactive Power Consumption	Section 6.2
Ride-Thru Requirement	4 and 15 minute outage
Boost Circuit Configuration	Table 6-3
DC Bus Threshold	Table 2-5
Low Bus Fault Setpoint	Table 2-5
Tolerance	±10%
DC Bus Output Fusing	Table 6-3
DC Boost Circuit Fusing	Table 6-3
Packaging	Table 2-2
Operating Temperature (Max)	40ºC
Status Output Signals	Opto FET 350V, 120mA

Table 2-5: Voltage Specifications Chart

INPUT VOLTAGE		OUTPUT DC VOLTAGE		
AC LINE	BATTERY RANGE VDC	BUS NOMINAL	THRESHOLD	LOW DC BUS FAULT SETPOINT
208	180 - 265	290	265 (adjustable from 220-300)	230
230	200 - 285	320	285 (adjustable from 220-300)	250
380	340 - 485	530	485 (adjustable from 440-540)	450
400	350 - 495	560	495 (adjustable from 440-540)	460
415	360 - 500	580	500 (adjustable from 440-540)	465
460	400 - 585	640	585 (adjustable from 525-625)	550
575	480 - 710	805	710 (adjustable from 650-750)	675

2.4. GENERAL PRECAUTIONS AND SAFETY WARNINGS

DANGER!

- HIGH VOLTAGES MAY BE PRESENT!
- 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 SERVICING THIS PRODUCT.
- FAILURE TO HEED THESE WARNINGS MAY RESULT IN SERIOUS BODILY INJURY OR DEATH!

CAUTION!

- THIS PRODUCT WILL GENERATE HIGH AMBIENT TEMPERATURES DURING OPERATION.
- THIS PRODUCT DOES NOT PROVIDE MOTOR OVERLOAD PROTECTION.
- THIS PRODUCT SHOULD BE INSTALLED ACCORDINGLY ON NON-FLAMMABLE SURFACES WITH CLEARANCES OF AT LEAST TWO INCHES IN ALL DIRECTIONS.
- ALWAYS ALLOW AMPLE TIME FOR THE UNIT TO COOL BEFORE ATTEMPTING SERVICE ON THIS PRODUCT.
- BEFORE ATTEMPTING INSTALLATION OR REMOVAL OF THIS PRODUCT, BE SURE TO REVIEW ALL DRIVE AND/OR RESISTIVE LOAD DOCUMENTATION FOR PERTINENT SAFETY PRECAUTIONS.
- INSTALLATION AND/OR REMOVAL OF THIS PRODUCT SHOULD ONLY BE ACCOMPLISHED BY A QUALIFIED ELECTRICIAN IN ACCORDANCE WITH NATIONAL ELECTRICAL CODE OR EQUIVALENT REGULATIONS.

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

2.5. Integration Recommendations for Battery Power Source Ride-Thru Systems

1. To protect the booster and battery from damage due to extreme circumstances the booster module should be shut down under the following conditions:
   - Over Temperature
   - Input Under Voltage
   - Active run time beyond booster rating

   For Standard Models or Models equipped with a DP Series Display
   - The 24V ENABLE command should be sent through the Input Under Voltage (IUV) and Over Temp (OT) contacts on the 3460M6 interface board.

   For Models equipped with Digital Display (DDM) Option
   - The 24V ENABLE command should be sent through the Fault2 contact -OR
   - The Fault2 contact should be monitored and the external ENABLE command removed when any Fault2 occurs -OR-
   - The display should be set up for automatic control mode where the display automatically shuts down the RUN under any of these conditions.

   All models should be factory set to automatically shutdown if any of these faults occur. Some end users purposely choose to ignore these warnings because the process is the paramount concern.

   To bypass this safety feature for Models with M6 interface
   - Remove series contacts from external ENABLE command loop
     - Remove factory installed wires between the Enable input and IUV & OT contacts on 3460M6 board and connect external Enable directly to 3460M6 TB7-1 & 2.
   - Change external command from Enable to Disable. (Factory set for Enable)
     - On the 3460M6 interface board move jumpers J15 and J16 from the N.O position to the N.C. position. The unit will be ready to run automatically upon power up and a 24V command will inhibit boosting.

   To bypass this safety feature for Models with Digital Display
   - Change display from automatic to manual mode
     - Place display in Manual control mode by ensuring jumper J14 is in the "A" (or right) position.
     - Bypass or remove factory installed jumper wire from Fault2 output. See Section 4.2.2.2.
   - Change external run command from Enable to Disable. (Factory set for Enable)
     - On the 3660I2 interface board ensure jumper J15 is in the "B" (or up) position. The unit will be ready to run automatically upon power up and the external 24V command will inhibit boosting.

   It is strongly recommended that the safety feature not be bypassed. If it is bypassed it is strongly recommended that the faults be monitored and action be taken immediately upon receiving these faults.
2. VFD ground fault circuits should be checked. Some VFDs have very sensitive ground faults, and when using external DC input they can be tripped. Be sure it can be disabled in case there is trouble, and be ready to add a ground fault detection somewhere upstream of the drive if that safety aspect is essential to the application.

3. INSTALLATION INSTRUCTIONS

See Section 7.2 for special considerations before installation.

3.1. ENVIRONMENT

Excessive heat within and around the Model M3460B Battery Regulator Ride-Thru Module may cause OVER-TEMP fault tripping. To prevent excess build up of heat, the max ambient temperature within the installation site should not exceed 40°C.

The Battery Regulator Ride-Thru Module is provided with internal heatsink cooling fans. However, non-condensing filtered air may still be required to cool the installation area if the ambient temperature exceeds 40° Celsius.

The Ride-Thru should be protected from corrosive environment.

3.2. UNPACKING

1. Inspect Ride-Thru module crate for shipping damage.
   - Notify the shipping carrier if damage is found.
2. Remove screws along bottom of the Ride-Thru module crate, lift cover off.
3. Inspect the Ride-Thru module for shipping damage, broken terminals, loose or missing IC's, etc.
   - Notify the shipping carrier if damage is found.
4. Remove Display Panel and disconnect from Booster.

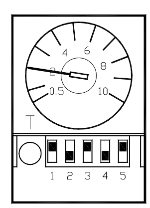
3.3. MOUNTING

All Battery Regulator Ride-Thru Modules are intended for wall or cabinet mounting. When installing these modules, it is important that they be properly oriented. All modules are provided with terminations at one end of the module’s chassis. Modules MUST be installed in either a vertical orientation, with terminations at the top end of the chassis, or in a horizontal orientation, with terminations positioned to the left of the chassis. NEVER install an M3460B Battery Regulator Ride-Thru Module in a horizontal orientation with the terminations positioned to the right of the chassis as this could allow internal capacitors to leak.

The entire Ride-Thru system is mounted on either of several rack mountable open chassis aluminum backplates.

- The “R2” chassis is shown in Figures 6-9 and 6-10.
- The “R9” chassis is shown in Figures 6-11 and 6-12.
- The “R10” chassis is shown in Figures 6-13 and 6-14.

1. Review Sections 3.1 and 3.2 above and the mounting drawings in Section 6.6 of this manual before proceeding with the installation process.
2. Ensure the Ride-Thru cooling fan timing relay is securely installed in the RLY1 socket and its settings are as shown to the right.



3. Remove the hardware securing the module to its pallet.
4. Lift backplate out of crate bottom using the 4 handles.
   - If backplate is too heavy, eyebolts may be installed in the backplate mounting holes for lifting by mechanical means.
5. Stand backplate upright in rack or cabinet. Slide the bottom of backplate to the rear of rack or cabinet while balancing the top of the module.
6. Secure the Ride-Thru backplate in place through the backplate’s .50-inch diameter mounting holes.
7. Install display panel in desired location and re-connect to booster module.

3.4. WIRING AND CUSTOMER CONNECTIONS

Review this entire Section before attempting to wire the Ride-Thru module.

3.4.1. POWER WIRING

CAUTION!

High voltages supplied to the Battery Regulator Ride-Thru include the input DC power and output DC bus. These voltages are derived from different sources. Each source must be separately disconnected and verified zero potential before servicing. Additionally, the Ride-Thru internal DC bus retains a hazardous voltage for several minutes after the input power has been disconnected. Wait at least five minutes after disconnecting power to allow the DC bus to discharge, and then verify zero potential before servicing. Failure to observe these precautions could result in severe bodily injury or loss of life.

1. Connect earth ground to Ground terminal. Maximum torque of 75 in-lbs.
2. Connect fused battery bus to BATT+ and BATT─ terminals at upper right corner of backplate. Maximum torque of 75 in-lbs for units >100kW and 45 in-lbs for units 100kW and below.
3. Ensure polarity is correct.
4. Connect fused drive buses to +POS+ and ─NEG─ terminals at upper left corner of backplate. Maximum torque of 75 in-lbs for units >100kW and 45 in-lbs for units 100kW and below.
5. Ensure polarity is correct.
6. Use copper conductors rated 75°C.

3.4.1.1. RIDE-THRU INPUT / OUTPUT POWER

Refer to Table 2-5 in Section 2 of this manual for required DC input voltage levels for each Ride-Thru unit.

3.4.1.2. DC INPUT AND OUTPUT CONNECTIONS

All customer power terminations for the Battery Regulator Ride-Thru module are provided at the top end of the module's chassis. These terminals will accept standard ⅜" diameter ring lugs for units >100kW and ¼" for units 75kW and below. Single or dual DC bus outputs are provided for connection to the DC bus of one or two drives. Pay careful attention to polarity when connecting DC inputs and outputs.

The module only provides termination points for the required power inputs and outputs. All power disconnects and fuses must be supplied by the customer. See Table 6-3 for recommended fuse ratings.

For assistance in selecting suitable battery strings for back up of the DC input, refer to the power curves provided in Section 6.4 of this manual.

3.4.1.3. SOURCE CONSIDERATIONS

The source for Model M3460B is a battery bank. See Battery Selection Curves in Section 6.4 and Battery Selection Data in Section 7.4.

3.4.1.4. GROUNDING REQUIREMENTS

Earth Ground stud is provided at the top of the backplate.

3.4.2. CONTROL INTERFACE WIRING

1. Connect system monitoring / control room wiring.

For units not using Digital Display go to Step 2.

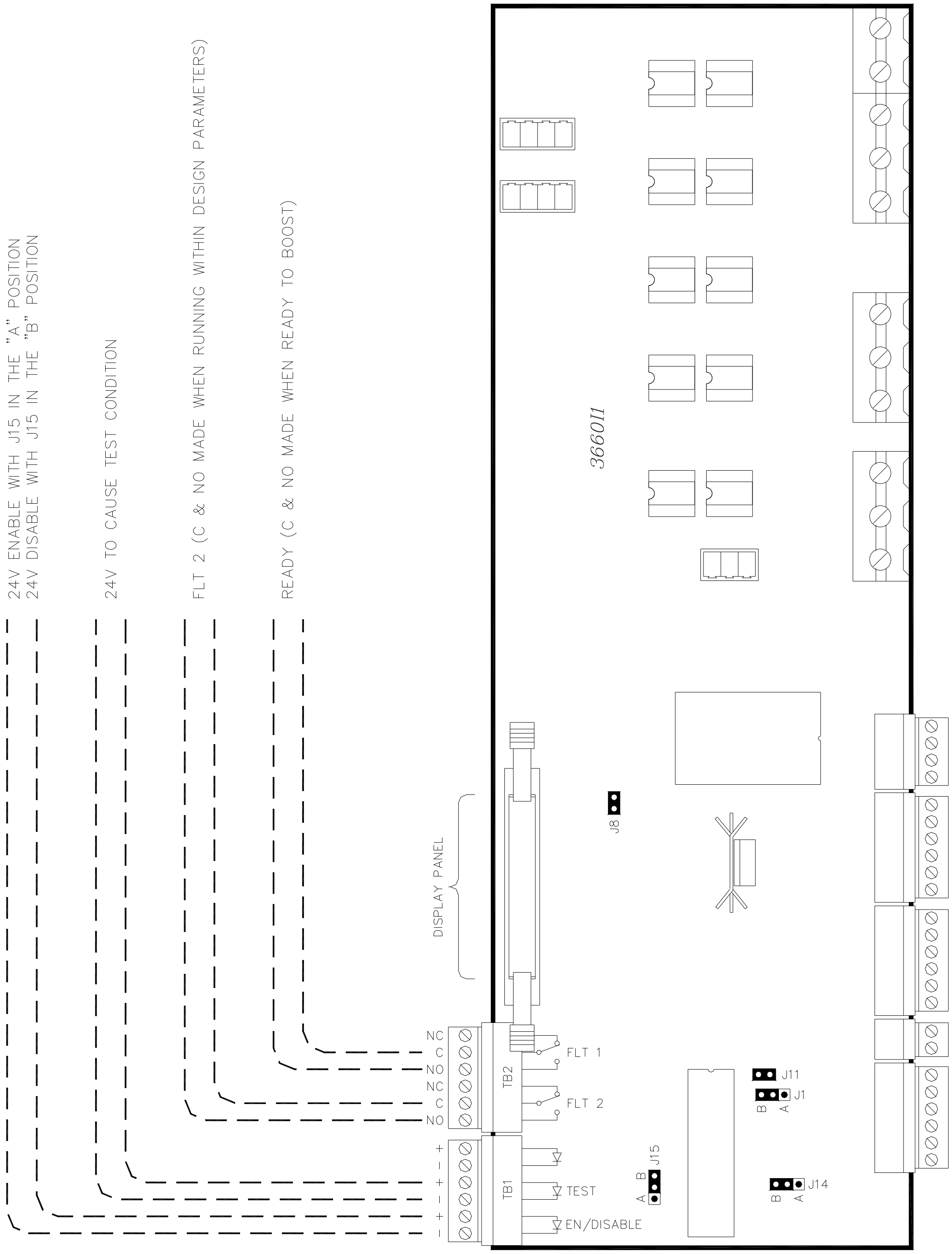
For units using Digital Display, go to Step 3.

2. For units using ASB 3460M6:
   - Refer to Section 4.2.1 of this manual for details.
   - Connect Monitor contacts at 3460M6-TB5.
   - If DPxx display option is used, connect display panel at 3460M6-TB6.
   - Connect 24VDC ENABLE signal to 3460M6-TB7-1,2.
   - Run ENABLE Contact through IUV to protect batteries and thru OT to protect the Ride-Thru Module.
   - Connect a momentary TEST signal to 3460M6-TB7-3,4. Leave open if not used.
3. For units using DDM:
   - Monitor Status2 at TB2 terminals 5&6.
   - Monitor Status1 at TB2 terminals 2&3.
   - Connect 24V ENABLE signal to TB1 terminals 5&6.
   - Connect 24V TEST signal (if used) to TB1 terminals 3&4.

3.4.2.1. FIELD TERMINATIONS

Figure 3-4 shows a typical example of field wiring for the M3460B Battery Regulator Ride-Thru. However, field termination locations for the Battery Regulator Ride-Thru modules will vary according to chassis size and output configuration. For chassis layouts and dimensional outlines, refer to Section 6.6 of this manual. For details on Status Signal Wiring, see Figure 4-1.

Figure 3-1: 3660I Interface Board Layout and ENABLE Command Wiring



Dwg #: 100031 Rev: 20100223

Figure 3-2: Typical Ride-Thru Field Connections with DDM Digital Display

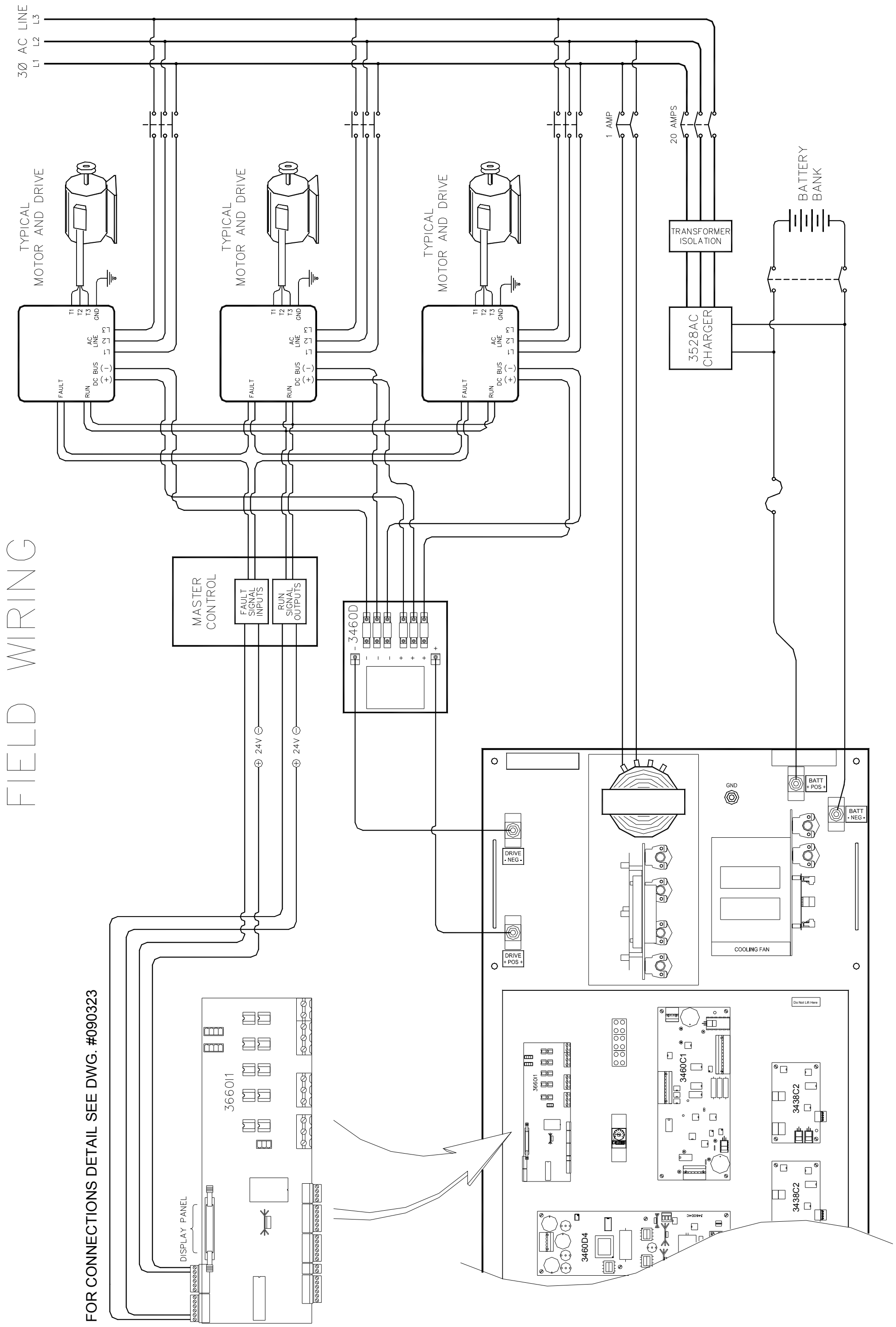
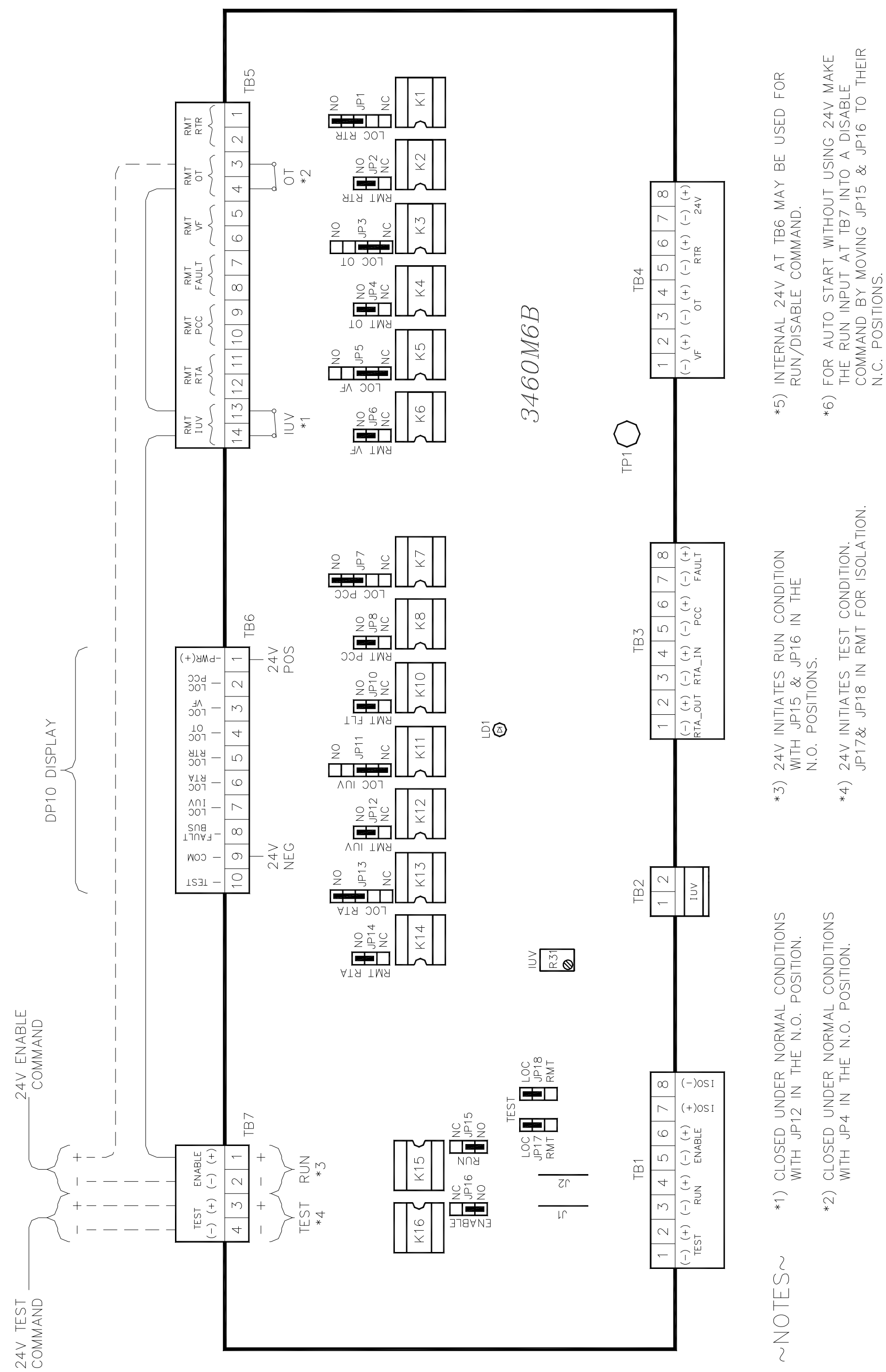
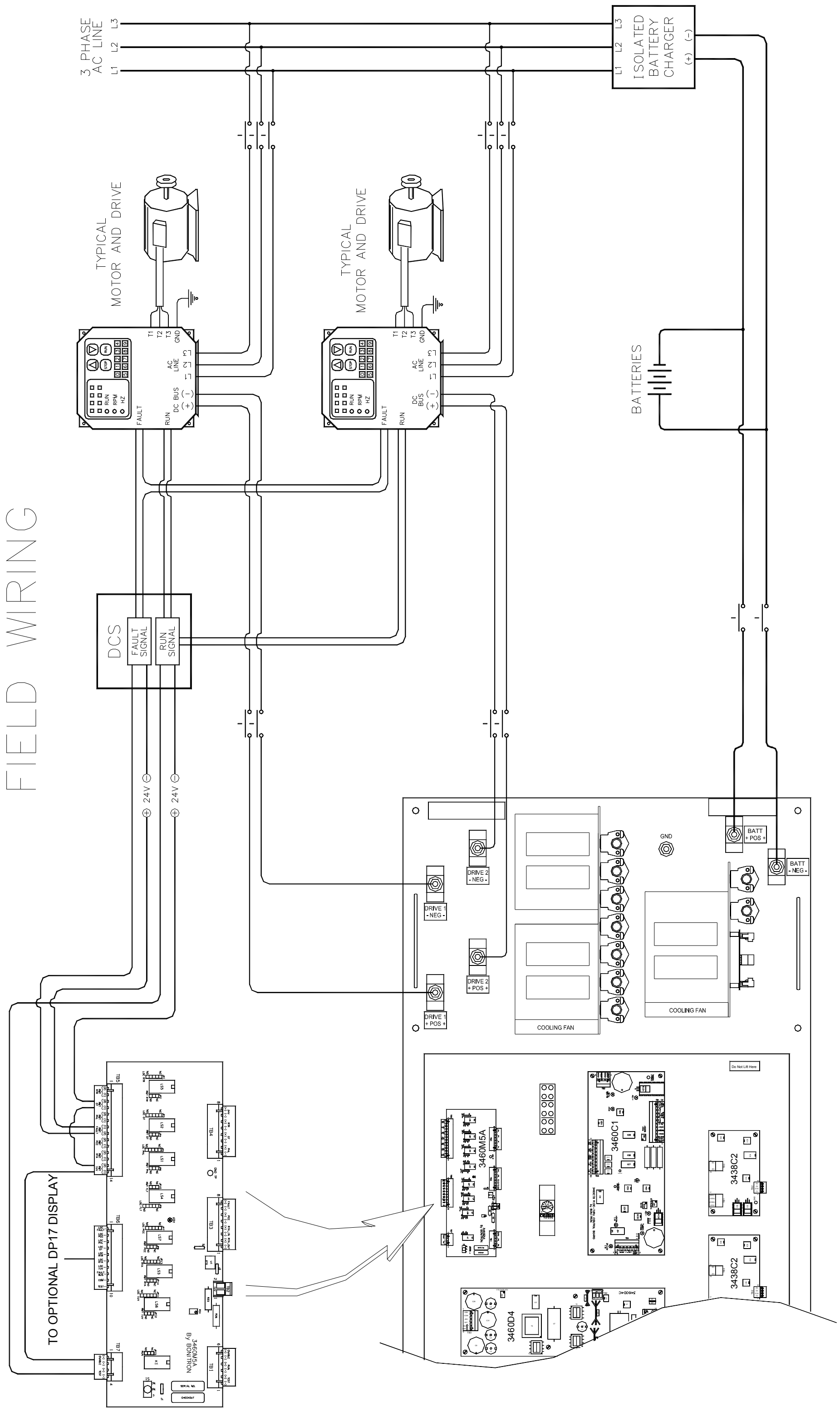


