Model M3528

Charger Module
A6 and K8 Chassis

Customer Reference Manual

Bonitron, Inc.
Nashville, TN

An industry leader in providing solutions for AC drives.

ABOUT BONITRON

Bonitron designs and manufactures quality industrial electronics that improve the reliability of processes and variable frequency drives worldwide. With products in numerous industries, and an educated and experienced team of engineers, Bonitron has seen thousands of products engineered since 1962 and welcomes custom applications.

With engineering, production, and testing all in the same facility, Bonitron is able to ensure its products are of the utmost quality and ready to be applied to your application.

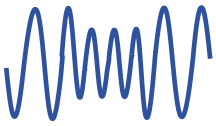
The Bonitron engineering team has the background and expertise necessary to design, develop, and manufacture the quality industrial electronic systems demanded in today's market. A strong academic background supported by continuing education is complemented by many years of hands-on field experience. A clear advantage Bonitron has over many competitors is combined on-site engineering labs and manufacturing facilities, which allows the engineering team to have immediate access to testing and manufacturing. This not only saves time during prototype development, but also is essential to providing only the highest quality products.

The sales and marketing teams work closely with engineering to provide up-to-date information and provide remarkable customer support to make sure you receive the best solution for your application. Thanks to this combination of quality products and superior customer support, Bonitron has products installed in critical applications worldwide.

AC Drive Options

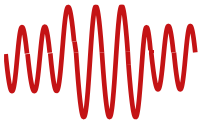
In 1975, Bonitron began working with AC inverter drive specialists at synthetic fiber plants to develop speed control systems that could be interfaced with their plant process computers. Ever since, Bonitron has developed AC drive options that solve application issues associated with modern AC variable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

World Class Products



Undervoltage Solutions

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



Overvoltage Solutions

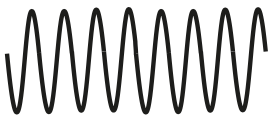
Braking Transistors
Braking Resistors
Transistor/Resistor Combo
Line Regeneration
Dynamic Braking for Servo Drives

Common Bus Solutions

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

Portable Maintenance Solutions

Capacitor Formers
Capacitor Testers



Power Quality Solutions

12 and 18 Pulse Kits

Green Solutions

Line Regeneration

This page left blank intentionally

1. INTRODUCTION

1.1. WHO SHOULD USE THIS MANUAL

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

Please keep this manual for future reference.

1.2. PURPOSE AND SCOPE

This manual is a user's guide for the model M3528 charger module. It will provide the user with the necessary information to successfully install, integrate, and use the M3528 with battery or capacitive energy storage systems.

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

1.3. MANUAL REVISION

Rev 00 is the original printing of the M3528 charger CE & UL listed manual.

Output and jumper position drawings were clarified in rev 00a.

A6 chassis dimensions were corrected in rev 00b.

Terminology was updated in rev 00c.

Branch circuit protection and wire sizing were updated in rev 00d.

Power wiring sizes and fusing were updated in rev 00e.

Updates to the startup up procedures in Section 5.1 were made in rev 00f.

Update made to Figures 3-1, 3-2, 3-3, and 3-4 in rev 00g.

C class updates were added in rev 00h.

Section 6.3 was updated in rev 00i

Section 3.4 was updated in rev 00j.

Table 6-4 was updated in rev 00m.

Figure 1-1: M3528 Charger in the A6 Chassis

1.4. SYMBOL CONVENTIONS USED IN THIS MANUAL AND ON EQUIPMENT

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

2. PRODUCT DESCRIPTION

Bonitron's M3528 charger is a voltage limited current source used to charge higher voltage batteries, ultracapacitor or double layer capacitor energy storage strings.

Variable frequency drive systems can require energy storage to back up power for mission critical or continuous processes. Any system requiring energy during a complete loss of input power need some type of energy storage device. These systems use batteries and ultracapacitors in strings with high voltage ranges at higher power ratings. Standard chargers typically do not have this voltage range, and are intended for use with batteries only. The M3528 charger module can charge battery or ultracapacitor strings from 175-675VDC.