Figure 3-3: 3460M6 Fault Multiplex Interface Board Layout and ENABLE Command Wiring



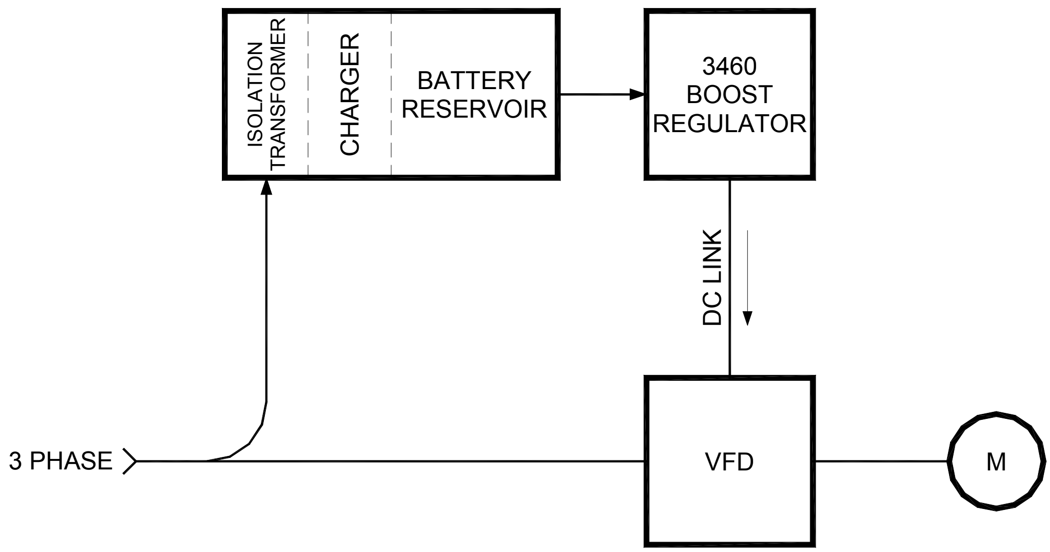
Dwg #: 080486 Rev: 20100317

Figure 3-4: Typical Ride-Thru Field Connections with M6 Board



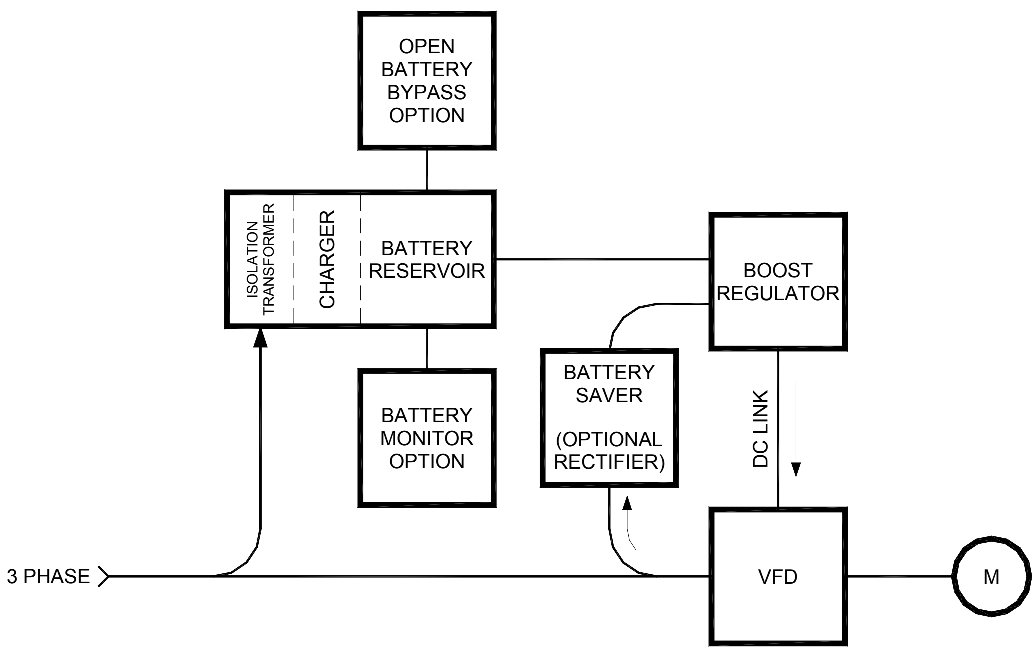
3.5. Typical Configurations

Figure 3-5: DRT Ride-Thru System Configuration 4



ABOVE 50KW, 10 SECOND - 60 MINUTE, 100% OUTAGE PROTECTION
USING DC BOOSTER WITH BATTERY RESERVOIR

Figure 3-6: DRT Ride-Thru System Configuration 6



30 SECOND - 60 MINUTE, 100% OUTAGE PROTECTION
USING DC BOOSTER WITH PROTECTED BATTERY BANK

Dwg #s: 040204 Rev: 20080604 and 040206 Rev: 20090512

4. OPERATION

4.1. FUNCTIONAL DESCRIPTION

The Battery Regulator Ride-Thru Module consists of a Pre-charge section and a Boost Converter section. Each of these sections is discussed briefly below.

4.1.1. PRE-CHARGE SECTION

This section allows the Battery Regulator Ride-Thru Module to safely pre-charge from either the drive DC bus, which is the preferred source, or the battery DC bus. Please note that the battery input is only sufficient to pre-charge the Ride-Thru DC bus. Do not attempt to pre-charge the drive DC bus from the batteries.

Upon application of power, current will bypass the isolation diodes through a series of resistors and PTCs. This will begin pre-charging the bus capacitors. If a problem exists on the Ride-Thru bus, the PTCs will open and pre-charging will stop. Allow approximately 5 minutes for the PTCs to cool before attempting another pre-charge. Please note that the pre-charge PTCs may open after 3 consecutive pre-charges.

When the DC bus reaches its proper level and pre-charging is complete, the Boost Converter section will be enabled and ready to supply power to the DC bus on demand. When the Boost Converter section is needed, an isolation SCR is turned on which provides a path around the pre-charge resistors and PTCs.

4.1.2. BOOST CONVERTER SECTION

The Ride-Thru Module's Boost Converter section is configured in "stages". Each Ride-Thru module can consist of 1, 2, or 4 stages depending on its rated power. Modules rated for 85ADC bus load are 1-stage units. Modules rated at 127 – 170ADC are 2-stage units. Modules rated at 255 – 340A are 4-stage units. Each chopper circuit, or stage, includes (1) DC bus inductor, (1) current sensor, (1) IGBT chopper transistor, (1) output fuse, and (1) blown fuse detector.

The Boost Converter section will regulate the DC bus voltage during line sag conditions to a factory-preset level. Under normal line conditions, the input power will be fed through resistors around the pre-charge SCR modules to the primary filter capacitors. If the voltage sags, the pre-charge SCR modules turn on and the Boost Converter section becomes active to regulate the bus voltage. An internal pot establishes this voltage. The voltage is sensed and regulated by the 3460C1 control board and pumped up by an IGBT chopper circuit or stage. If the DC bus level drops, the IGBT chopper transistor is turned on and the DC bus inductor is connected between the primary DC bus and the negative bus. The inductor current increases and energy is stored in the inductor until a maximum current is reached. At this point the transistor is turned OFF and the energy is transferred to the drive DC bus. Each of the chopper circuits is phase shifted (180° for 2-stage, 90° for 4-stage) from the others to minimize peak current demands.

The boost chopper will switch as fast as needed to keep the DC bus at the preset level. When the maximum switching frequency is reached, the DC bus will drop. When the DC bus drops below 50%, the run relay will drop out and the bus chopper will stop switching. An over-voltage condition on the DC bus (approximately 720VDC) will cause the Ride-Thru section to shut down. The Ride-Thru section will be re-enabled once the DC bus voltage drops below approximately 620VDC for a 460VAC system.

If a chopper circuit output fuse should fail, the corresponding Blown Fuse Detector will activate, and the Ride-Thru Ready signal will turn OFF indicating a fault. The remaining stages will continue to operate during this fault condition.

Cooling fans within the Ride-Thru module will activate to cool the internal components of the Ride-Thru when the chopper section is called on. These fans are controlled by relay (RLY1) to run continuously for a preset time of 120 minutes. RLY1 is factory preset. This setting must not be altered.

4.2. FEATURES

4.2.1. TERMINAL STRIP I/O FOR STANDARD MODELS

Connections for all of the Ride-Thru status and control signals described below are provided on the 3460M6 Fault Multiplex (MUX) interface board on all systems. Refer to the appropriate drawing in Section 6.6 of this manual for 3460M6 locations and to Figures 3-3 and 3-4 for details.

The 3460M6 Fault Multiplex interface board receives and monitors the various Ride-Thru system status signals. These signals are described in detail in this section. The board provides a pair of output signals (1 local, 1 remote) for each of the individual Ride-Thru status signals as well as for a multiplexed fault output. Local outputs are at TB6, are rated for 24V, and are referenced to a single common at TB6-9. These are typically used for the local display panel. Remote outputs are at TB5, are valued for 24V, and each signal pair is isolated. All output contacts are jumper selectable for Normally Open or Normally Closed conditions to provide proper logic state.

4.2.1.1. RIDE-THRU CONTROL INPUTS

There are two inputs that affect control of the Battery Regulator Ride-Thru system: Enable and Test. Each of these inputs is described below.

ENABLE INPUT

The Ride-Thru Module requires a 24VDC signal as an ENABLE input to allow operation of the control circuitry. When this signal is present and the Ride-Thru DC bus is pre-charged, the Ride-Thru module is ready. If the signal is removed, the control board will not be enabled, and the Pre-charge Complete (PCC) and Ride-Thru Ready (RTR) conditions will not occur. The 3460M6 Status Interface board accepts a 24VDC ENABLE signal at TB7-1,2. In order to prevent accidental discharge of battery, IUV signal should be used to remove ENABLE input when battery bank drops below recommended value; and the OT signal should be used to remove the ENABLE in case the Booster Module overheats. (See Figure 3-3)

TEST INPUT

The Ride-Thru accepts a 15-24V signal for TEST and calibration purposes. This remote signal is connected across terminals TB7-3,4 of the 3460M6 Status Interface board.

Initiating the TEST command will cause the Ride-Thru to raise the DC bus level by 100VDC. The inverter input current will drop and the Ride-Thru current will start. If the 3460C1 test time jumper J4 is set to EXT

(External), the DC bus threshold will remain raised for as long as the switch is pressed. If the 3460C1 test time jumper J4 is set to INT (Internal), the DC bus will remain raised for 2 seconds. If this is done under load, time-out will occur in 2 seconds.

This test provides positive proof of Ride-Thru readiness. This test is also useful during field calibration of the Threshold Voltage. (See Section 4.4.1)

4.2.1.2. RIDE-THRU STATUS OUTPUTS

There are six Ride-Thru status signals that are monitored by the 3460M6 Fault Multiplex Interface board: INPUT UNDER-VOLTAGE (IUV), VOLTAGE FAULT (VF), OVER TEMPERATURE (OT), PRECHARGE COMPLETE (PCC), RIDE-THRU READY (RTR), and RIDE-THRU ACTIVE (RTA). Each of these signals, as well as a multiplexed fault output, is described below.

The 3460M6 Status Interface board provides a pair of output signals (1 local, 1 remote) for each of the individual Ride-Thru status signals as well as for the multiplexed fault output. All output signals are rated at 350V, 120mA, 35Ω ON. All output signals are jumper selectable for normally open (N.O.) or normally closed (N.C.) conditions to provide proper logic state.

Local outputs are non-isolated and are suitable for display purposes. All local output connections are provided at TB6 on the 3460M6 board. Remote outputs are isolated and are suitable for use with a PLC interface. All remote output connections are provided at TB5 on the 3460M6 board.

INPUT UNDER-VOLTAGE (L-IUV & R-IUV)

The INPUT UNDER-VOLTAGE signal becomes active when battery voltage drops below the minimum requirements specified in Section 2 of this manual. Bonitron recommends this signal be used to remove the Enable below desired level.

This output is provided for field connection at terminals TB5-13,14 on the 3460M6 board.

VOLTAGE FAULT (L-VF & R-VF)

The VOLTAGE FAULT signal is factory set to become active when the DC bus output voltage drops 25V below the threshold level. Bonitron recommends this signal be used to begin the kinetic buffering process, or other controlled shutdown.

This output is provided for field connection at terminals TB5-5,6 on the 3460M6 board.

OVER-TEMP (L-OT & R-OT)

The OVER-TEMP signal becomes active if the temperature of any heatsink or choke within the Ride-Thru unit exceeds 160°F.

This output is provided for field connection at terminals TB5-3,4 on the 3460M6 board.

PRECHARGE COMPLETE (L-PCC & R-PCC)

The PRECHARGE COMPLETE contact will become active when the DC bus has reached the preset pre-charge level.

This output is provided for field connection at terminals TB5-9,10 on the 3460M6 board.

RIDE-THRU ACTIVE (L-RTA & R-RTA)

The RIDE-THRU ACTIVE signal becomes active if the module is regulating the DC bus voltage under an input voltage dip condition. The RTA signal is also used by the fan relay via an on-board optical output. The Ride-Thru Active signal output has a hold time of approx. 2 seconds after the Ride-Thru Active condition is gone.

This output is provided for field connection at terminals TB5-11,12 on the 3460M6 board.

RIDE-THRU READY (L-RTR & R-RTR)

The RIDE-THRU READY contact will become active when the module is fully operational and capable of regulating the rated DC bus voltage under the specified power sag conditions.

This output is provided for field connection at terminals TB5-1,2 on the 3460M6 board.

MULTIPLEXED FAULT (L-FAULT & R-FAULT)

The VOLTAGE FAULT, OVER-TEMP, and RIDE-THRU READY signals from the system can be combined to provide a pair of multiplexed fault contact outputs. If any of the three multiplexed signals indicates a problem, the Fault output will change states.

The multiplexed fault outputs are provided for field connection at terminals TB5-7,8 on the 3460M6 board.

4.2.2. TERMINAL STRIP I/O FOR MODELS WITH DIGITAL DISPLAY

4.2.2.1. RIDE-THRU CONTROL INPUTS

ENABLE COMMAND (ENABLE/DISABLE) INPUT

The Enable command input is isolated and should be between 20 and 28VDC. Connection is made on TB1 terminals 5&6 of the 3660I interface board. It can be configured to be an Enable or a Disable command. Jumper J15 on the 3660I interface board determines the active state of this input. With J15 in the "A" position 24VDC allows the booster to become active if the DC bus is below the threshold. With J15 in the "B" position the booster can become active with no input voltage, while 24V will inhibit the booster from switching.

TEST COMMAND

The test command input is isolated and should be between 20 and 28VDC. Connection is made on TB1 terminals 3 & 4 of the 3660I interface board. The test command will cause the booster to become active raising the DC bus above normal line conditions in order to prove the booster is able to function. The test command will cause switching in real time (as long as the test command is active high) but will be shut down from Fault2 conditions if the display is in automatic mode.

4.2.2.2. RIDE-THRU STATUS OUTPUTS

FAULT1 OUTPUT

Fault1 signal is an optically isolated relay contact used for remote status monitoring and can be accessed via TB2 terminals 1-3 (N.C. at 1&2, N.O. at 2&3). Precharge Complete, Ride-Thru Ready, or Output Under

Voltage signals will cause Fault1 contact to change states. Operator intervention is required to determine the cause of the fault.

FAULT2 OUTPUT

Fault2 signal is an optically isolated relay contact used for remote status monitoring and can be accessed via TB2 terminals 4-6 (N.C. at 4&5, N.O. at 5&6).

Input Under voltage, Over-temp, or RTA time will cause Fault2 to change states. If the display is set for automatic mode, Fault2 conditions will cause the booster to shut down switching. Operator intervention is required to determine the cause of the fault. Fault2 is a latching fault and the booster will not run again until the source of the fault clears AND a reset is given either from the front panel or by cycling the external Enable command. In manual mode this fault still latches, but it will not shut down the booster.