2.1. RELATED PRODUCTS

M3460 SERIES RIDE-THRU MODULES

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

M3534 SERIES RIDE-THRU MODULES

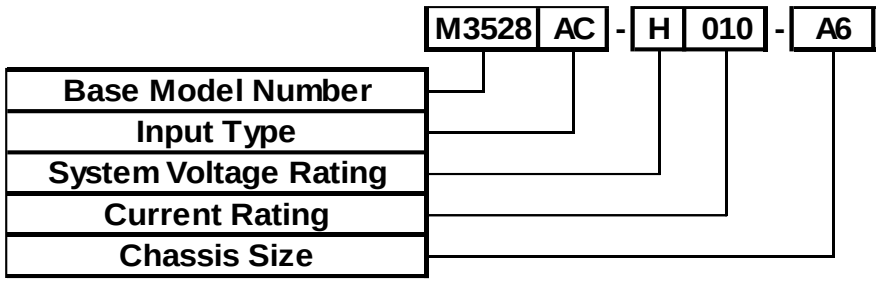
Voltage regulators used for sag or outage protection of lower power systems.

M3628 ULTRACAPACITOR SAFETY DISCHARGERS

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

2.2. PART NUMBER BREAKDOWN

Figure 2-1: Example of M3528 Part Number Breakdown



BASE MODEL NUMBER

The base model number for all charger modules is **M3528**.

INPUT TYPE

The input type indicates either AC or DC input. The DC input is only available in the 10 amp models.

SYSTEM VOLTAGE RATING

The system voltage rating indicates the nominal system voltage levels as listed in Table 2-1.

Table 2-1: System Voltage Rating Codes

RATING CODE	NOMINAL VOLTAGE (AC LINE / DRIVE BUS)
L	230VAC / 325VDC
E	380-415VAC / 540-585VDC
H	460VAC / 650VDC
C	575VAC / 810VDC

CURRENT RATING

The current rating indicates the maximum charging current for the M3528 in DC Amps. This rating is directly represented by a 3-digit value. For instance, the rating for a 10ADC M3528 is indicated as **010**. Note the maximum charging current for C class charger is 5ADC.

CHASSIS SIZE

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

Table 2-2: Chassis Size Codes

CHASSIS SIZE	DIMENSIONS H x W x D	CURRENT RATING
A6	18.60” x 6.25” x 11.25”	10A / 5A
K8	20.00” x 8.10” x 11.10”	20A

2.3. GENERAL SPECIFICATIONS

Table 2-3: General Specifications Chart

PARAMETER	SPECIFICATION
AC Input Voltage	208 - 575VAC
DC Input Voltage	295 - 650VDC
DC Charging Voltage	175 - 675VDC
Bulk Charge / Equalize Voltage	2% - 9% above Charge Voltage
Max DC Charging Current	5A /10A / 20A
Enclosure Rating	Open
Environmental	• Indoor use only • Maximum operating altitude: 2000m or 6500ft • Ambient temperature range: 5°C to 40°C • Maximum relative humidity 80% for temperatures up to 31°C decreasing linearly to 50% relative humidity at 40°C • Pollution degree: 2- Normally, only non-conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation is to be expected, when the equipment is out of operation. • Installation/overvoltage category: II

2.4. General Precautions and Safety Warnings

DANGER!

- High voltages may be present!
- Never attempt to operate this product with the enclosure cover removed!
- Never attempt to service this product without first disconnecting power to and from the unit.
- Always allow adequate time for residual voltages to drain before opening the enclosure.
- **FAILURE TO HEED THESE WARNINGS MAY RESULT IN SERIOUS INJURY OR DEATH!**

CAUTION!

- Certain components within this product may get hot during operation.
- Always allow ample time for the unit to cool before attempting service on this product.
- Installation and/or removal of this product should only be accomplished by a qualified electrician in accordance with National Electrical Code or equivalent regulations.
- Before attempting installation or removal of this product, be sure to review all system documentation for pertinent safety precautions.
- No user-serviceable parts are contained within this product. Inoperable units should be replaced or returned for repair.