4.2.3. LOCAL INDICATORS (ON BOOSTER MODULE PCBS)

Table 4-1: The following LED indicators can be found on the 3460C1 pcb:

SIGNAL	ID #	COLOR	DESCRIPTION
+15V	LED 6	Red	Indicates +15V is present
-15V	LED 7	Red	Indicates -15V is present
PCC	LED 4	Red	Indicates precharge has completed and enable command is present
RTR	LED 3	Red	Indicates precharge is complete, enable command is present, and there are no blown stage fuses.
RTA	LED 2	Red	Indicates Ride Thru is active
TEST	LED 1	Red	Indicates test is in progress
BF	LED 5	Red	Indicates a stage fuse is blown

Table 4-2: The following LED indicators can be found on the 3460M6 pcb:

SIGNAL	ID #	COLOR	DESCRIPTION
No Fault	LED 1	Green	Indicates there are no faults in the booster module

Table 4-3: The following LED indicators can be found on the 3460D5 pcb:

SIGNAL	ID #	COLOR	DESCRIPTION
+23V	LED 3	Red	Indicates +23V is present
-23V	LED 4	Red	Indicates -23V is present
ISO 23	LED 2	Red	Indicates isolated 23V is present
Bus OK	LED 1	Green	Indicates output DC bus level is OK

Figure 4-1: Status & Control Field Connections (M6 Basic Schematic)

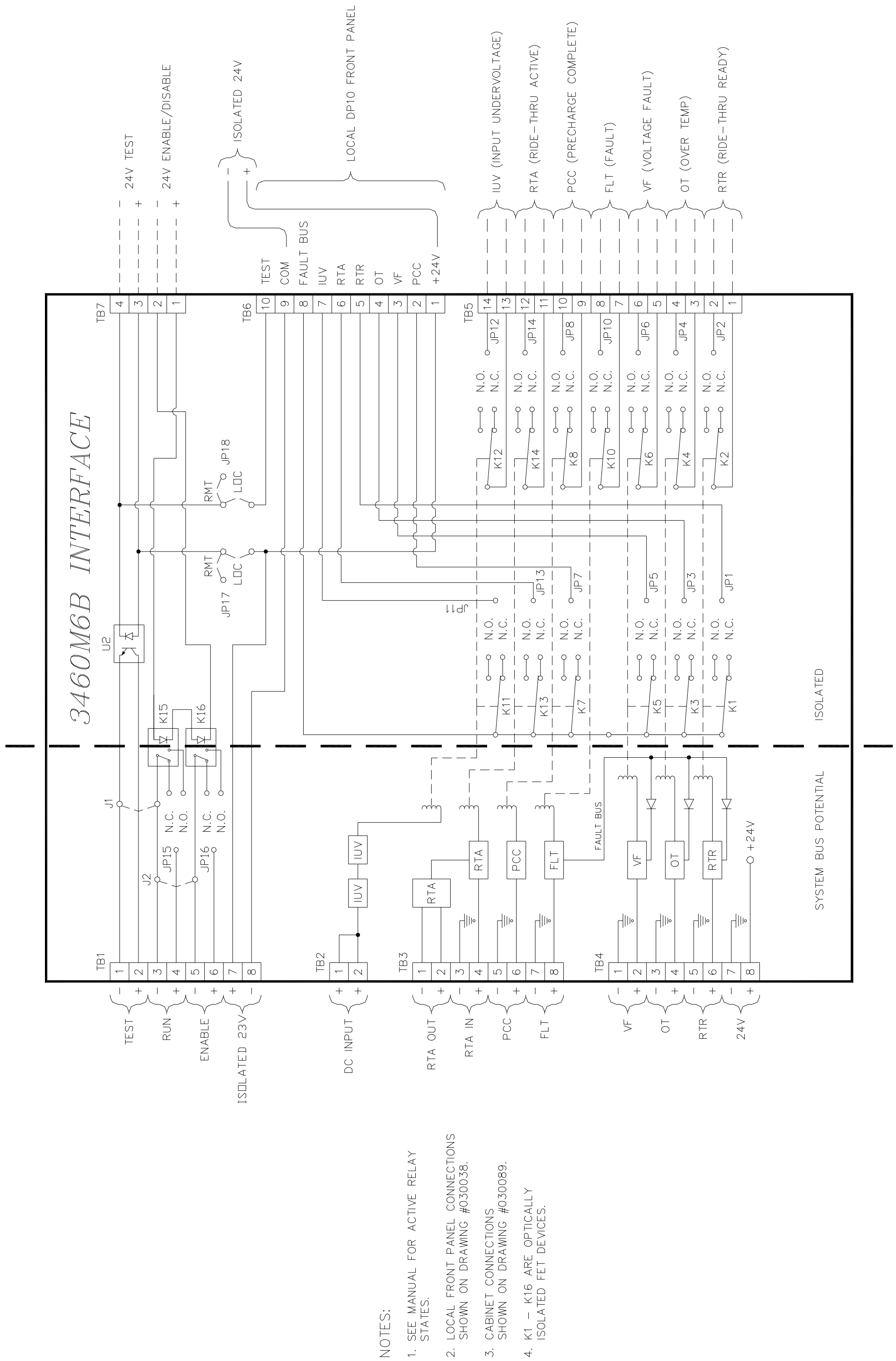


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Table 4-4: Control Signal Specifications

CONTROL / STATUS SIGNAL	SIGNAL SPECS	ACTIVE STATE
Alternate Enable Input	24VDC @ 35mA	24VDC to run
Test Input	24VDC @ 35mA	24VDC to test
Ride-Thru Status Outputs	Jumper selectable N.O. / N.C. OptoFET 350V @ 120mA	Jumper selectable (see Figures 3-1, 4-1 and Table 4-2)

Table 4-5: 3460M6 Fault Multiplex Interface I/O Signal Logic Jumper Details

STATUS SIGNAL	OUTPUT	LOCAL / REMOTE	LOGIC STATE JUMPERS		OUTPUT TERMINALS
			JUMPER	FACTORY SETTING	
Multiplexed Fault	L-FAULT	Local	None	Normally CLOSED (N.C.)	TB6-8,9
	R-FAULT	Remote	J10	Normally OPEN (N.O.)	TB5-7,8
Pre-charge Complete	L-PCC	Local	J7	Normally OPEN (N.O.)	TB6-2,9
	R-PCC	Remote	J8	Normally OPEN (N.O.)	TB5-9,10
Voltage Fault	L-VF	Local	J5	Normally CLOSED (N.C.)	TB6-3,9
	R-VF	Remote	J6	Normally OPEN (N.O.)	TB5-5,6
Over Temperature	L-OT	Local	J3	Normally CLOSED (N.C.)	TB6-4,9
	R-OT	Remote	J4	Normally OPEN (N.O.)	TB5-3,4
Ride-Thru Ready	L-RTR	Local	J1	Normally OPEN (N.O.)	TB6-5,9
	R-RTR	Remote	J2	Normally OPEN (N.O.)	TB5-1,2
Ride-Thru Active	L-RTA	Local	J13	Normally OPEN (N.O.)	TB6-6,9
	R-RTA	Remote	J14	Normally OPEN (N.O.)	TB5-11,12
Input Under-voltage	L-IUV	Local	J11	Normally CLOSED (N.C.)	TB6-7,9
	R-IUV	Remote	J12	Normally OPEN (N.O.)	TB5-13,14

4.2.4. LOCAL METERS AND COUNTERS

Local meters or counters are not standard features on this model.

4.2.5. DIGITAL DISPLAYS

Display Display panels are not a standard feature, but can be purchased as an option.

4.2.5.1. BASIC DIGITAL DISPLAY MODES

AUTOMATIC CONTROL MODE

In this mode the processor monitors some Ride-Thru functions and will automatically shut down the run command, thus stopping the boost function. Fault signals are available for remote notification.

The Ride-Thru can be enabled remotely with a 24V command, or automatically if J15 is set for a 24V Disable command. In both cases, the run command will ultimately be shut down if certain faults appear. J15 can be set for a 24V Disable command so that with no input from the control room the booster is automatically ready to run once proper power is applied.

MANUAL CONTROL MODE

In this mode the processor will only monitor the system status, and will not shut down the run command. In this mode, it is recommended that fault signals are monitored, and a remote enable or disable signal be used to stop the switching.

In an effort to keep the Bonitron module from running outside its specifications, Bonitron will ship with the system set up for automatic control. Since some applications are of such crucial importance, we realize the desire to continue running may outweigh any concerns for the Ride-Thru system. If your application is this critical, you may want to use the manual mode.

TO CHANGE BETWEEN AUTOMATIC TO MANUAL MODES

See Figure 3-1 for Jumper Locations.

To place the display in the Manual mode, place J1 and J14 in the up or “A” position.

To place the display in the Automatic mode, place J1 and J14 in the down or “B” position.

ENABLE MODE

In this mode a 24V input causes the booster to become enabled providing there are no fault conditions. A fault condition may shut down the run command to the booster depending on the position of J14.

DISABLE MODE

In this mode a 24V input causes the booster to become disabled, and no boosting can occur. Use this mode if no external Enable command is used.

TO CHANGE BETWEEN ENABLE AND DISABLE REMOTE CONTROL MODES

To make the remote 24V signal an Enable command, place J15 in the “A” position.

To make the remote 24V signal a Disable command or to run automatically without external input, place J15 in the “B” position.

FAULT SIGNALS

Fault1 will change states if OUV or BF occur, or if RTR & PCC turn off, signaling to the control room that an operator should go out and check the Ride-Thru front panel for more information. This signal may be considered a READY signal.

Fault2 will change states only if Over-Temp, Input Under-Voltage, or Active Time faults occur. If any of these faults occur, and the Ride-Thru is in automatic control, the run command will be shut down. If Fault2 occurs, and the display is in manual mode, there should be immediate attention given to the Ride-Thru system, and remotely shutting down the boost function should be considered.

TEST FUNCTION

Test mode can be disabled by removing J11. See Figure 3-1 for physical location.

Table 4-6: Manual Control with Enable Signal

3660I JUMPERS		3660I SIGNAL INPUTS			3660I OUTPUTS				3660D DISPLAY PANEL
J1 AND J14	J15	OT, IUV OR RTO	RTR, PCC, BF OR OUV	ENABLE	FLT 1	FLT 2	RUN 1	LATCH	DISPLAY FAULT INDICATIONS
A or "MANUAL"	A or "ENABLE"	OK		24V	-	-	X	-	Normal
				0	-	-	-	-	
		Fault		24V	-	X	X	Y	Temp, Batt UV or RTA Time
				0	-	X	-	Y	
			OK	24V	-	-	X	N	Normal
				0	-	-	-	N	
			Fault	24V	X	-	X	N	RTR, PCC, BF or OUV
				0	X	-	-	N	

Table 4-7: Manual Control with Disable Signal

3660I JUMPERS		3660I SIGNAL INPUTS			3660I OUTPUTS				3660D DISPLAY PANEL
J1 AND J14	J15	OT, IUV OR RTO	RTR, PCC, BF OR OUV	ENABLE	FLT 1	FLT 2	RUN 1	LATCH	DISPLAY FAULT INDICATIONS
A or "MANUAL"	B or "DISABLE"	OK		24V	-	-	-	-	Normal
				0	-	-	X	-	
		Fault		24V	-	X	-	Y	Temp, Batt UV or RTA Time
				0	-	X	X	Y	
			OK	24V	-	-	-	N	Normal
				0	-	-	X	N	
			Fault	24V	X	-	-	N	RTR, PCC, BF or OUV
				0	X	-	X	N	

Table 4-8: Automatic Control with Enable Signal

<table>
<tr><th colspan="2">3660I JUMPERS</th><th colspan="3">3660I SIGNAL INPUTS</th><th colspan="4">3660I OUTPUTS</th><th>3660D DISPLAY PANEL</th></tr>
<tr><th>J1 AND J14</th><th>J15</th><th>OT, IUV OR RTO</th><th>RTR, PCC, BF OR OUV</th><th>ENABLE</th><th>FLT 1</th><th>FLT 2</th><th>RUN 1</th><th>LATCH</th><th>DISPLAY FAULT INDICATIONS</th></tr>
<tr><td rowspan="8">B or “AUTOMATIC”</td><td rowspan="8">A or “ENABLE”</td><td rowspan="2">OK</td><td rowspan="4"></td><td>24V</td><td>-</td><td>-</td><td>X</td><td>-</td><td rowspan="2">Normal</td></tr>
<tr><td>0</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td rowspan="2">Fault</td><td>24V</td><td>-</td><td>X</td><td>-</td><td>Y</td><td rowspan="2">Temp, Batt UV or RTA Time</td></tr>
<tr><td>0</td><td>-</td><td>X</td><td>-</td><td>Y</td></tr>
<tr><td rowspan="4"></td><td rowspan="2">OK</td><td>24V</td><td>-</td><td>-</td><td>X</td><td>N</td><td rowspan="2">Normal</td></tr>
<tr><td>0</td><td>-</td><td>-</td><td>-</td><td>N</td></tr>
<tr><td rowspan="2">Fault</td><td>24V</td><td>X</td><td>-</td><td>X</td><td>N</td><td rowspan="2">RTR, PCC, BF or OUV</td></tr>
<tr><td>0</td><td>X</td><td>-</td><td>-</td><td>N</td></tr>
</table>

Table 4-9: Automatic Control with Disable Signal

<table>
<tr><th colspan="2">3660I JUMPERS</th><th colspan="3">3660I SIGNAL INPUTS</th><th colspan="4">3660I OUTPUTS</th><th>3660D DISPLAY PANEL</th></tr>
<tr><th>J1 AND J14</th><th>J15</th><th>OT, IUV OR RTO</th><th>RTR, PCC, BF OR OUV</th><th>ENABLE</th><th>FLT 1</th><th>FLT 2</th><th>RUN 1</th><th>LATCH</th><th>DISPLAY FAULT INDICATIONS</th></tr>
<tr><td rowspan="8">B or “AUTOMATIC”</td><td rowspan="8">B or “DISABLE”</td><td rowspan="2">OK</td><td rowspan="4"></td><td>24V</td><td>-</td><td>-</td><td>-</td><td>-</td><td rowspan="2">Normal</td></tr>
<tr><td>0</td><td>-</td><td>-</td><td>X</td><td>-</td></tr>
<tr><td rowspan="2">Fault</td><td>24V</td><td>-</td><td>X</td><td>-</td><td>Y</td><td rowspan="2">Temp, Batt UV or RTA Time</td></tr>
<tr><td>0</td><td>-</td><td>X</td><td>-</td><td>Y</td></tr>
<tr><td rowspan="4"></td><td rowspan="2">OK</td><td>24V</td><td>-</td><td>-</td><td>-</td><td>N</td><td rowspan="2">Normal</td></tr>
<tr><td>0</td><td>-</td><td>-</td><td>X</td><td>N</td></tr>
<tr><td rowspan="2">Fault</td><td>24V</td><td>X</td><td>-</td><td>-</td><td>N</td><td rowspan="2">RTR, PCC, BF or OUV</td></tr>
<tr><td>0</td><td>X</td><td>-</td><td>X</td><td>N</td></tr>
</table>

4.3. START-UP

This section provides details on the start-up procedure for the cabinet mountable M3460B Battery Regulator Ride-Thru system. **Please read through this section in its entirety before proceeding.**

4.3.1. PRE-POWER CHECKS

1. Ensure the Bonitron Ride-Thru has been properly installed as per the instructions in Section 3 of this manual.
2. The Ride-Thru DC bus threshold must be coordinated with the under voltage trip setting of the inverter. If the threshold is too close to the nominal bus, the Ride-Thru may supply power to the drive continuously, and overheat. If the threshold is too close to the under voltage trip level of the inverter, the system may not ride through, and under voltage trips will still occur. Most inverters have an under voltage trip point of -15% of nominal. Some inverters can be reprogrammed to change this trip level. Bonitron typically would like the DC bus threshold to be about -10% of the nominal bus. For example, Bonitron sets all 460VAC systems to hold the DC bus to 585VDC.
    - Refer to your inverter's documentation for details on adjustment of the under voltage trip setting.
        - Some inverters automatically change this setting when main voltage is programmed, and is typically 80-85% of full DC bus voltage.
        - Some inverters do not allow adjustment.
    - Refer to Section 4.4 for details on how the Ride-Thru DC bus threshold can be changed.
3. If start-up must be done during production runs, disable the inverter ground fault until testing can be done. See Section 7.3, step 9.
4. If equipped with the Ride-Thru disconnect, turn off, and apply power to the system. Otherwise, proceed to the Startup Procedure Section.
    - Ensure that the associated inverter is working properly.
    - Confirm the under voltage trip point if possible.
5. Initialize the battery cabinet.
    - High voltage battery cabinets are shipped with links missing.

DANGER!

As battery modules are connected, high voltage levels will be present inside cabinet. Be careful around these high level DC voltages! Insulating gloves should be worn while standing on an insulated mat when touching battery power plugs.

- Verify that battery disconnect or breaker switch is OFF.
- Re-connect battery bank link as instructed by battery bank documentation package provided by battery bank manufacturer.
- Measure battery string voltage.
    - Should measure halfway between nominal and charge voltage.
- Ensure polarity on both sides of the battery breaker is correct before closing breaker.
    - ** Incorrect polarity will cause blown fuses and possible equipment damage.

4.3.2. STARTUP PROCEDURE AND CHECKS

1. Turn on battery disconnect first.

CAUTION!

> *To avoid the possibility of blowing fuses if the battery disconnect is opened, allow DC bus to discharge until* ***PRECHARGE COMPLETE*** *and* ***RIDE-THRU READY*** *LEDs go* ***OFF****, before turning battery disconnect back on, or remove RUN/ENABLE to allow soft pre-charge.*

- RTM primary DC bus will charge to battery input level.
  - Inrush current should be less than 20 amps.
  - Pre-charge circuit PTCs may overheat with more than 2 consecutive pre-charge cycles.

  <u>FOR MODELS EQUIPPED WITH DP17 DISPLAY PANELS:</u>
  - Front Panel Display should be as follows:
    - POWER LED turns ON
    - PCC LED is OFF
    - RTR LED is OFF
    - RTA LED is OFF
    - VF LED is OFF
    - OT LED is OFF
    - Voltmeter should read battery voltage
    - Current meter should read zero amps

  <u>FOR MODELS EQUIPPED WITH DDM DIGITAL DISPLAY PANELS:</u>
  - See DDM manual for details on display navigation.
    - Clear Batt UV fault
    - Front Panel LEDs should be as follows:
      - POWER LED turns ON
      - Status LED remains OFF
    - Fault LED remains ON
    - Front Panel Display should be as follows:
      - PCC and RTR fault

  <u>FOR STANDARD MODELS:</u>
  - 3460C1 control board LEDs should be as follows:
    - +15V = ON
    - –15V = ON
    - PRECH COMPL = OFF
    - RT READY = OFF
    - RIDE-THRU ACTIVE = OFF
    - BLOWN FUSE = OFF
    - TEST = OFF
  - 3460M6 Interface board LED should be as follows:
    - NO FAULT LED should be OFF
  - 3460D5 Power Supply board LEDs should be as follows:
    - +23v = ON
    - -23v = ON
    - ISO 23v = ON
    - Bus OK = ON

2. Apply ENABLE command.
   - Audible ticking can be heard.

- RTM Secondary output DC bus will be boosted to the threshold level.
- See Threshold Adjustment Procedure in Section 4.4 for typical settings.

FOR MODELS EQUIPPED WITH DP17 DISPLAY PANELS:

- Front Panel Display should be as follows:
  - POWER LED turns ON
  - PCC LED turns ON
  - RTR LED turns ON
  - RTA LED turns ON
  - VF LED remains OFF
  - OT LED remains OFF
  - Voltmeter should read threshold voltage
  - Current meter should read zero amps
  - Counter should increment once

FOR MODELS EQUIPPED WITH DDM DIGITAL DISPLAY PANELS:

- See DDM manual for details on display navigation.
- Front Panel LEDs should be as follows:
  - POWER LED turns ON
  - Status LED turns ON
  - Fault LED turns OFF
- Front Panel LCD Display should be as follows:
  - All faults should clear upon Enabling
  - Bargraph display reads input and output voltages

FOR STANDARD MODELS:

- 3460C1 control board LEDs should be as follows:
  - +15V = ON
  - –15V = ON
  - PRECH COMPL = ON
  - RT READY = ON
  - RIDE-THRU ACTIVE = Flashing ON
  - BLOWN FUSE = OFF
  - TEST = OFF
- 3460M6 Interface board LED should be as follows:
  - NO FAULT LED should be ON
- 3460D5 Power Supply board LEDs should be as follows:
  - +23v = ON
  - -23v = ON
  - ISO 23v = ON
  - Bus OK = ON

3. Initiate a test command.

FOR MODELS EQUIPPED WITH DP17 DISPLAY PANELS:

- Press test button on panel.

FOR MODELS EQUIPPED WITH DDM DISPLAY PANELS:

- Navigate to test screen and press the right arrow button.

FOR STANDARD MODELS WITH NO DISPLAY PANEL:

- Apply 24V to test input on 3460M6 interface board.
- RTM secondary output DC bus should rise to test level.

- See threshold adjustment procedure and Table 4-10 for typical settings.
- 3460C1 RIDE-THRU ACTIVE LED should quickly turn on and then flash during remainder of test cycle.
- 3460C1 Blown fuse indication should remain OFF.
- 3460C1 RT READY indication should remain ON.
- Front panel should show activity.
- DP17 will NOT count local test cycles.
- DDM will count local test cycles.

4. For multiple output systems, turn on single phase to “P300” power supply.
   - DC bus will rise to a little below nominal line value.
   - RTA indication will turn OFF.
5. Connect inverter loads.
   - Turn on drive bus disconnect switches (one at a time for multiple output systems).
     - Ensure drive bus levels downstream of isolation diodes are HIGHER than the Ride-Thru bus level.
     - When the drive is fully loaded and the DC bus level drops, some residual current up to .5 ADC may flow from Ride-Thru to the drive’s busses.
6. Verify remote status connections if used.
   - Logic states selectable by jumpers on 3460M6 or 3660I1 interface boards
     - Removing Enable should remove Ride-Thru Ready, and cause a fault condition.

     FOR STANDARD MODELS AND THOSE WITH DP17 DISPLAY PANELS

     - Refer to Table 4-2 and Figure 4-1 for fault signal logic jumper selection details for 3460M6 board.

     FOR MODELS EQUIPPED WITH DDM DIGITAL DISPLAY PANELS

     - See DDM manual for details on display navigation.
     - Refer to Figure 3-1 and Tables 4-6 through 4-9 of this manual.
7. Verify system capability.
   - Run inverter under some load. Initiate a test.
   - The 3460C1 TEST LED should come ON for 2 seconds.
   - The 3460C1 RIDE-THRU ACTIVE LED should come ON for 2 seconds (RTA will flash if the load is light, stay on if the load is heavy).
   - DC bus on Ride-Thru should rise.
   - Drive DC bus should rise.
   - Motor speed should not change.
   - Inverter input current should drop.
8. Verify energy storage bank charge.
   - Remove AC power from the fully loaded inverter simulating an outage event.
   - The DC bus voltage should drop to and hold at the threshold.
   - Ride-Thru Active LED should turn ON.
   - Activity counter should increment.
   - DC input will drop as the batteries discharge.

- Do not allow batteries to discharge below suggested minimum levels. See Table 6-4.
- Motor speed should remain constant.

FOR MODELS EQUIPPED WITH DDM DIGITAL DISPLAY PANELS:

- See DDM manual for details on display navigation.
  - Bargraph meters can be set to read input and output voltages, as well as input and output currents.
    - Factory default settings are input and output voltage.
  - Real time and length of activity data can be accessed via front panel.

This completes the start up procedure.

4.4. OPERATIONAL ADJUSTMENTS

4.4.1. THRESHOLD VOLTAGE AND LOW BUS SENSE ADJUSTMENT PROCEDURES FOR M3460 RIDE-THRU SYSTEMS

This section provides details on Threshold Voltage and Low Bus Sense Adjustment Procedures for Model M3460 Ride-Thru Systems. **Please read through this section in its entirety before proceeding**.

4.4.1.1. OVERVIEW

The Threshold voltage level is the voltage at which the Bonitron Model M3460 Ride-Thru Module maintains the DC bus during a power sag. Whenever the DC bus level drops to the threshold setpoint, the Ride-Thru Module becomes active to regulate the DC bus voltage to the threshold setpoint voltage.

Generally, the threshold level should be set at 10-15% below the nominal DC bus level. An actual on-site level setting must be determined by the loaded DC bus level as well as the amount of ripple present on the DC bus. The Ride-Thru Module should not become ACTIVE during normal everyday operation.

The Threshold level is factory preset on all Bonitron Model M3460 Ride-Thru Modules. These levels are specified in the Voltage Specifications section of the Customer Reference manual for each Ride-Thru module. However, some field adjustment of this level may be required to achieve the optimum setpoint level for any given system.

It is important to note that the Ride-Thru module's LOW DC BUS or VOLTAGE FAULT (VF) setpoint is factory preset to approximately 5% below the threshold voltage. This setpoint should be maintained at approximately 5% below threshold to avoid improper VF activity.

*** Please note that not all models are wired to utilize the VOLTAGE FAULT. ***

Table 4-10 lists the typical factory setpoints for the threshold, LOW DC BUS (VF) and TEST BOOST levels for the Model M3460 Ride-Thru Modules based on the system AC or DC input voltage requirements.

* Any ripple on the DC bus will be sensed by the control circuits. A multimeter may not show ripple valleys that drop below the threshold causing activity. In this case, an oscilloscope should be used.

Table 4-10: Factory Setpoints for Threshold and Test Boost Voltages

SYSTEM AC VOLTAGE	MINIMUM INPUT VOLTAGE	THRESHOLD	LOW DC BUS (VF)	TEST BOOST
230	200VDC	285VDC	260VDC	+50VDC
380	340VDC	485VDC	460VDC	+75VDC
400	350VDC	495VDC	470VDC	+100VDC
415	360VDC	505VDC	480VDC	+100VDC
460	400VDC	585VDC	560VDC	+100VDC

4.4.1.2. DETERMINING THE THRESHOLD VOLTAGE SETPOINT

Testing and adjustment of the threshold voltage setpoint can be performed on systems in either an "On-line and loaded" or an "Off-line and unloaded" condition as described in Methods 1 and 2 below. Each of the two methods described require that you monitor the DC bus voltage during the testing and adjustment procedures.

Monitor both the drive and booster DC bus levels. The drive DC bus should be higher than the Booster DC bus. If it is not, the Booster will constantly feed the drive bus, and this is an undesirable condition.

CAUTION!

Be sure to read through both adjustment methods completely before attempting any adjustment of the Threshold and Low DC Bus voltage setpoints.

METHOD 1: DETERMINING THRESHOLD VOLTAGE SETPOINT FOR ON-LINE LOADED SYSTEMS

1. Verify proper installation.
2. Ensure that the Bonitron Model M3460 Ride-Thru Module has been properly installed and wired according to all applicable system and module wiring diagrams.
3. Initiate the TEST sequence while monitoring the DC bus voltage.
    - On modules so equipped, the TEST button is located on the module's control/display front panel. DP17 Diagnostic Display Panels use the 3660D1 display board which is equipped with an on-board J1 jumper to enable/disable the TEST button. To enable the display front panel TEST button, be sure the J1 jumper is in position A. Setting jumper J1 to position B will disable the display front panel TEST button.
    - On Digital Displays, press any button to access the Main Menu and follow prompts to initiate a TEST sequence.
    - For modules without a control/display front panel, a 24VDC signal is required at 3460M6 TB7-3,4 to initiate the test. Refer to applicable field wiring diagrams for switch connection points. (Figure 4-1)
4. Read the DC bus meter and subtract the Boost voltage.
5. When the TEST sequence is initiated, the Threshold voltage level is "Boosted" for a certain period of time. This time interval is dependent upon the setting of jumper J4 on the 3460C Control Board. With the J4 jumper in the INT position, the interval will be

approximately 2 seconds. With the jumper in the EXT position, the Boost will be maintained in real-time for as long as the test is active.

6. During the Boost period, you should see the DC bus level increase. The amount that the DC Bus actually increases will depend on the Boost and Threshold level adjustments as well as the input voltage and DC bus output current.
7. For example, for a Ride-Thru system with an input voltage of 460VAC, the Threshold voltage level is preset to be 590VDC and the Boost voltage level is factory preset for an increase of 100VDC.

Assuming that the preset levels have not been altered, initiating the test described above on a lightly loaded system of this nature will cause the DC bus level to rise to 690VDC (590VDC + 100VDC). Subtracting the Boost voltage (100VDC) from the reading shows that the actual Threshold voltage level is 590VDC.

Initiating this test on a heavily loaded system of this nature will also cause the DC bus level to rise. However, the DC bus will stop rising once current limit is reached.

NOTE: The adjustable Boost voltage level is factory preset. It is not recommended that this setpoint be altered. If the setpoint has been changed from its original factory setting, this test method will be inaccurate.

METHOD 2: DETERMINING THRESHOLD VOLTAGE SETPOINT FOR OFF-LINE UNLOADED SYSTEMS

1. Remove input voltage supply from system.
2. As the DC bus drops to the Threshold setpoint voltage, the Ride-Thru module will become active. The Ride-Thru will then maintain the DC bus voltage at the Threshold setpoint level as long as the energy storage bank has enough voltage left. Read the DC bus voltage as it is being maintained. This is the Threshold setpoint voltage.

4.4.1.3. ADJUST THE SETPOINTS AND REPEAT THE TEST

Once the actual Threshold voltage has been determined you can make adjustments, if required, to achieve the optimum setting for your system. The Low DC Bus setpoint should be adjusted to match any Threshold adjustment that is made.

The Threshold voltage should be set to approximately 10% below the nominal DC bus under load, and coordinated to be above the associated inverter's under-voltage trip level. Most inverters have an under-voltage trip point of approximately 15% below the nominal DC bus under load. Some inverters can be reprogrammed to change this trip level as needed.

Adjustment pot R7 on the 3460C1 control board (see Figure 4-2) is used to set the Threshold voltage level. Adjusting the pot in a clockwise direction will raise the setpoint level by approximately 12 volts per revolution of the pot adjustment screw. Alternately, a counter-clockwise adjustment of the pot will lower the setpoint level. The Threshold setpoint level can be adjusted to approximately ±35VDC of the factory setpoint previously listed in Table 4-10.

Adjustment pot R3 on the 3460D5 power supply board (see Figure 4-3) is used to set the Low DC Bus voltage level. Adjusting the pot in a clockwise direction will raise the setpoint level by approximately 5.5 volts per revolution of the pot adjustment screw. Alternately, a counter-clockwise adjustment of the pot will lower the setpoint level. Be sure to match any adjustment made to the Threshold voltage level.

****** Please note that not all models are wired to utilize the VOLTAGE FAULT.

After making the adjustments, repeat the test from Section 4.4.1.2 to verify the new setpoint. Fine tune the adjustment and retest as necessary.

Figure 4-2: Typical Ride-Thru Module 3460C1 Control Board Layout

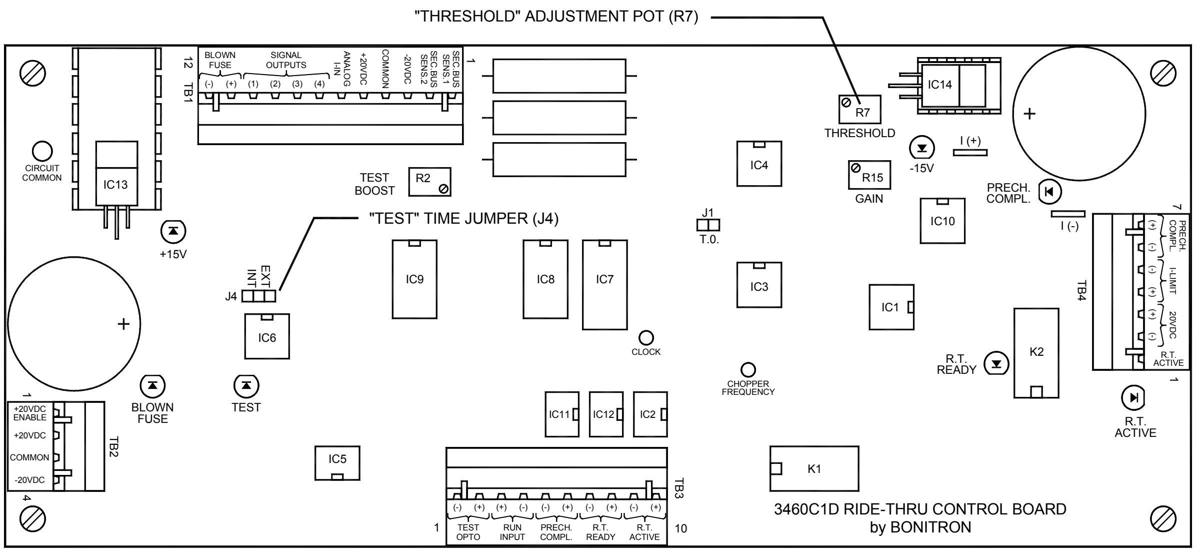
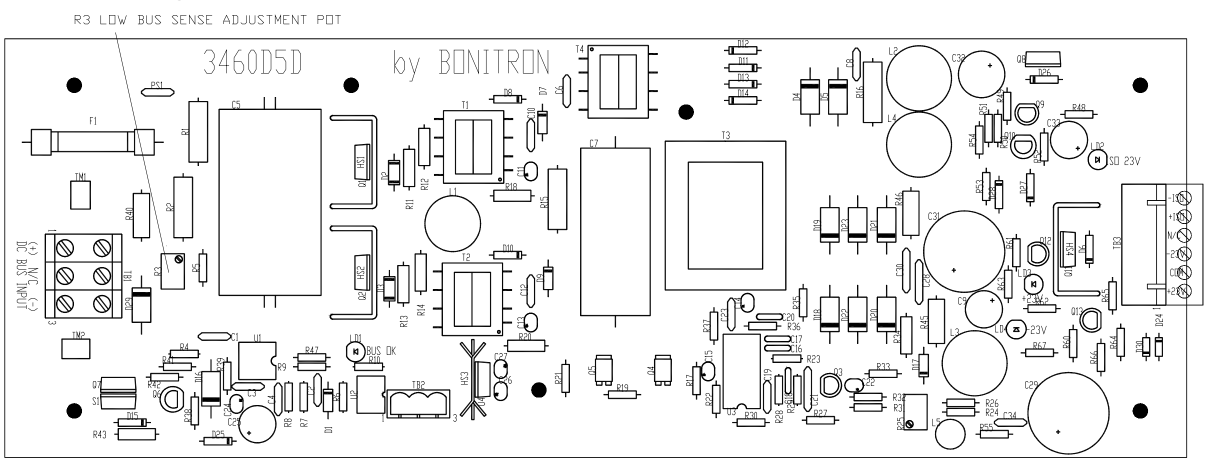


Figure 4-3: Ride-Thru Module 3460D5 Power Supply Board Layout



5. MAINTENANCE AND TROUBLESHOOTING

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

5.1. PERIODIC TESTING

The Bonitron M3460B Ride-Thru Module is designed to be low maintenance. However the connected energy storage battery bank will degrade over time, and should be periodically checked. Bonitron recommends a yearly test of the system in order to ensure the electronics package is operating properly, and the storage bank has proper capacity. The following steps can be taken to ensure reliability and give comfort that the system is still able to Ride-Thru an outage event.

5.1.1. PERIODIC MAINTENANCE PROCEDURE FOR MODEL M3460B

1. Monitor Booster Module LEDs in standby mode.

MODELS WITH DP17 DISPLAY PANELS

- Monitor front panel LEDs For the DP17 Display Panel in standby mode.
  - Power LED should be ON.
  - Pre-charge Complete LED should be ON.
  - Ride-Thru Ready LED should be ON.
  - Ride-Thru Active LED should be OFF.
  - Voltage Fault LED should be OFF.
  - Over-temperature LED should be OFF.
- Verify Activity Counter.
  - More than 10 counts per month may mean the Ride-Thru is improperly adjusted. Refer to Section 4.4.1.2 for adjustment details.
  - Note count for Factory records.
  - Compare event log with known PQ event data.
  - Report count to Bonitron via your local service representative.
- Verify DC bus current meter.
  - Meter should read zero amps under normal conditions.
- Verify DC bus voltage meter.
  - Ride-Thru bus should be about 10 – 25VDC below the Inverter bus.
  - DC voltmeter should read within 1% of calibrated multimeter.

MODELS WITH DDM DIGITAL DISPLAY PANELS

Refer to the M3660DM Digital Display Manual for instructions to navigate through the display screens.

- Monitor Front panel LEDs in standby mode.
  - Power LED should be ON.
  - Status LED should be OFF.
  - Fault LED should be OFF.
- Check Active cycle counter screen.

- More than 10 counts per month may mean the Ride-Thru is improperly adjusted. Refer to Section 4.4.1.2 for adjustment details.
- Note count for Factory records.
- Compare event log with known PQ event data.
- Report count to Bonitron via your local service representative.
- Verify DC bus current meter.
  - Input and output current should read zero amps under normal conditions.
- Verify DC bus voltage meter.
  - Ride-Thru output bus (drive side) should be about 10 – 25V DC below the Inverter bus.
- Ride-Thru input bus (battery side) should show full charged voltage.

STANDARD MODELS WITHOUT DISPLAY PANEL

Open cabinet to access booster module LEDs.

- 3460C1 Control Board:
  - LED 6 (+ 15V) should be ON.
  - LED 7 (– 15V) should be ON.
  - LED 4 (PCC) should be ON.
  - LED 3 (RTR) should be ON.
  - All other 3460C1 LEDs should be OFF.
- 3460M6 Interface board LED should be as follows:
  - NO FAULT LED should be ON.
- 3460D5 Power Supply board LEDs should be as follows:
  - +23V = ON.
  - -23V = ON.
  - ISO 23V = ON.
  - Bus OK = ON.
- Verify DC bus levels.
  - Ride-Thru output bus should be about 10 – 25VDC below the Inverter bus.
  - Ride Thru Input bus should be at the fully charged battery level.

2. Verify Threshold by removing power.

FOR STANDARD SINGLE OUTPUT SYSTEMS

- Open the DC disconnect between the Ride-Thru module and inverter DC bus. (Refer to Section 4.4.1.2)

FOR MULTIPLE OUTPUT SYSTEMS

- Turn off the single phase source to the 300W DC bus bias supply. (Refer to Section 4.4.1.2)
  - The DC bus voltage should drop until it reaches the threshold.
  - Ride-Thru Active indication should begin to flash or turn on.
  - DC bus should hold at the threshold.
  - This threshold level should be 20 – 30 volts below the normal LOADED inverter DC bus.

- Re-close the disconnect between Ride-Thru and inverter or re-apply power to the 300W bias supply.
    - To verify Threshold using the TEST feature, refer to step 3 in Section 4.4.1.2.

CAUTION!

> *Each Bonitron Ride-Thru should be tested under load during initial start up to verify the functionality of the test circuit and that the test does not negatively affect the process. However, Bonitron recommends that, if the process is critical, the test cycle be initiated just before or during a shutdown to avoid unforeseen problems.*

3. Verify switching circuits.
    - Initiating the TEST sequence while running the inverter:
        - Ride-Thru DC bus current should flow during the 2-second test cycle.
        - Inverter input current should **drop**.
        - Ride-Thru DC bus voltage should **rise** up to or near 100VDC above the threshold.
        - Inverter DC bus voltage should **rise** to 100VDC above the threshold.
        - Ride-Thru Active LED should turn **ON**.
        - Motor speed should **remain constant**.
4. Verify energy storage bank charge.
    - Remove AC power from the fully loaded inverter simulating an outage event.
        - The DC bus voltage should **drop** to and hold at the threshold.
        - Ride-Thru Active LED should turn **ON**.
        - Activity Counter should increment.
        - DC input will drop as the batteries discharge.
            - Do not allow batteries to discharge below suggested minimum levels. See table 6-4.
            - Motor speed should **remain constant**.
    - Re-apply AC power to inverter input.

This completes the maintenance procedure.

5.2. MAINTENANCE ITEMS

5.2.1. HEATSINK FANS:

The worst case life expectancy for the Papst fans would be 37,000 hours (4.23 years) of running @ 50ºC. If adjusted properly the RTM should only be active once every power outage. In this case the fans will only run for two hours every time the power is lost. Since the fans are set to run for 2 hours after any activity, this translates into over 18,000 Ride-Thru events.

The answer for maintenance interval then depends upon the amount of time the fan is running, the amount of dirt in the air, and the ambient temperature of the cabinet.

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

5.2.2. 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.

5.2.3. CAPACITOR REPLACEMENT CRITERIA:

Bonitron Model M3460B Ride-Thru 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 capacitor manufacturer has given a rating of 11 years MTBF if ambient temp is 50ºC, capacitors are held at 100% rated voltage, and caps run full ripple current at 1% duty.

With typical operating conditions of 35ºC, caps running at 75% rated voltage, and a duty cycle of one sag 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.)

5.2.4. CAPACITOR TESTING PROCEDURE:

1. Remove power to unit and wait for DC bus to drain.
2. Install Gate drive board extension cables to allow the top panel door to open exposing the capacitor bank.
3. Re-apply power and measure voltage across each cap and make note for future reference.
    - 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.
4. Remove power and replace both capacitors.

5.3. TROUBLESHOOTING

SYMPTOM	ACTION
No LEDs	• Check incoming power • Check power supply 3460D5 for all voltages – replace if incorrect
No +15 or -15 LEDs	• Check power supply 3460D5 for all voltages. – replace if incorrect • If OK, then replace 3460C1 control pcb
System Fault	• Check 3460M6 Green Fault LED – if ON check system wiring. • Check 3460M6 inputs at TB – 4 pins 1,2, 3,4 and 5,6 ▪ If all low replace 3460M6 ▪ If any one is high • RTR – follow No RTR • OT- follow overtemp • VF – Low output voltage can cause fault. See threshold adjustment procedure for voltage levels
No RTR	• Check for run command • Check stage fuses – look for blown fuse LED on 3460C1 • Check 3460M6 interface • IF OK replace 3460C1 control pcb
No PCC	• Check DC bus level – if not OK check pre-charge ckts or bus caps • Check for run command • Check stage fuses – look for blown fuse LED on 3460C1 • Check 3460M6 interface • IF OK replace 3460C1 control pcb
No IUV	• Check input battery voltage level • Re-calibrate 3460M6 interface IUV level to meet system needs • If calibration not possible replace 3460M6 interface pcb
Constant IUV	• Check input battery voltage level • Check fuses if input is zero • Re-calibrate 3460M6 interface IUV level to meet system needs • If calibration not possible replace 3460M6 interface pcb
No VF	• Check DC bus voltage level at input to 3460D5 ▪ With nominal DC bus level this is normal ▪ Readjust if VF doesn't change states when bus drops below setpoint. see threshold adjustment procedure • If adjustment will not allow VF, replace 3460M6
Constant VF	• Check DC bus voltage level at input to 3460D5 ▪ Readjust if bus level is OK, see threshold adjustment procedure ▪ With no run command and no drive bus connected this is normal • output will = battery input and cause VF fault ▪ If unit has timed out and no drive bus is connected this is normal • output will = battery input and cause VF fault
RTA always ON	• Check DC bus levels on both sides of diodes • Check for overheated pre-charge ckt ▪ Too much activity can cause stage fuse failures, overheating and draining of the battery • Check threshold level, if changed over time adjust level or replace 3460C1 • Check J1 TIME OUT jumper on 3460C1
RTA ACTIVE for short periods only	• Check 3460C1 J1 TIME OUT jumper ▪ If OFF, unit will only run 2 seconds at full load

Continued..