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

This page left blank intentionally

3. INSTALLATION INSTRUCTIONS

The M3528 has an open type chassis construction. It is intended to be part of a larger variable frequency drive system, and will require different hardware for interconnection based on the installation. An appropriate enclosure may need to be provided to protect personnel from contact and the system from damage. The enclosure may also need to protect the equipment from the installation environment.

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

3.1. ENVIRONMENT

The maximum ambient operating temperature of the M3528 should not exceed 40°C. Temperatures above this can cause overheating during operation.

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

3.2. UNPACKING

Inspect the shipping crate and M3528 for damage.
Notify the shipping carrier if damage is found.

3.3. MOUNTING

Mounting dimensions can be found in Section 6.

Remove the M3528 from the shipping crate and mount it in the desired location using the mounting slots and holes and ¼" diameter studs or bolts. Mounting hardware is not supplied with the M3528.

3.4. WIRING AND USER CONNECTIONS

Review this entire Section before attempting to wire the M3528.

3.4.1. POWER WIRING

DANGER!

BATTERY SYSTEMS MUST BE HANDLED WITH EXTREME CARE. THE POWER CONNECTIONS TO BATTERY SYSTEMS CAN BE AT LETHAL VOLTAGES WHICH CANNOT BE REMOVED.

ENSURE THAT ALL STORAGE BANK MODULES ARE DISCONNECTED AND LOCKED OUT BEFORE ATTEMPTING SERVICE OR INSTALLATION.

USE PROPER TOOLS AND PROCEDURES TO MINIMIZE RISK OF INJURY OR DEATH.

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

This section provides information pertaining to the field wiring connections of the M3528. Actual connection points and terminal numbers of the AC drive system will be found in the documentation provided with the drive system.

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

Table 3-1: M3528AC Power Wiring Connections

TERMINAL DESIGNATION	FUNCTION	WIRING SPECIFICATION	CONNECTION	TORQUE
AC LINE L1 L2 L3	AC Input	600VAC	#10 lug ring or spade	20 lb-in
STORAGE BUS - +	DC Output	600VAC	#10 lug ring or spade	20 lb-in
⏚	Ground	600VAC	#10 lug ring or spade	15 lb-in

Table 3-2: M3528DC Power Wiring Connections

TERMINAL DESIGNATION	FUNCTION	WIRING SPECIFICATION	CONNECTION	TORQUE
INPUT BUS + -	DC Input	600VAC	#10 lug ring or spade	20 lb-in
STORAGE BUS - +	DC Output	600VAC	#10 lug ring or spade	20 lb-in
⏚	Ground	600VAC	#10 lug ring or spade	15 lb-in

Main power connections should be made with copper wire rated 75°C or equivalent; and use compression fitting lugs. Wire sizing should be appropriate for the current being carried. System ratings are listed in Section 6.

3.4.1.1. AC LINE (L1 L2 L3) CONNECTIONS

An isolation transformer should be used with the M3528AC models to prevent the rectifier section of the M3528 charger from supplying power to the drive. The AC Line connections should be made to the output of the isolation transformer. The AC Line connections are not available on the M3528DC models.

CAUTION!

IT IS RECOMMENDED TO USE A DELTA-DELTA ISOLATION TRANSFORMER. IF A WYE CONFIGURATION IS USED ON THE SECONDARY WINDING, THE NEUTRAL SHOULD NOT BE EARTH GROUNDED. THIS CAN CAUSE GROUND FAULTS ON THE DRIVE AND AFFECT THE FUNCTIONALITY OF THE SYSTEM!

3.4.1.2. INPUT BUS (+ -) CONNECTIONS

When a M3528DC model is used, the Input Bus connections should be made to the Storage Bus terminals of the Ride-Thru.

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

The Input Bus connections are not available on the M3528AC models.

3.4.1.3. STORAGE BUS (- +) CONNECTIONS

The Storage Bus connections should be made to the capacitor or battery bank.