SYMPTOM	ACTION

RTA never ON	• Check RUN command
	• Initiate test cycle or remove power
	  ▪ Watch and listen for signs of activity
	    • Check RTA contact and LEDs
	    • Ticking sound when active
	• Check power quality data to confirm sag events should have caused activity to occur
	• If no activity ever replace 3460C1

Overtemp	• Check for constant current on the negative and positive DC bus links
	• Check temp sensors
	  ▪ On SCR heatsink
	  ▪ On diode heatsinks
	  ▪ On IGBT heatsinks
	  ▪ On chokes (if used)
	• Check pre-charge network for overheating – (cause of constant activity)
	• If all OK replace 3460M6 interface pcb
	• Check activity record –too much activity causes overtemp

Blown Fuse LED ON	• Check stage fuses – indicator on BLOWN FUSE will be tripped • If all stage fuses are OK replace 3460C control pcb
Blown stage fuses	• Check for shorted IGBT ▪ Replace 3438C2 gate driver if IGBT is bad • Check or replace stage choke current sensor • Check or replace 3438S stage IGBT snubber • Check activity record –too much activity causes fuse fatigue
TEST won't work	• Check DC bus level – too high causes no test • Check blown fuse LED during test – If ON check stage fuses • Check 3460C1 J1 TIME OUT jumper to be OFF • Check test input to 3460C1 • If OK replace 3460C1
Voltage fluctuates during TEST mode	• Check threshold and test boost level settings. Over-voltage shutdown can occur if settings are too high on 460V systems, causing an oscillation and low voltage reading • Lower threshold level and retry
Stays in TEST mode	• Replace 3460C1

Pre-charge overheated	• Check DC bus ripple voltage. Too much ripple can cause PTCRs to overheat
	  ▪ Add parallel pre-charge PTCRs
	  ▪ Change series pre-charge resistance
	  ▪ Add fan to cool PTCRs
	  ▪ Add isolated bias supply
	• Pre-charge can only be done 3 consecutive times before overheating can occur

6. ENGINEERING DATA

6.1. RATINGS TABLES

Table 6-1: 4 Minute kW Ratings Table

SYSTEM VOTAGE RATING CODE	E			H		C
DC BUS CURRENT	380VAC SYSTEMS	400VAC SYSTEMS	415VAC SYSTEMS	433VAC SYSTEMS	460VAC SYSTEMS	575VAC SYSTEMS
43	21	22	23	24	25	31
85	41	43	45	47	50	62
130	62	65	67	70	75	95
170	83	87	90	94	100	125
255	125	130	135	141	150	187
340	165	175	180	188	200	N/A
460	225	234	243	254	270	337
610	297	306	324	338	360	N/A
690	338	351	365	381	405	505
920	446	459	486	508	540	673
1150	N/A	N/A	N/A	N/A	N/A	842
1225	594	612	648	677	720	N/A
1375	N/A	N/A	N/A	N/A	N/A	1010
1530	743	765	810	846	900	N/A
1835	891	918	972	1016	1080	N/A

Table 6-2: 15 Minute kW Ratings Table

SYSTEM VOTAGE RATING CODE	E			H		C
DC BUS CURRENT	380VAC SYSTEMS	400VAC SYSTEMS	415VAC SYSTEMS	433VAC SYSTEMS	460VAC SYSTEMS	575VAC SYSTEMS
22	10	11	11	12	12.5	16
43	21	22	23	24	25	32
65	31	32	34	35	38	47
85	41	43	45	47	50	62
130	62	65	67	70	75	95
170	83	87	90	94	100	125
230	112	117	122	127	135	168
305	149	156	162	169	180	N/A
345	167	176	182	190	202	252
460	223	235	244	254	270	337
575	N/A	N/A	N/A	N/A	N/A	421
613	297	313	325	339	360	450
690	N/A	N/A	N/A	N/A	N/A	505
765	372	391	406	423	450	N/A
918	446	470	487	508	540	N/A

Table 6-3: Model Specifications

DC Bus Current①	Backplate Size	Boost Circuit Configuration	Boost Circuit Fuse Rating	Recommended Fuse Rating ② ③	
				Battery Input	DC Bus Output
43A	R10	1-Stage	100A	70A	40A
85A	R10	1-Stage	125A	125A	100A
127A	R9	2-Stage	125A	200A	150A
170A	R9	2-Stage	125A	250A	175A
255A	R2	4-Stage	125A	400A	300A
340A	R2	4-Stage	125A	500A	350A

① Please note that the DC Bus Current ratings listed above indicate the TOTAL DC Bus current that can safely be handled by the Battery Regulator Ride-Thru unit. While each DC output from the Ride-Thru is capable of handling this load, for Ride-Thru units with multiple outputs, the combined load of all outputs must not exceed this rating.

② Fuses recommended for use with M3460B Ride-Thru systems should be 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, 700 volts maximum when protected by recommended fuses.

Table 6-4: Battery Bank Typical Values

System AC Voltage	208	230	380	400	415	433	460
Battery Qty	18	20	34	35	36	38	40
Nominal Voltage	216	240	408	420	432	456	480
Full or Float Voltage	243	270	459	473	486	513	540
Equalize Voltage	249	277	470	484	498	526	554
Discharged Voltage	180	200	340	350	360	380	400
Overvoltage Trip	255	284	482	496	510	539	567
Undervoltage Trip	175	195	331	341	351	370	390

6.2. WATT LOSS (INACTIVE POWER CONSUMPTION)

- <100 Watts for units rated at 170ADC bus load or less.
- <200 Watts for units rated at greater than 170ADC bus load.
- All M3460B models are 93% efficient or better @ full load, 50% sag.

6.3. CERTIFICATIONS

- Standard M3460B models are UL Listed.

6.4. BATTERY SELECTION DATA

When selecting a battery string for use with the Model M3460B Battery Regulator Ride-Thru Modules, please note that the battery string voltage must be between 200VDC and 320VDC for units rated at 200V, between 320VDC and 540VDC for units rated at 320V and 350V, or between 400VDC and 640VDC for units rated at 400V.