If connecting to a capacitor bank, it should be fully discharged when this connection is made.

Since a battery bank cannot be fully discharged without damaging the batteries, a disconnect or contactor should be placed between the Storage Bus terminals of the M3528 and the battery bank terminals.

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

CAUTION!

THE M3528 SHOULD BE POWERED ON AND THERE SHOULD BE LESS THAN 50VDC DIFFERENCE BETWEEN THE VOLTAGE AT THE STORAGE BUS TERMINALS OF THE M3528 AND THE VOLTAGE AT THE BATTERY BANK WHEN THE DISCONNECT OR CONTACTOR IS CLOSED.

IF THE M3528 OUTPUT IS GREATER THAN 50VDC HIGHER THAN THE BATTERY VOLTAGE, CONNECT THE BATTERY BANK DISCONNECT BEFORE TURNING THE M3528 ON AND ENABLING.

FAILURE TO HEED THIS WARNING COULD RESULT IN DAMAGE TO THE SYSTEM!

DANGER!

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

3.4.1.4. GROUNDING REQUIREMENTS

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

3.4.2. CONTROL INTERFACE AND I/O WIRING

Control wiring allows for remote enabling and monitoring of the M3528. Inputs can be a dry contact using an internally generated, isolated supply, or an external 24VDC signal.

Table 3-3: User I/O Connections With 3528C2 or 3528C3 Boards

TERMINAL	FUNCTION	ELECTRICAL SPECIFICATIONS	WIRE AWG	TORQUE
TB3-1	24VDC+	24 VDC, 50 mA	16	2.1 lb-in
TB3-2	Enable Input			
TB3-3	24VDC+			
TB3-4	Equalize Input			
TB3-5	Input Common			
TB4-1	Output Common	350V, 120mA		
TB4-2	Charging Output			
TB4-3	Ready Output			

3.5. TYPICAL CONFIGURATIONS

Figure 3-1: M3460 Ultracapacitor System

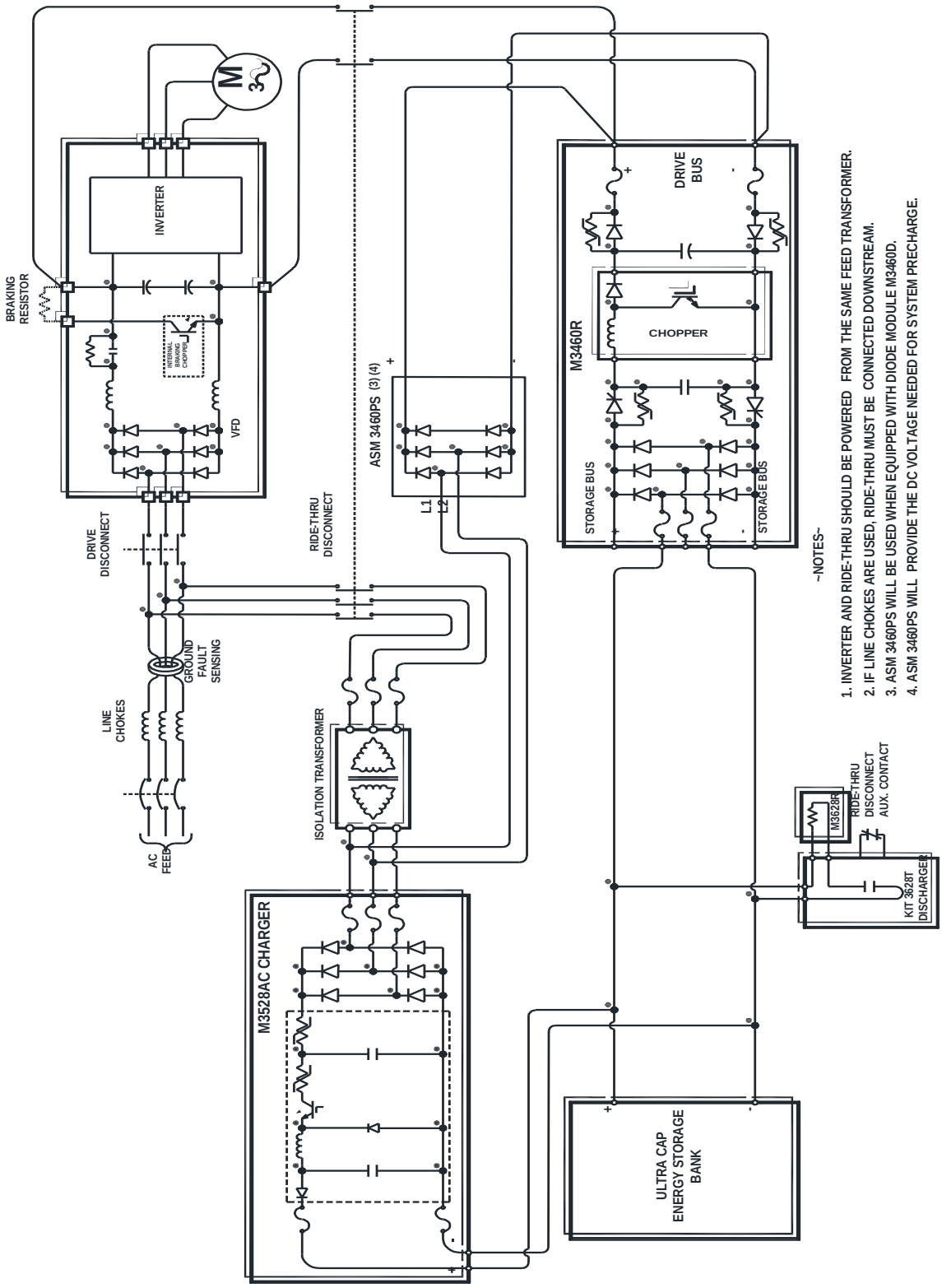