Figure 6-1: Power Curves For 12kW to 25kW Systems

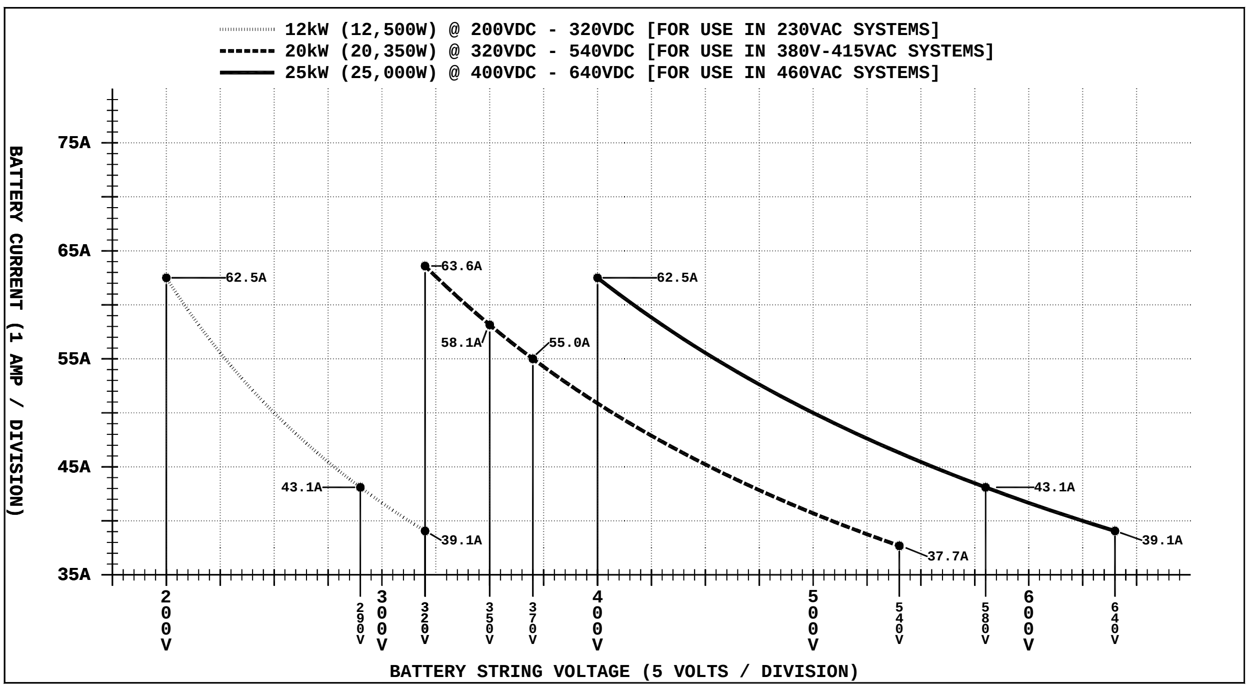


Figure 6-2: Power Curves For 18kW to 37kW Systems

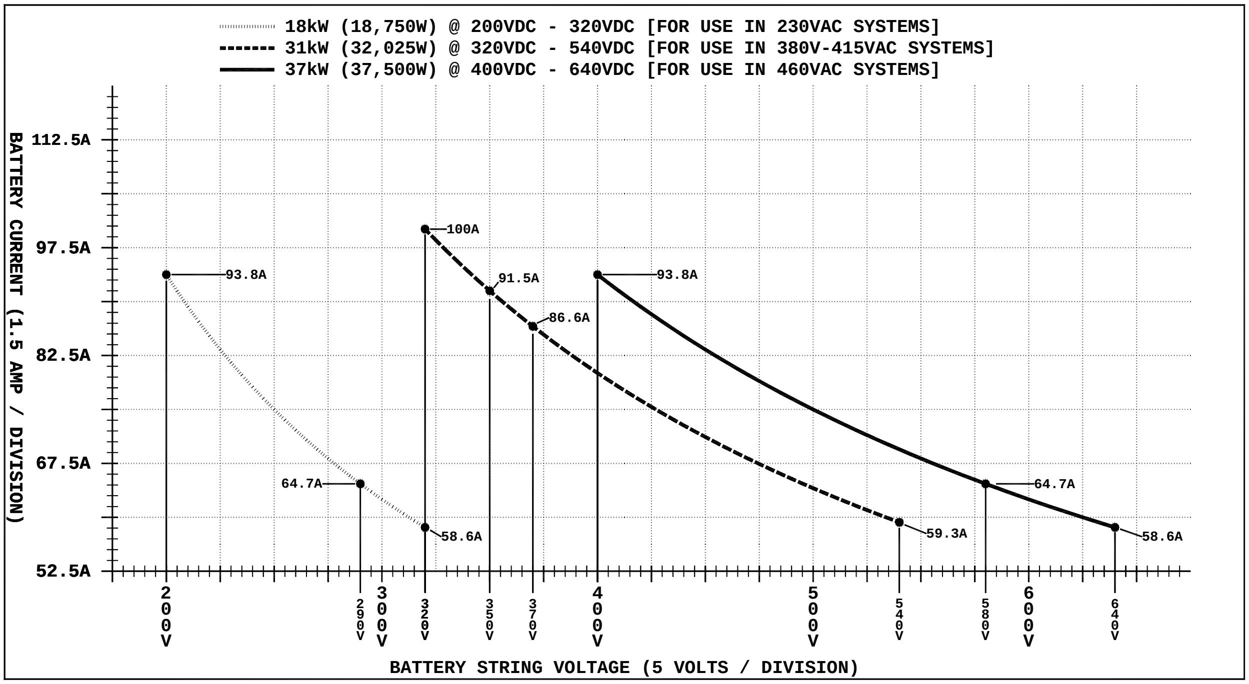


Figure 6-3: Power Curves For 25kW to 50kW Systems

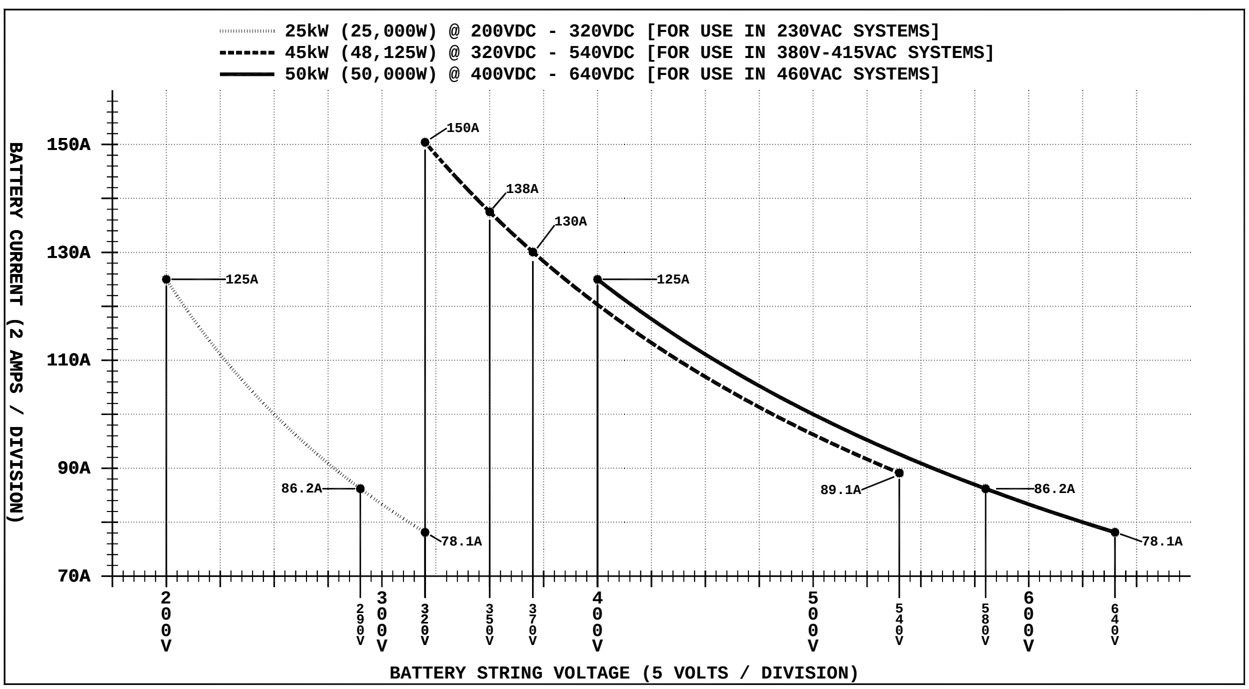


Figure 6-4: Power Curves For 37kW to 75kW Systems

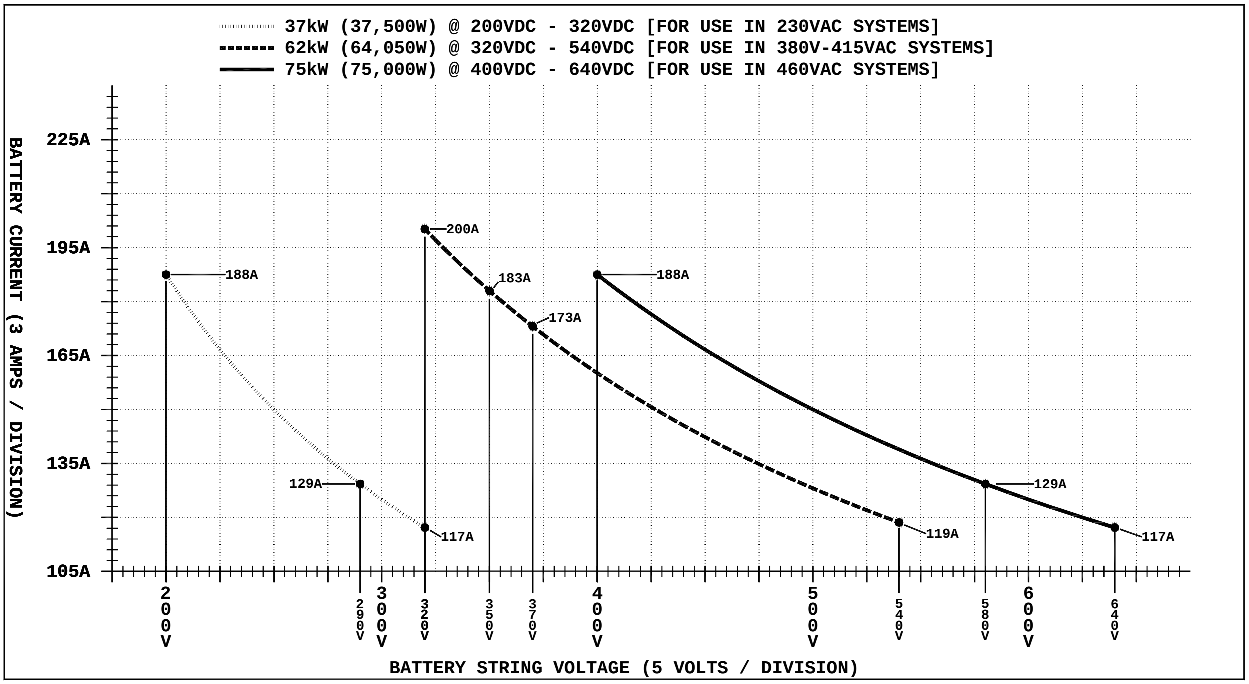


Figure 6-5: Power Curves For 50kW to 100kW Systems

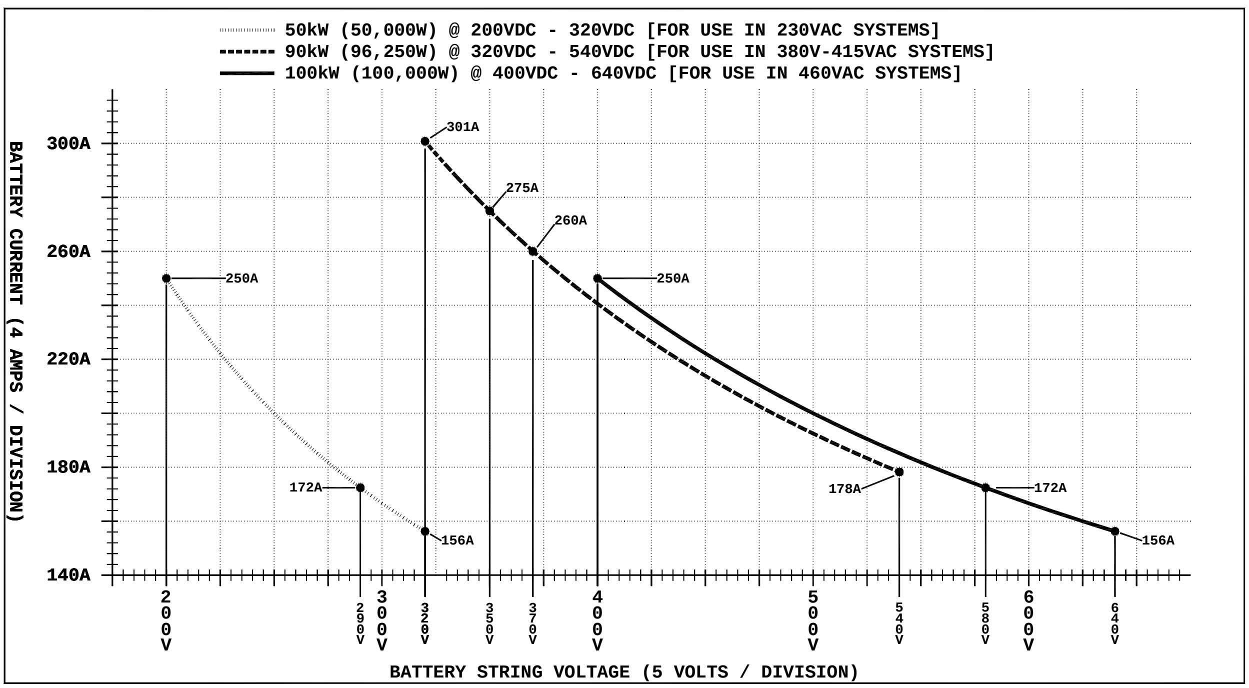


Figure 6-6: Power Curves For 75kW to 150kW Systems

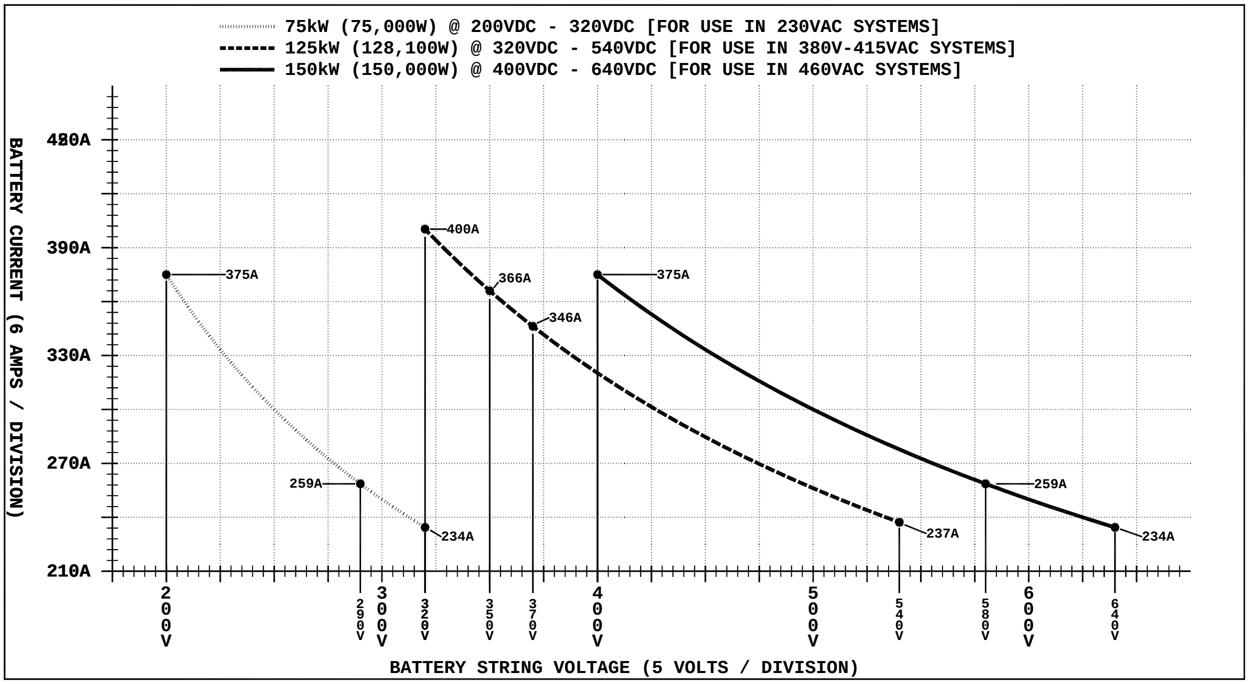


Figure 6-7: Power Curves For 100kW to 200kW Systems

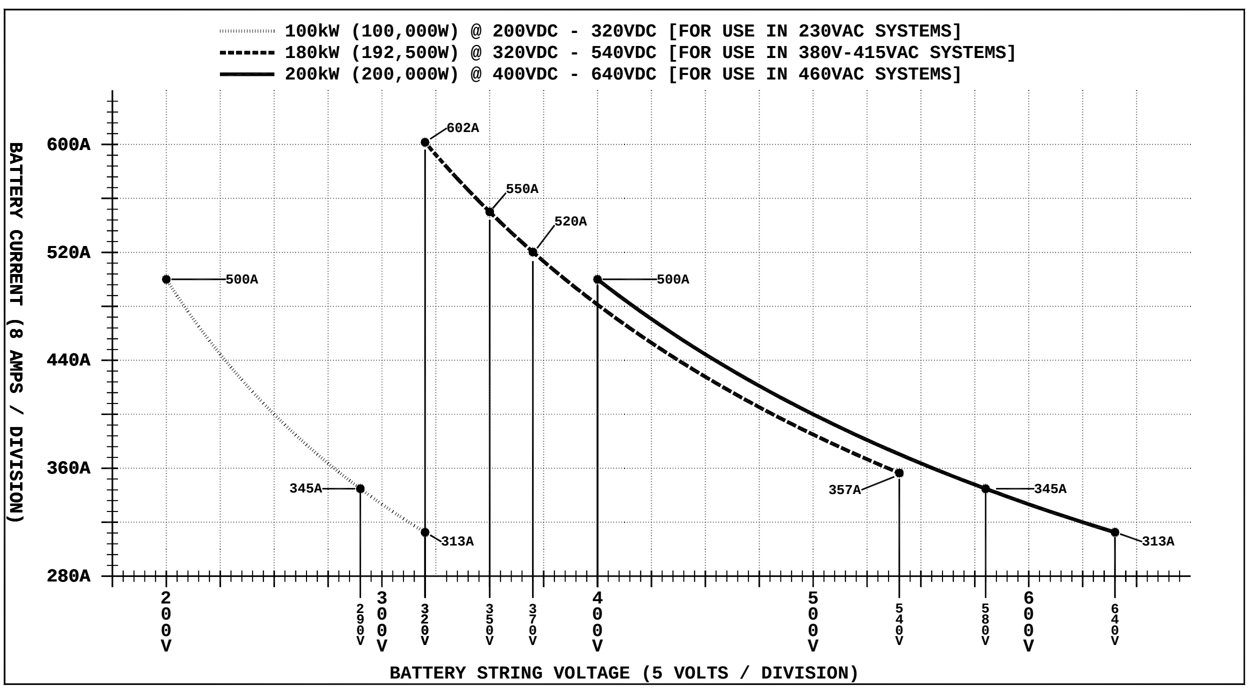
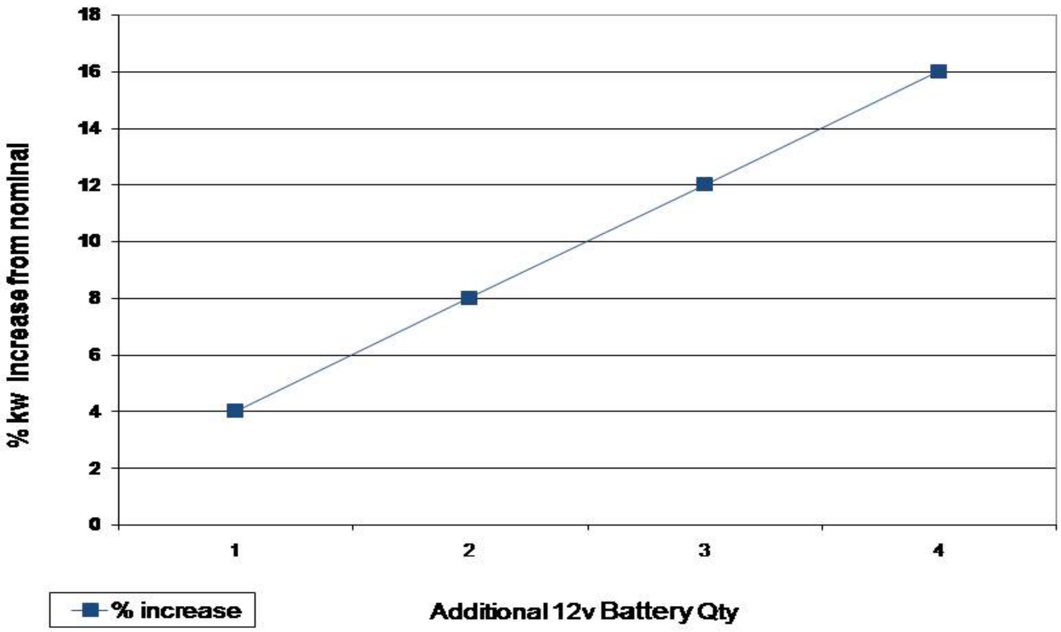


Figure 6-8: Typical Extended Ratings



6.5. FUSE/CIRCUIT BREAKER SIZING AND RATING

Fuses recommended for use with M3460B Battery Regulator Ride-Thru systems should be Gould-Shawmut A70QS series, Buss FWP series, or equivalent semiconductor fuses. See Table 6-3 for fuse size and ratings.

The Battery Regulator Ride-Thru Module provides internal boost circuit fusing only. All input and output fusing and power disconnects are provided by the customer.

- M3460B units are certified by UL to be suitable for use on a circuit capable of delivering not more than 10,000 RMS symmetrical amperes, 700 volts maximum when protected fuses recommended in Table 6-3: Model Specifications.
- Maximum allowed Duty Cycle is 4 minutes on at full load, followed by 4 hours off.
- These devices do not provide motor overload protection.

6.6. DIMENSIONS AND MECHANICAL DRAWINGS

Figure 6-9: Single Output R2-Chassis Dimensional Outline

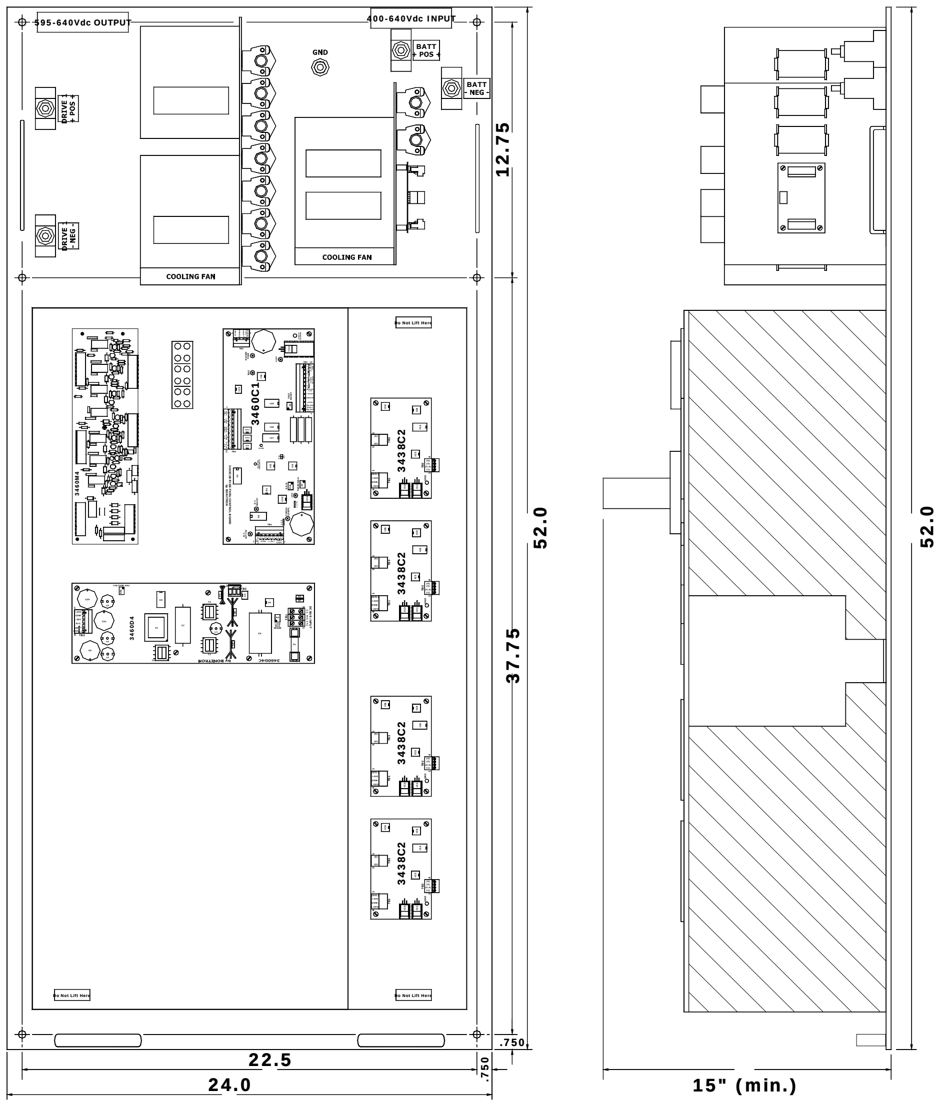


Table 6-5: Single Output R2-Chassis Ride-Thru Modules

MODEL NUMBER	INPUT VOLTAGE	POWER RATING	BOOST CONFIG.	AMPS
M3460B-E130-xxx-R2	350 – 565VDC	130kW	4-Stage	255
M3460B-E175-xxx-R2	350 – 565VDC	175kW	4-Stage	340
M3460B-H150-xxx-R2	400 – 640VDC	150kW	4-Stage	255
M3460B-H200-xxx-R2	400 – 640VDC	200kW	4-Stage	340

Figure 6-10: Dual Output R2-Chassis Dimensional Outline

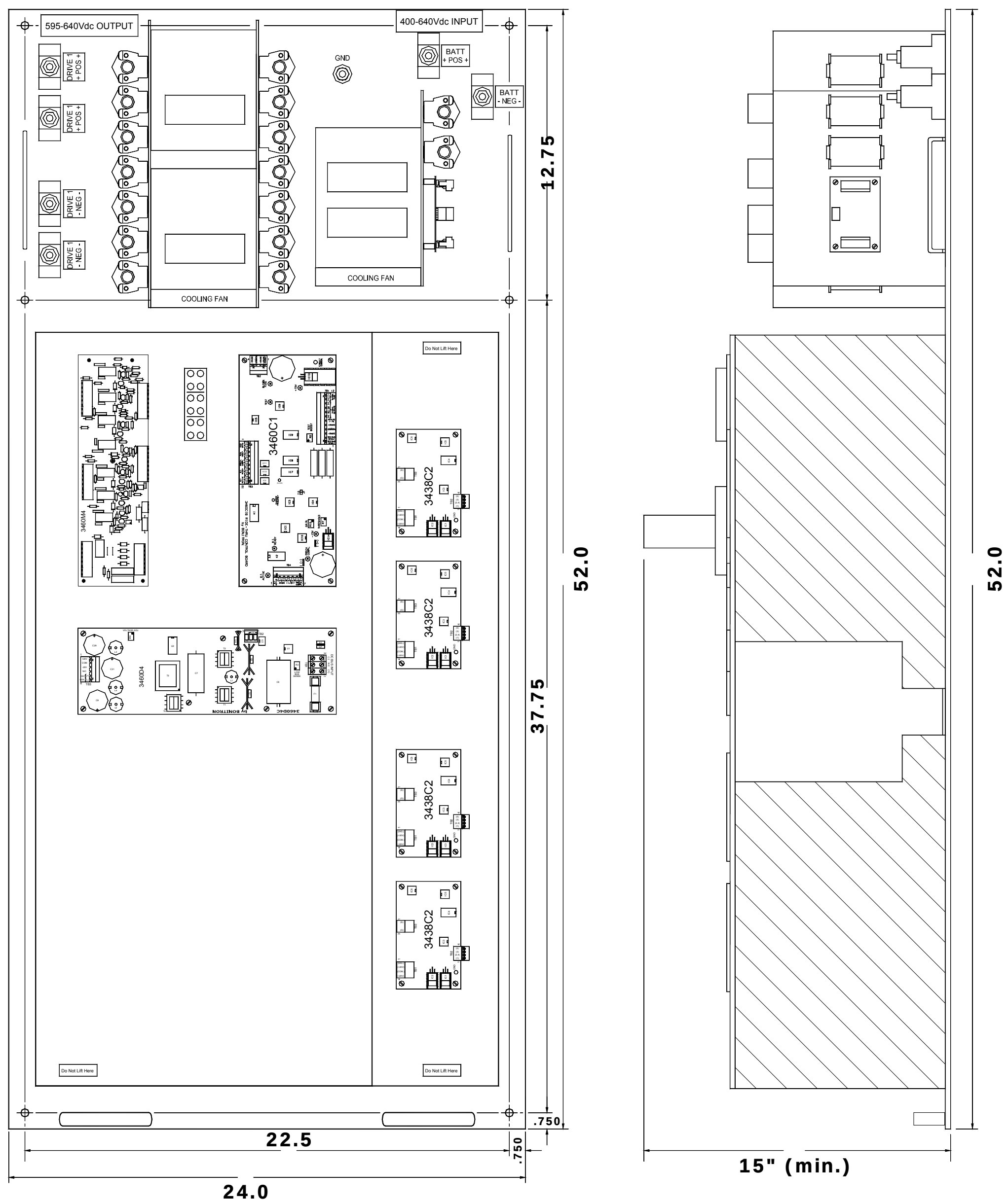


Table 6-6: Dual Output R2-Chassis Ride-Thru Modules

MODEL NUMBER	INPUT VOLTAGE	POWER RATING	BOOST CONFIG.	AMPS
M3460B-E130-xxx-R2-D	350 – 565VDC	130kW	4-Stage	255
M3460B-E175-xxx-R2-D	350 – 565VDC	175kW	4-Stage	340
M3460B-H150-xxx-R2-D	400 – 640VDC	150kW	4-Stage	255
M3460B-H200-xxx-R2-D	400 – 640VDC	200kW	4-Stage	340

Figure 6-11: Single Output R9-Chassis Dimensional Outline

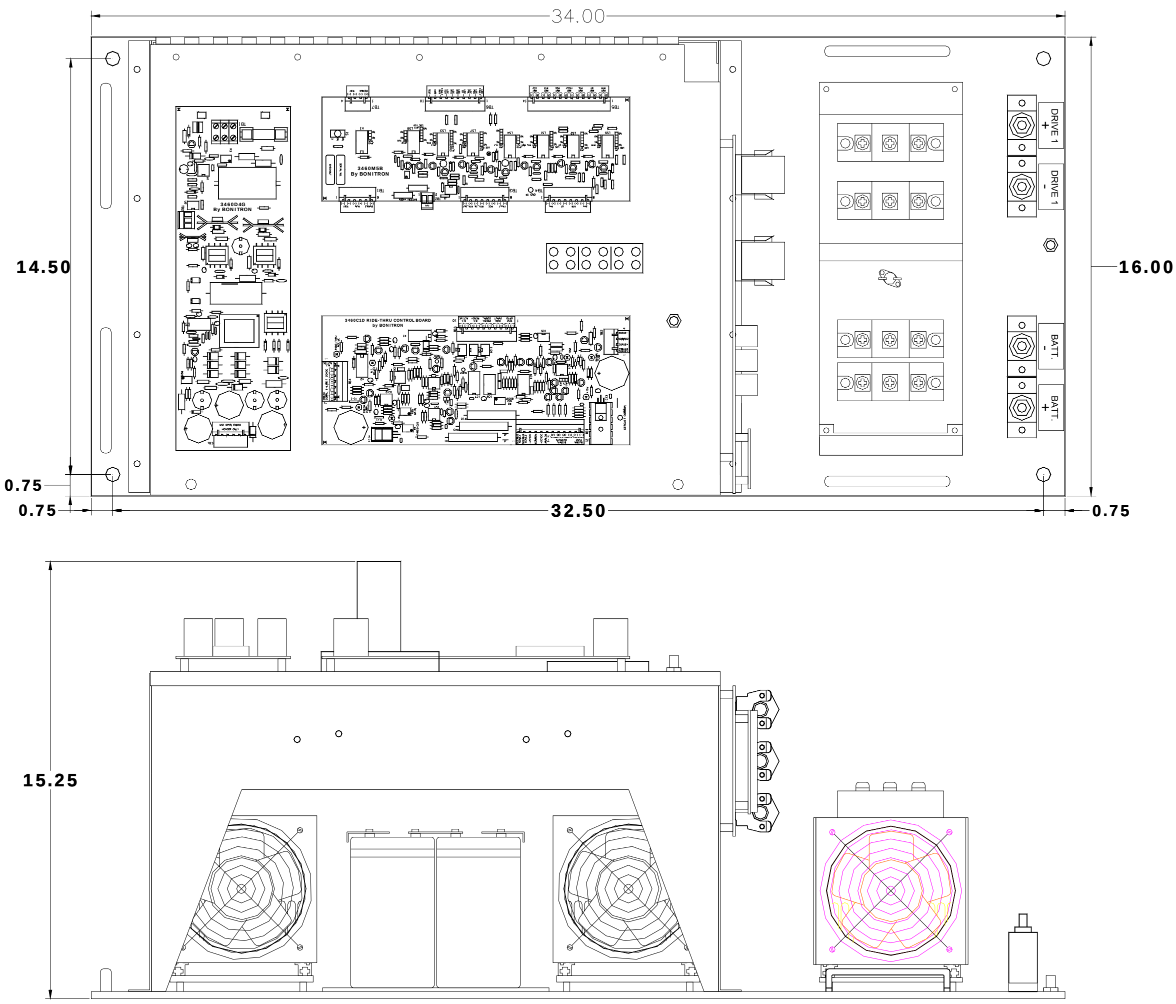


Table 6-7: Single Output R9-Chassis Ride-Thru Modules

Model Number	Input Voltage	Power Rating	Boost Config.	Amps
M3460B-E065-xxx-R9	350 – 565VDC	65kW	2-Stage	127
M3460B-E087-xxx-R9	350 – 565VDC	87kW	2-Stage	170
M3460B-H075-xxx-R9	400 – 640VDC	75kW	2-Stage	127
M3460B-H100-xxx-R9	400 – 640VDC	100kW	2-Stage	170

Figure 6-12: Dual Output R9-Chassis Dimensional Outline

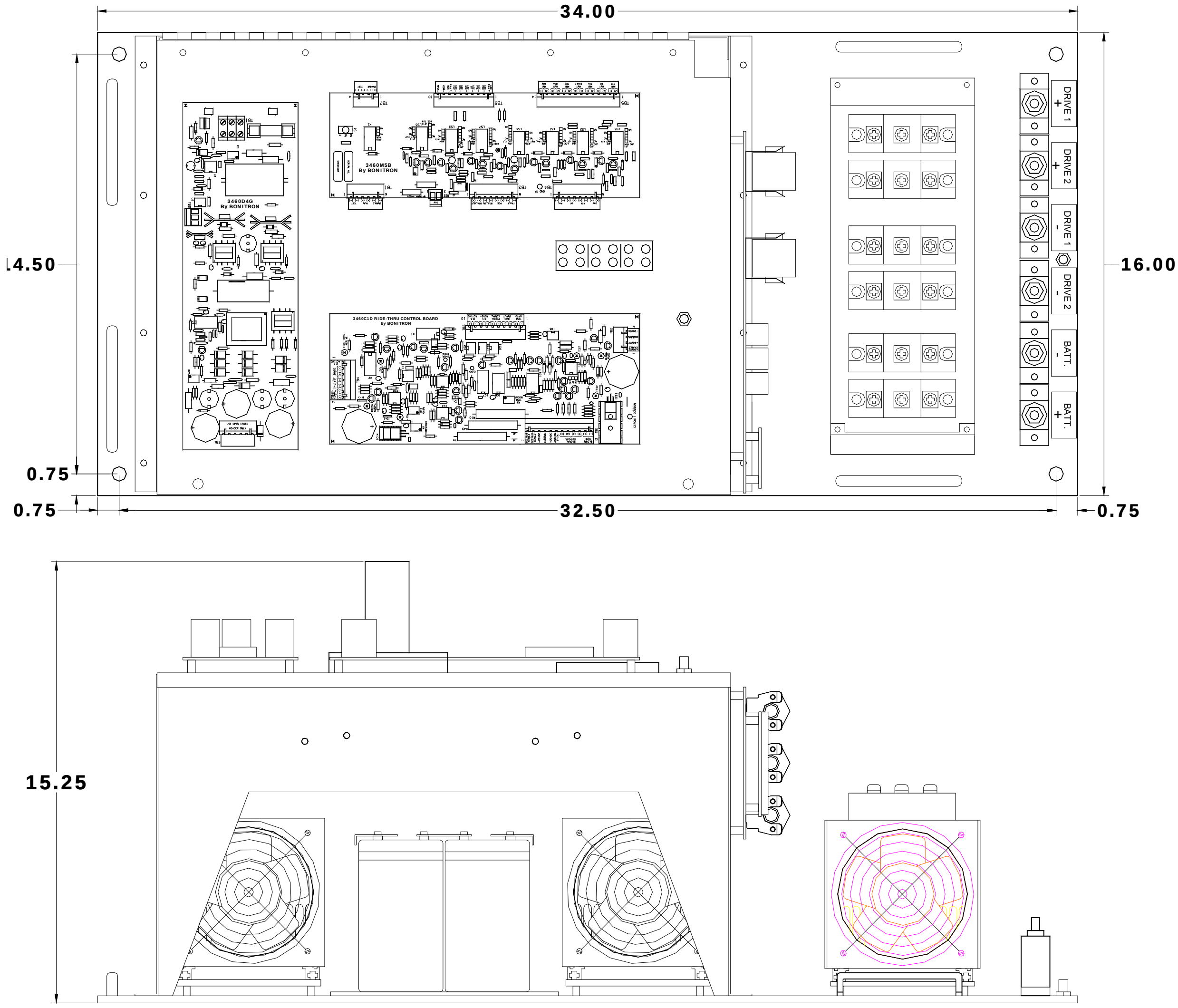


Table 6-8: Dual Output R9-Chassis Ride-Thru Modules

MODEL NUMBER	INPUT VOLTAGE	POWER RATING	BOOST CONFIG.	AMPS
M3460B-E065-xxx-R9-D	350 – 565VDC	65kW	2-Stage	127
M3460B-E087-xxx-R9-D	350 – 565VDC	87kW	2-Stage	170
M3460B-H075-xxx-R9-D	400 – 640VDC	75kW	2-Stage	127
M3460B-H100-xxx-R9-D	400 – 640VDC	100kW	2-Stage	170

Figure 6-13: Single Output R10-Chassis Dimensional Outline

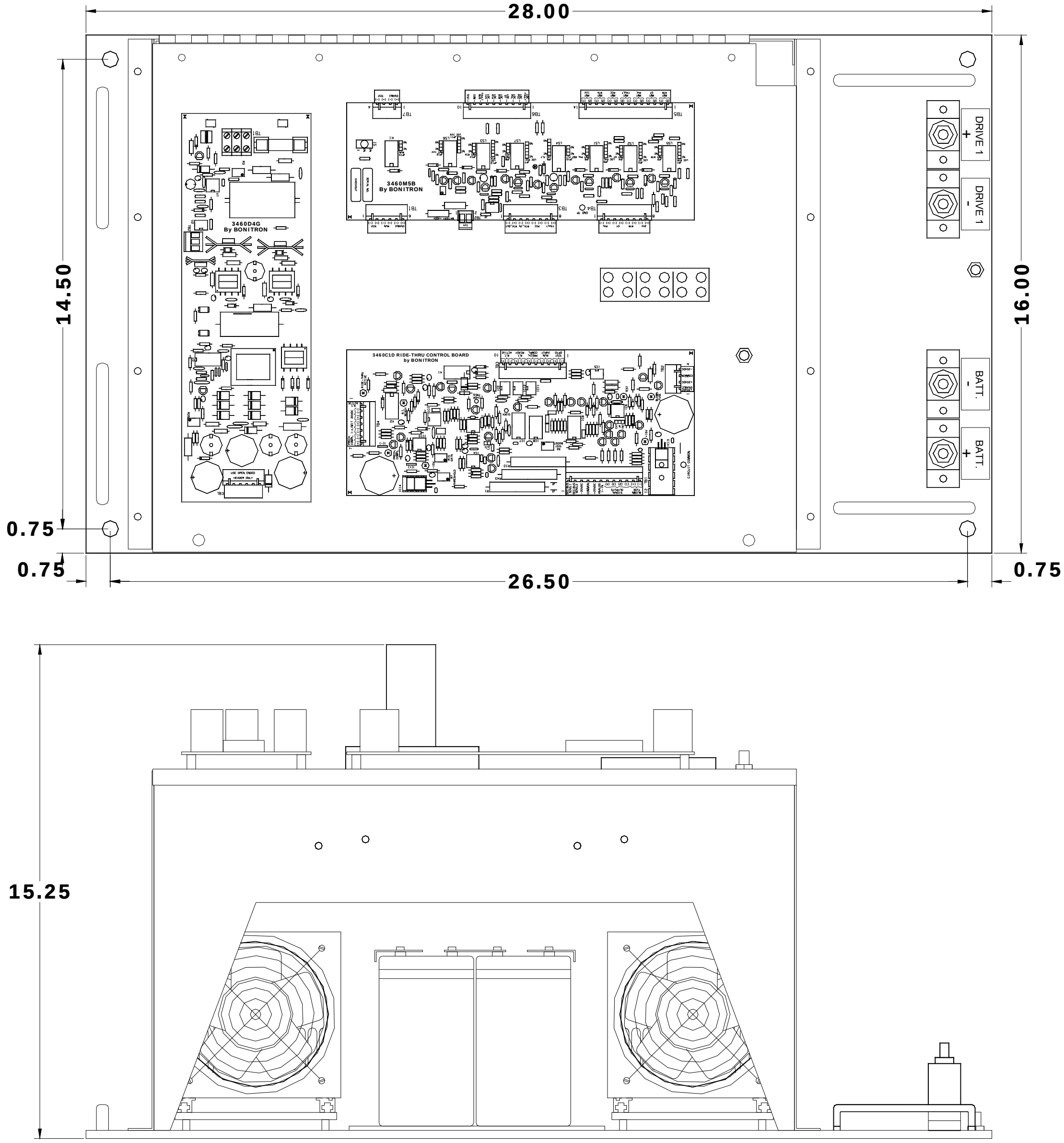


Table 6-9: Single Output R10-Chassis Ride-Thru Modules

MODEL NUMBER	INPUT VOLTAGE	POWER RATING	BOOST CONFIG.	AMPS
M3460B-E043-xxx-R10	350 – 565VDC	43kW	1-Stage	85
M3460B-H050-xxx-R10	400 – 640VDC	50kW	1-Stage	85

Figure 6-14: Dual Output R10-Chassis Dimensional Outline

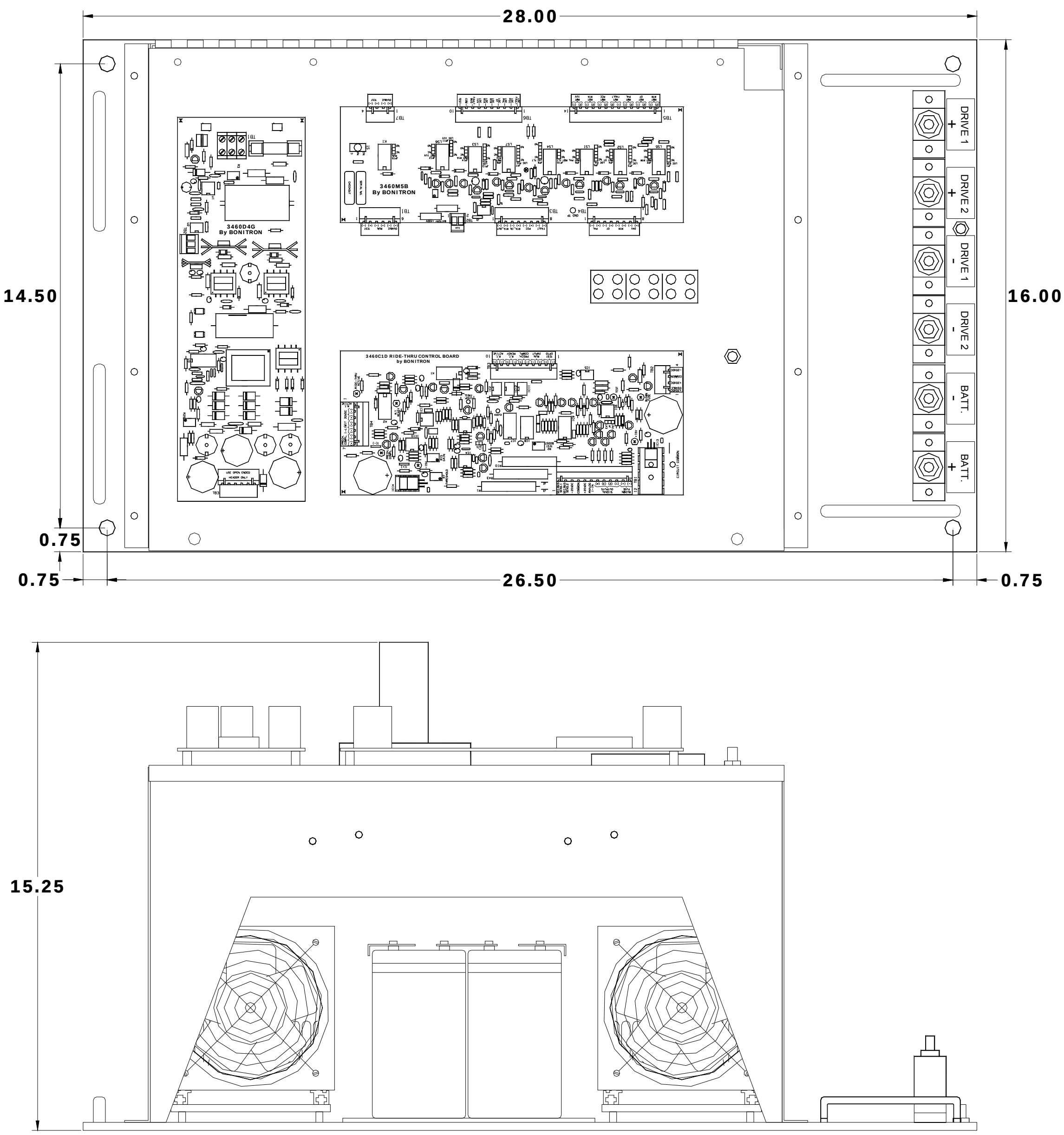
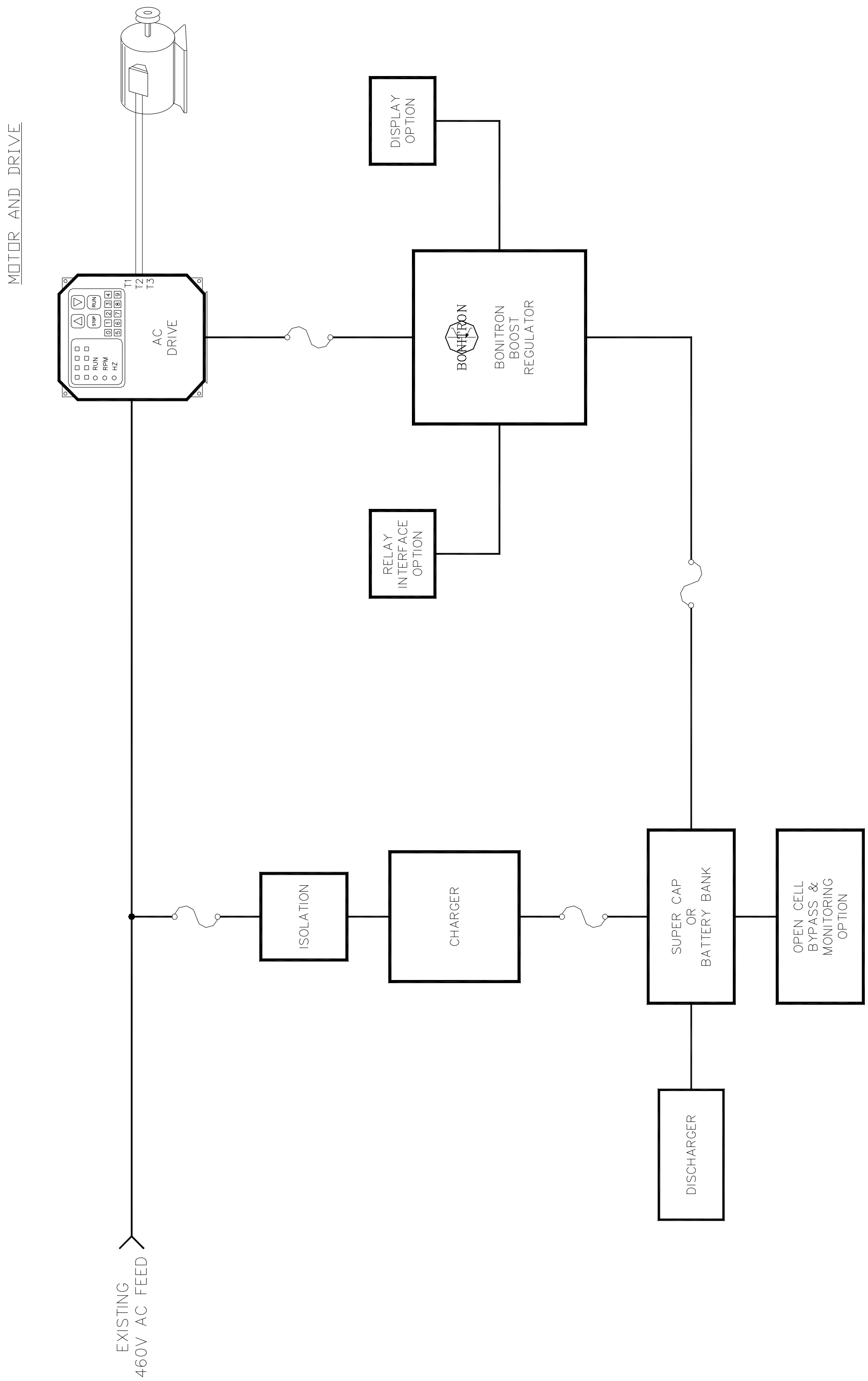


Table 6-10: Dual Output R10-Chassis Ride-Thru Modules

MODEL NUMBER	INPUT VOLTAGE	POWER RATING	BOOST CONFIG.	AMPS
M3460B-E043-xxx-R10-D	350 – 565VDC	43kW	1-Stage	85
M3460B-H050-xxx-R10-D	400 – 640VDC	50kW	1-Stage	85

6.7. BLOCK DIAGRAM

Figure 6-15: Basic 100% Outage Ride-Thru System



6.8. SUPPLEMENTAL DRAWINGS

Figure 6-16: Typical M3460B Interconnection with Existing Drive System

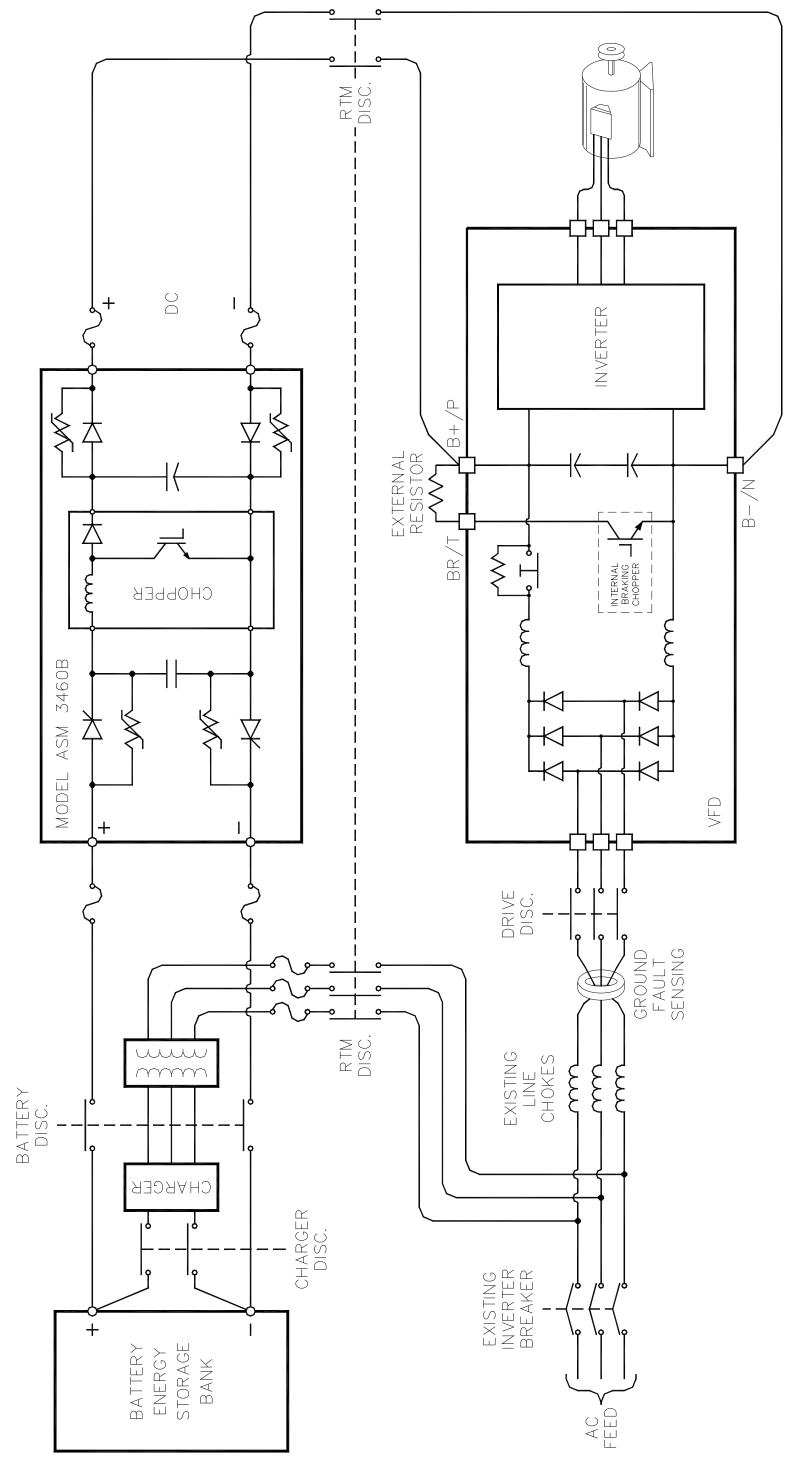
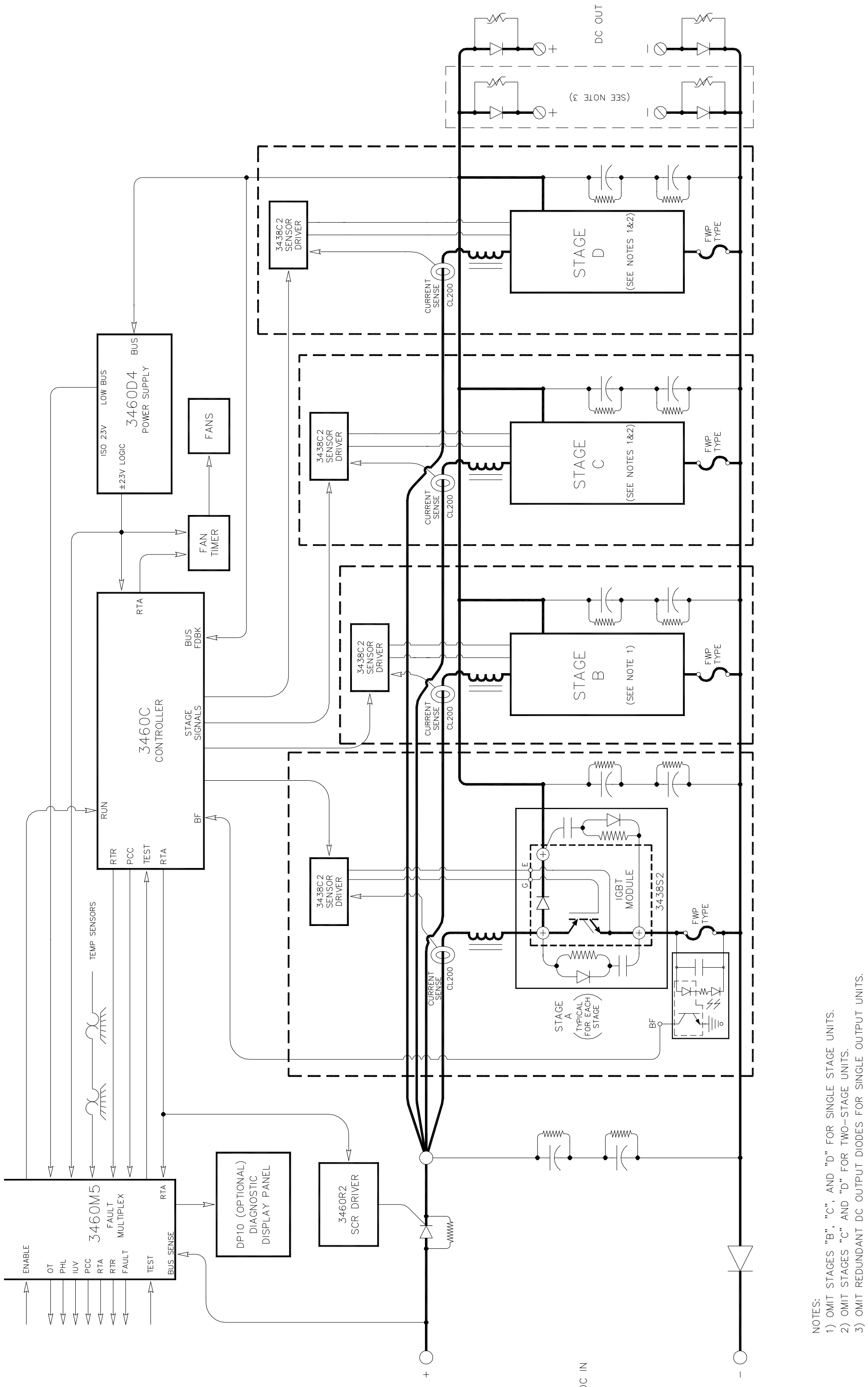
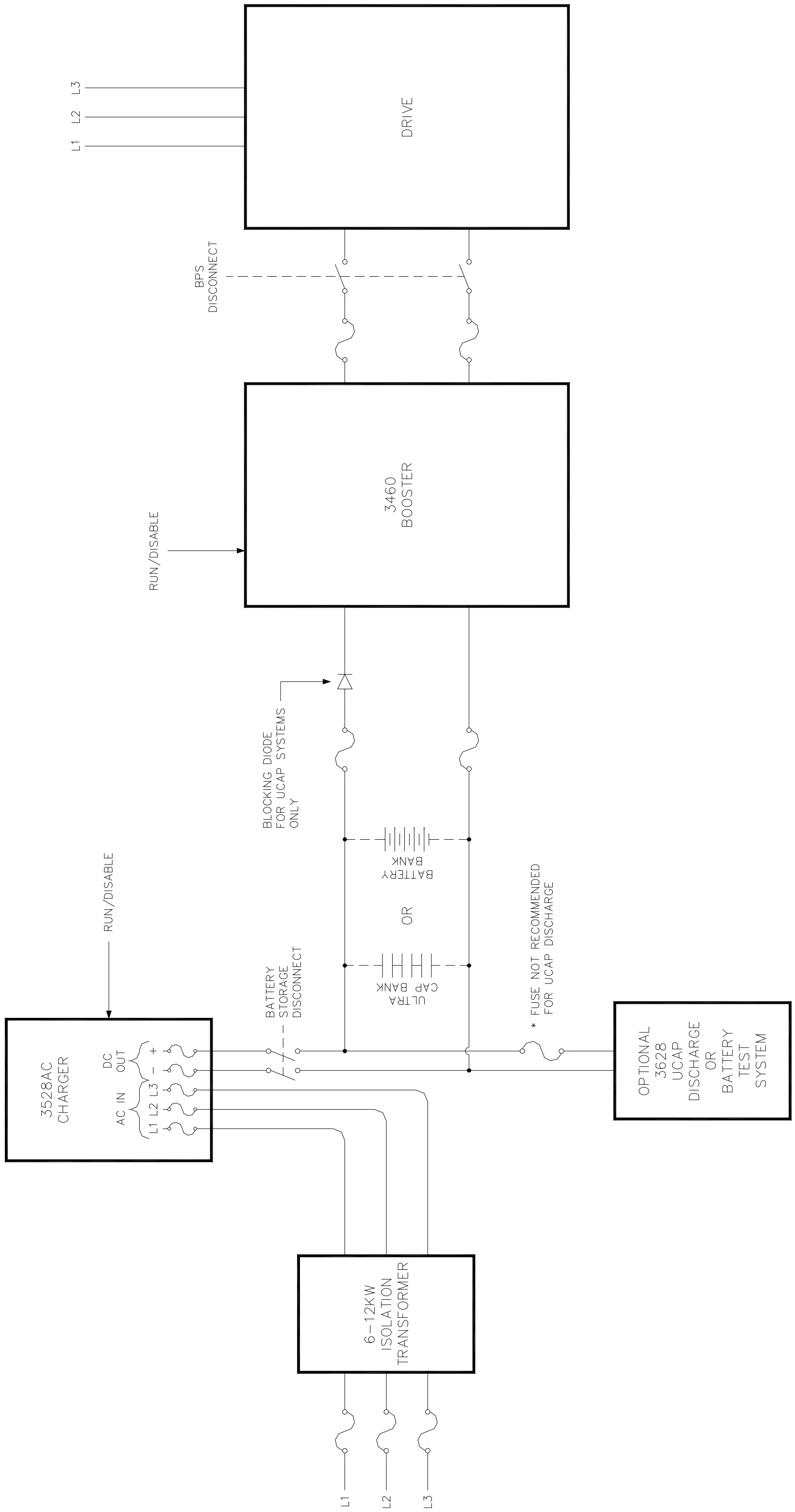


Figure 6-17: Typical Battery Reg. Ride-Thru Basic Signal Flow



Dwg #: 040289 Rev: 20071213

Figure 6-18: Schematic of the 100% Outage Ride-Thru System



6.9. Recommended Spare Parts

The part numbers listed in Table 6-12 represent a listing of all major components and the quantities of each used in various Bonitron Model M3460B Battery Regulator Ride-Thru Modules.