Figure 3-2: M3460 Battery System

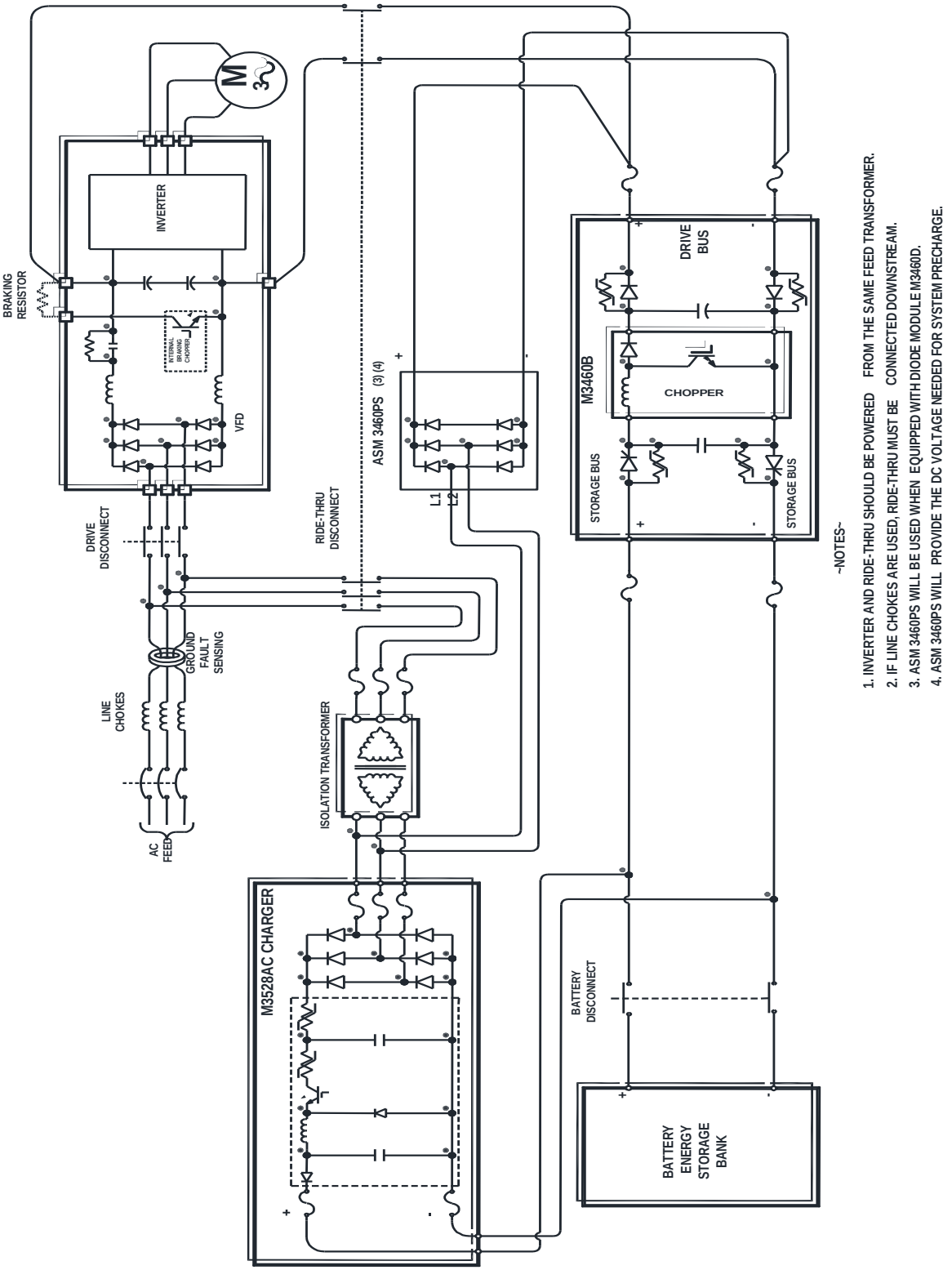


Figure 3-3: M3534 Ultracapacitor System

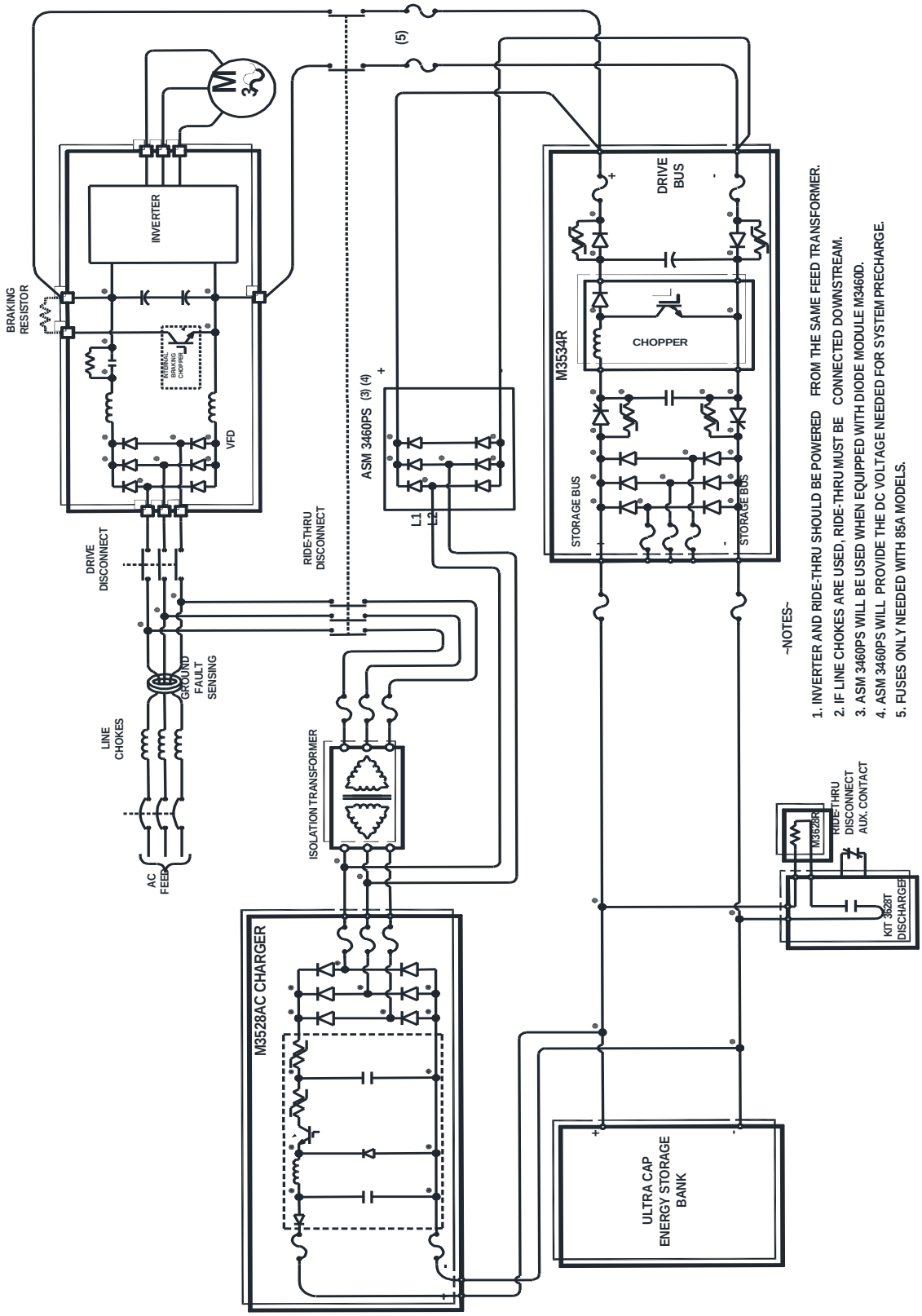
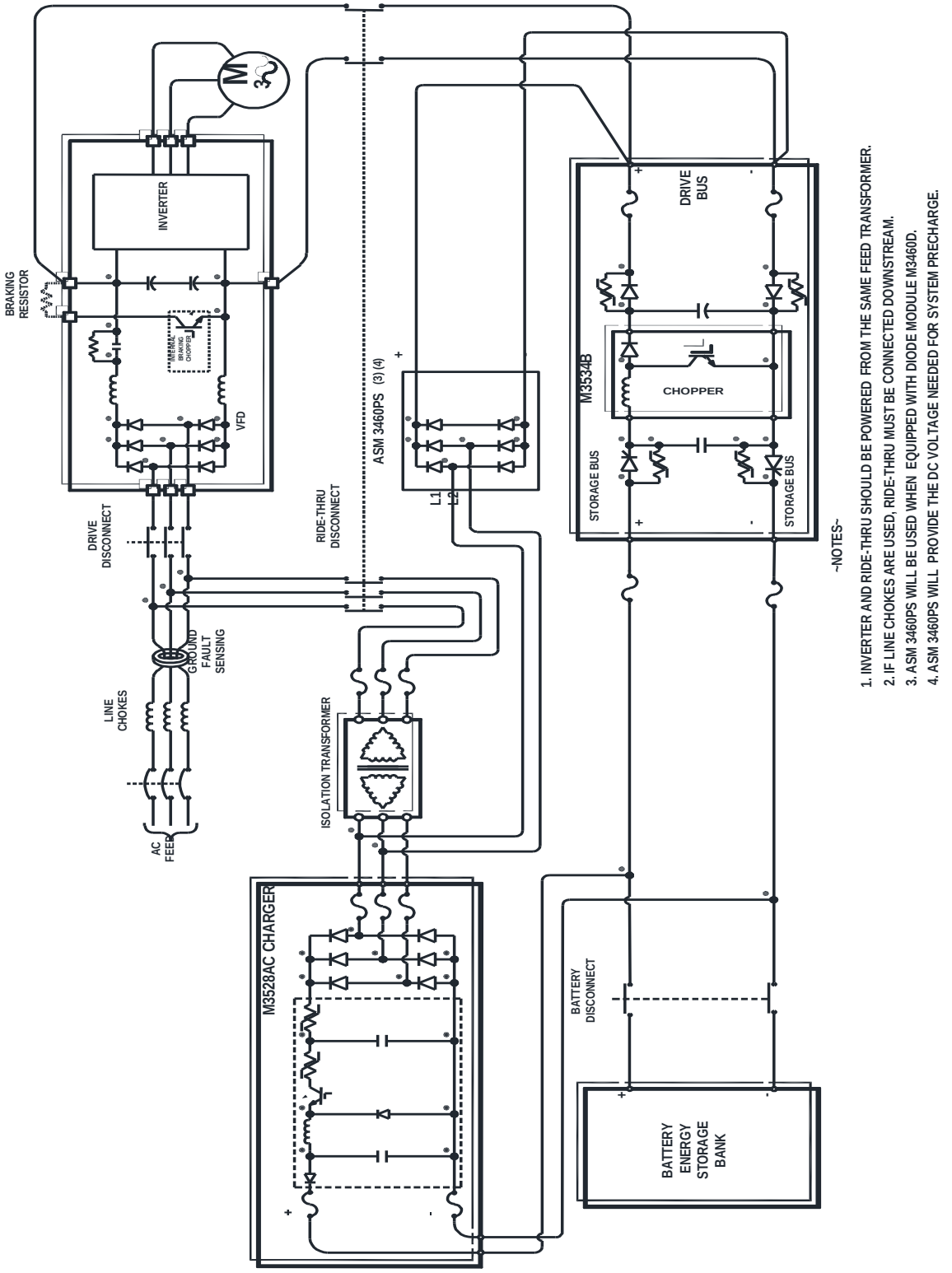