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

Each printed circuit board has a serial sticker (i.e. 3460C1DJ #125). Please refer to Table 6-11 below. Include every character when ordering spare PCBs – this will help ensure a proper order.

Parts should be ordered by the responsible party through your local distributor or system integrator.

Table 6-11: Example of PCB Serial Sticker

Model #	Function	Layout Version	Component Version	Serial Number
3460	C1	D	J	125

Table 6-12: M3460B Spare Parts List

		M3460B-E087-xxx-R9	M3460B-E130-xxx-R2	M3460B-H050-xxx-R10	M3460B-H075-xxx-R9	M3460B-H100-xxx-R9	M3460B-H150-xxx-R2	M3460B-H200-xxx-R2
Part Number	**Part Description**	**Quantity Used Per Module**						
FS FWP-125A	BUSS type FWP-8125B 1250 amp fuse	2	4	-	2	-	4	4
FS FWP-100A	Buss type FWP-100B 100 amp fuse	-	-	2	-	4	-	-
IST FAN-22	EBM Papst #4484F Fan: 24VDC, 100CFM	4	6	4	4	6	6	6
IST TS-OA160	160° F thermostatic switch for Semiconductor heatsinks	4	6	4	4	6	6	6
IST TS-OA220	220deg F thermostatic switch for chokes	2	4	1	2	2	2	4

NOTICE!

Spare circuit boards are available for companies with active personnel who have training certificates on file with Bonitron.

7. APPENDICES

7.1. DRIVE RIDE-THRU SELECTION GUIDE

Bonitron manufactures several different DRT models for specific applications. The following is a general guideline for applying the appropriate model for best cost effectiveness. Short term outage is defined as less than 2 seconds, and long term outage is defined as more than 2 seconds.

1. Fractional to 3hp, 50% sag or 100% short term outage should consider M3534EC.
2. Fractional to 3hp, 100% long term outage should consider S3534BR.
3. 3hp to 67hp 50% sag should consider M3534R.
4. 3hp to 15hp 100% short term outage should consider S3534CR.
5. 15hp to 67hp 100% short term outage should consider S3534UR.
6. 3hp to 67hp 100% long term outage should consider S3534BR.
7. 75hp to 2000hp 50% sag should consider M3460R.
8. 75hp to 2000hp 100% short term outage should consider S3460UR.
9. 75hp to 2000hp 100% long term outage should consider S3460BR.

7.2. INSTALLATION CONSIDERATIONS FOR DRIVE RIDE-THRU SYSTEMS

The following should be considered when installing a Bonitron Ride-Thru:

1. Inverter logic voltage must be backed up
   - Most new Inverters derive logic supply from DC bus
   - Install UPS on circuits with AC feed
2. Any control or Interlock relays must be backed -up
   - Test Relays at half voltage for dropout
   - Use DC relays on logic supply
   - Install UPS on circuits with AC feed
3. Determine the maximum motor voltage needed
   - To ensure Threshold level is sufficient to supply motor
     Most inverters automatically compensate RMS to motor
4. Determine battery bank voltage
   - See charts in manual for proper sizing
5. Determine Charger current ratings. Size according to:
   - Charge - recharge time specifications
   - Battery bank capacity
   - Joule loss during full load full time outage
6. Verify actual AC line voltage and inverter DC bus level
   - To ensure Threshold level is set – 10% of nominal DC bus level
   - To ensure valleys of ripple do not cause unwanted activity
7. Determine Inverter low bus trip point
   - To ensure Threshold level is above inverter dropout
8. Determine Inverter high bus trip point
   - To ensure Test level will not over voltage inverter
9. Cabinet airflow
   - M3460B units are 93% efficient or better. Extra cooling may be required for full 4 minute outage

- M3528 Charger and transformer combination is 93% efficient or better and will run for several hours during a full recharge cycle

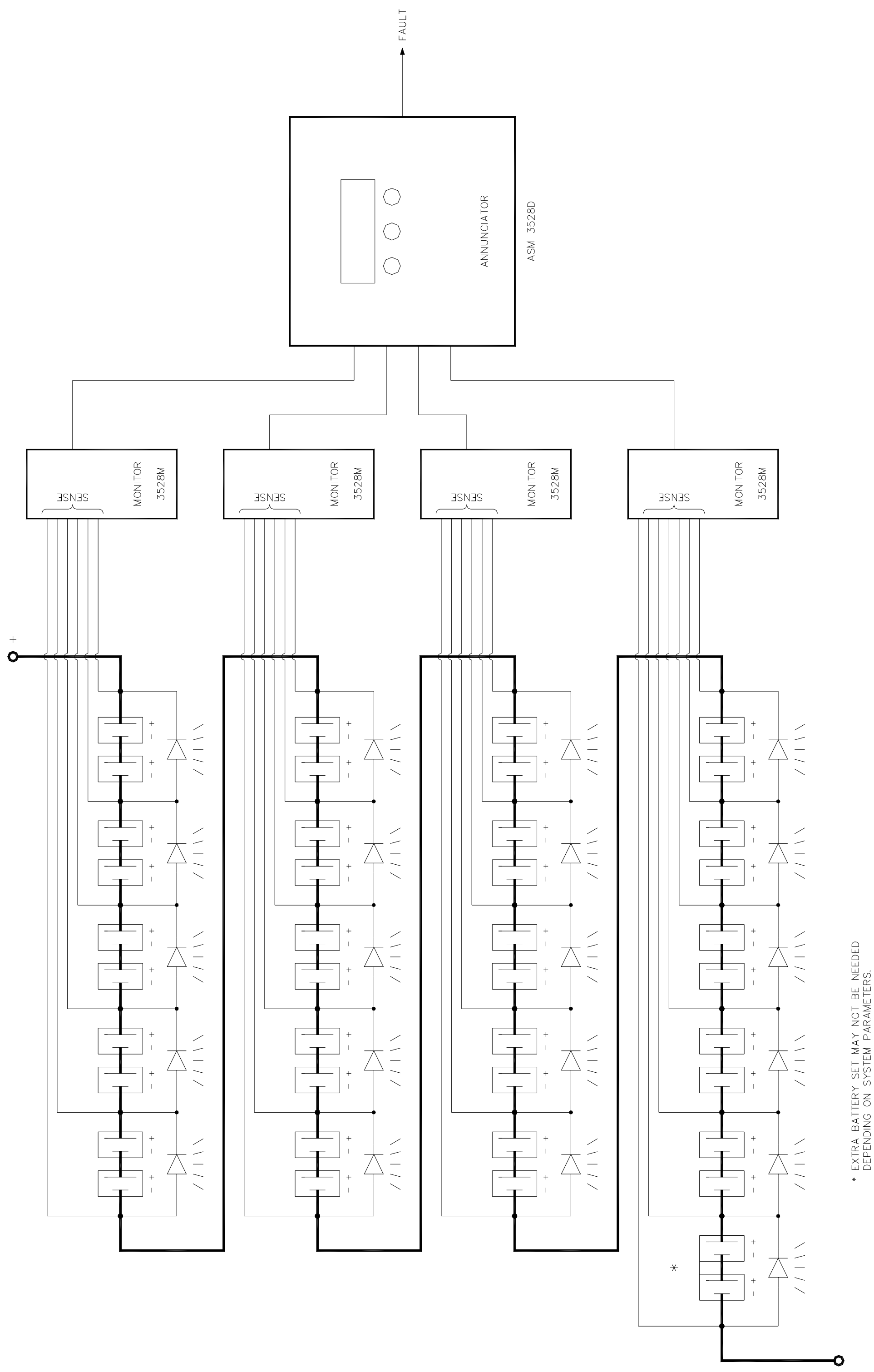
10. Inverter ground fault circuits
    - Ensure battery charger is isolated
11. Electrical safety
    - Use shunt trip interlock between Inverter and Ride-Thru to keep battery bank from supplying power during inverter maintenance
12. Control room monitoring of status signals
    - Dry fault contact option available
13. Wiring
    - IR drop of interconnection wiring should be considered for long wire runs
14. Local wiring codes

7.3. Application Notes for M3460B Modules

When selecting a Battery Regulator Ride-Thru Module, be certain to choose a module with a power rating (kW) equal to or exceeding that of the drive(s) being supplied by the module. Be sure to account for drive and motor losses.

1. A disconnect should be installed between the drive DC bus and the booster DC output for maintenance purposes.
2. Fusing should be installed between the drive DC bus and the booster DC output. A70Q series or FWP series 700V are OK.
3. A disconnect should be installed between the charger and the battery bank. (AC and DC fusing is included inside charger box)
4. Fusing should be installed in the isolation transformer primary circuit. 500V slow blow type.
5. A disconnect should be installed between the battery bank and booster module.
6. Fusing should be installed between the battery bank and the booster input. Semiconductor 600V is OK.
7. Airflow must be supplied to the cabinet housing the booster and charger modules to remove heat during outage and recharge time, and can use thermal temp switch, RTA signal, or power loss to initiate cooling. Standby power losses are less than 300W for booster and charger and transformer. Cooling should continue 12 hours after active cycle starts.
8. The RUN command should be sent through the under-voltage and over-temp contacts on the Bonitron 3460M6 interface board, so that in either case the system will shutdown, preventing damage to the booster or battery bank. Some end users purposely choose to ignore these warnings because the process is the paramount concern.
9. VFD ground fault circuits should be checked. Some VFDs have very sensitive ground faults, and when using external DC input they can be tripped. Be sure it can be disabled if a problem should occur, and be ready to add a ground fault detection somewhere upstream of the drive if that safety aspect is essential to the application.

Figure 7-1: 480VDC Battery Bypass System



7.4. BATTERY SELECTION GUIDE

Use the following steps in conjunction with Battery Voltage Selection Curves to aid in selecting batteries for use with Bonitron Drive Ride-Thru Systems. Table 1 below shows typical battery voltage levels for various system AC voltages.

Table 7-1: Typical Battery Voltage Levels

SYSTEM AC VOLTAGE	BATTERY SERIES QTY	NOMINAL DC VOLTAGE	DISCHARGED VOLTAGE	CHARGING VOLTAGE	EQUALIZE VOLTAGE
460	40	480	400	540	554
433	38	456	380	513	526
415	36	432	360	486	498
400	35	420	350	473	484
380	34	408	340	459	470
230	20	240	200	270	277
208	18	216	180	243	249

To choose batteries, follow these steps.

We will use a 460VAC system rated for 200W, in need of 4 minutes of ride through time for our example. Use Table 7-1 for data.

1. Find max current at min DC battery voltage for the given kW rating of the system.
   a) Ex: 460VAC 200kW system, ÷ 400VDC min DC input = 500 amps.
   b) ** Battery bank must be capable of 500 amps.
2. Next choose enough series batteries to get the minimum voltage when discharged. Use this to ensure the battery bank has enough voltage for the boost regulator module to work from. (See Table 7-1 for min DC voltages.)
   a) Battery life is dependent on discharge voltage. The lower they are allowed to discharge, the shorter the life.
      i. We use 1.67 per cell as a minimum, which equals 10V per battery.
         - ** 400VDC minimum ÷ 10V discharge level = 40 series batteries.
   b) NOTE: Charging voltage should not exceed the threshold voltage of the boosting system. (Typically 585VDC for 460VAC drive system.)
      i. Typical recommended charging voltage is 1.125 x battery voltage.
      ii. 40 batt x 12V x 1.125 = 540VDC.
3. Choose a battery with enough watts per cell for the time you need.
   a) Add up all the power consumption to be sure the batteries have enough storage.
      i. Ensure drive losses have been accounted for (95% efficient).
      ii. Ensure booster losses have been accounted for (95% efficient).
      iii. Add 15% in time or kW for headroom.
   b) Battery specs usually show watts per cell at discharge rates.
      i. Watts per cell usually refers to the 2V cell inside the battery.
      ii. Each 12V battery has 6 cells.
      iii. Available watts per cell increases with a longer discharge time.
   c) Ex: 200kW for 4 minutes (200W ÷ .95eff ÷ .95eff + 15% headroom = 254kW) x 240 sec = 61 mega joules).
      i. 40 series batteries x 6 cells each = 240 cells total.
      ii. 61 MJ ÷ 240 cells, ÷ 240 sec = 1061 watts per cell

- 1061W per cell is very high for a typical VRLA battery so two parallel strings will likely be needed.

iii. 1061Wpc ÷ 2 strings = 530 watts per cell for each string.

For this application you will need 80 batteries rated for 250 amps that can deliver 530W per cell for 4 minutes, with an end voltage of 1.67V per cell.

7.5. VRLA BATTERY MAINTENANCE RECOMMENDATIONS

- This is a general recommendation. Always follow the specific Battery manufacturers' recommendation if available.

Table 7-2: VRLA Batter Maintenance Recommendations

	MONTHLY	QUARTERLY	ANNUAL
Measure and record battery voltage	✓	✓	✓
Measure and record charger output current and voltage	✓	✓	✓
Measure and record ambient temp	✓	✓	✓
Inspect battery, rack, cabinet and area	✓	✓	✓
Inspect cells/units for cracks, leakage, and jar/cover distortion	✓	✓	✓
Inspect for evidence of corrosion at the terminals, connections, rack or cabinet	✓	✓	✓
Measure and record the voltage of each cell/unit		✓	✓
Measure and record the internal resistance cell /unit		✓	✓
Measure and record the negative post temperature of each cell /unit		✓	✓
Measure and record connection resistance cell/unit		✓	✓
For applications with a discharge rate of 1 hour or less measure and record a sample of connection resistances (min. of 10% or 6 connections)		✓	✓
Measure and record 100% of connection resistances			✓
Measure and record torque values of each connection			✓
Record date of cleaning and inspection	✓	✓	✓
Provide inspection report	✓	✓	✓

Figure 7-2: Typical Drive Bus Voltage for 400VAC Systems (VDC)

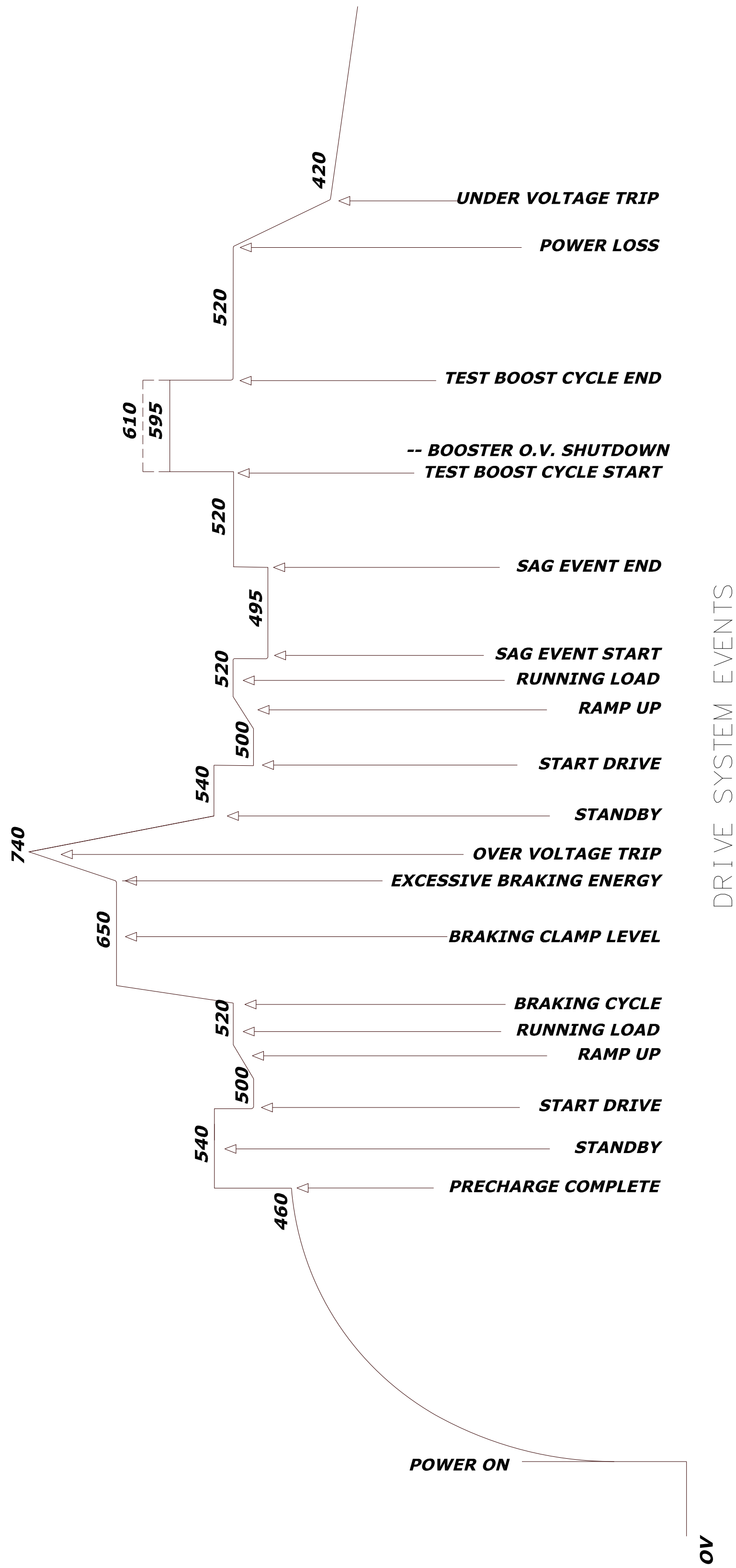
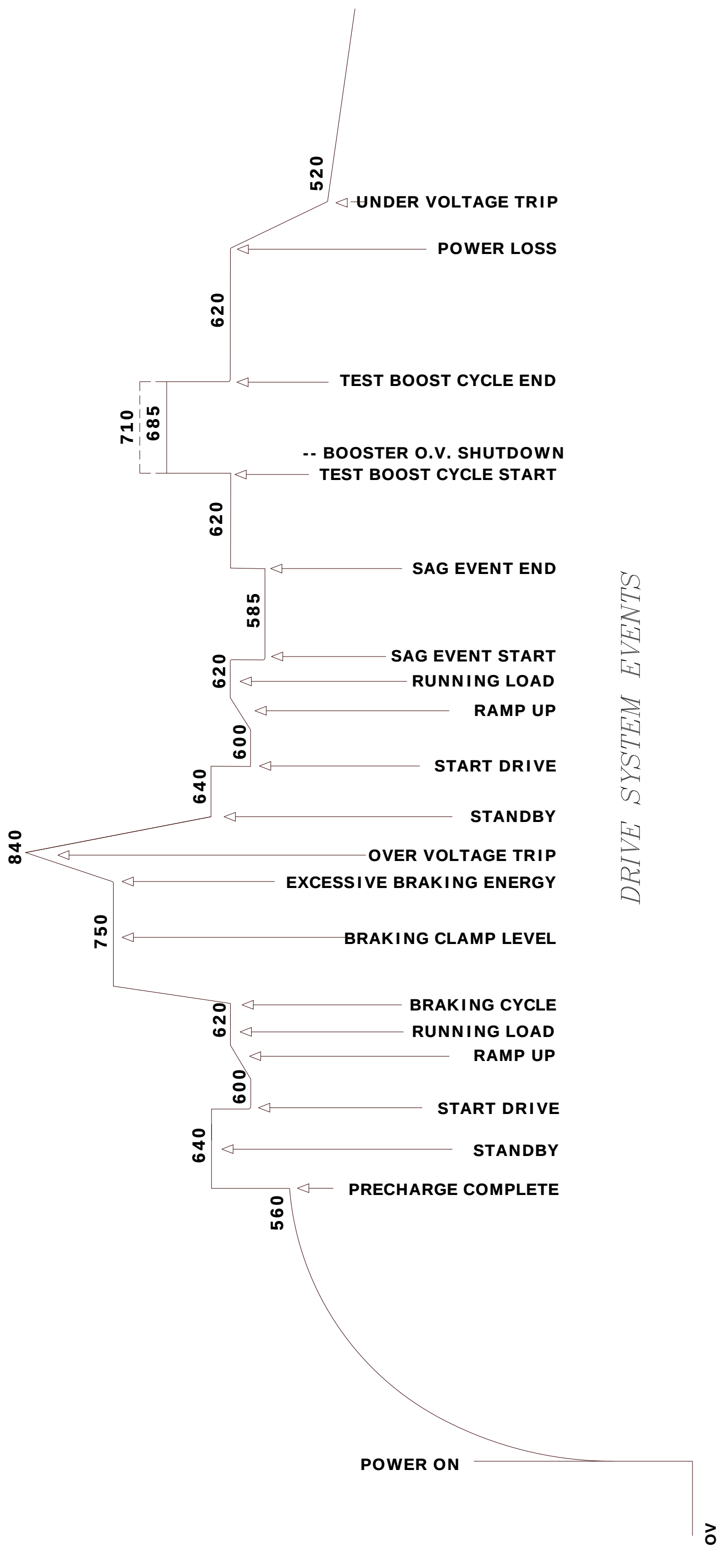


Figure 7-3: Typical Drive Bus Voltage for 460VAC Systems (VDC)



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