Figure 3-4: M3534 40A Battery System



This page left blank intentionally

4. OPERATION

4.1. FUNCTIONAL DESCRIPTION

The M3528 charger module is a voltage and current limited power supply used to charge energy storage devices such as battery banks or high energy storage capacitor banks.

The M3528 may be used to charge a battery or an ultracapacitor bank. The M3528 charger does not test for battery impedance or voltage in order to start charging. Charging will begin when power is applied, the charge enable is active, and the output is sensed to be below set-point. Once charged, the M3528 maintains full voltage.

4.2. OPERATION MODES AND CONFIGURATION

4.2.1. NORMAL OPERATION

During normal operation, the M3528 will charge the attached storage bank to the voltage and current set by the potentiometers on the 3528C2 or 3528C3 board.

This mode is activated by the Enable input.

4.2.2. EQUALIZE MODE

DANGER!

- ***DO NOT** USE THIS MODE FOR CAPACITOR STORAGE SYSTEMS. EXTREME DAMAGE AND CATASTROPHIC FAILURE CAN OCCUR IF CAPACITOR STORAGE BANKS ARE EXPOSED TO VOLTAGES ABOVE THEIR RATING!*
- ***OVERCHARGING BATTERIES OR CHARGING AT LEVELS ABOVE THE RECOMMENDED FULL VOLTAGE CAN DAMAGE THE BATTERIES BY OVERHEATING, HYDROGEN GAS PRODUCTION, FIRE AND EXPLOSIONS.***
- ***PERFORM THIS PROCEDURE ONLY PER THE INSTRUCTIONS FROM THE BATTERY MANUFACTURER!***

While in Equalize mode, the M3528 will charge the attached storage bank to a voltage slightly higher than the full voltage setting. This can force long strings of batteries to have a more even charge across cells.

The equalize voltage is set at the factory to be 2.5% higher than the full voltage setting. However, this can be adjusted from 2-9% with a potentiometer on the control board. See Section 4.4

This process can operate in two modes, Timed and Input Follow. The mode is selected by J6 on the 3528C2 board or J3 on the 3528C3 board. Placing the jumper in the ON position selects Timeout mode and placing the jumper in the OFF position selects Input Follow mode.

In Input Follow mode, the M3528 is in Equalize mode as long as the Equalize input is active.

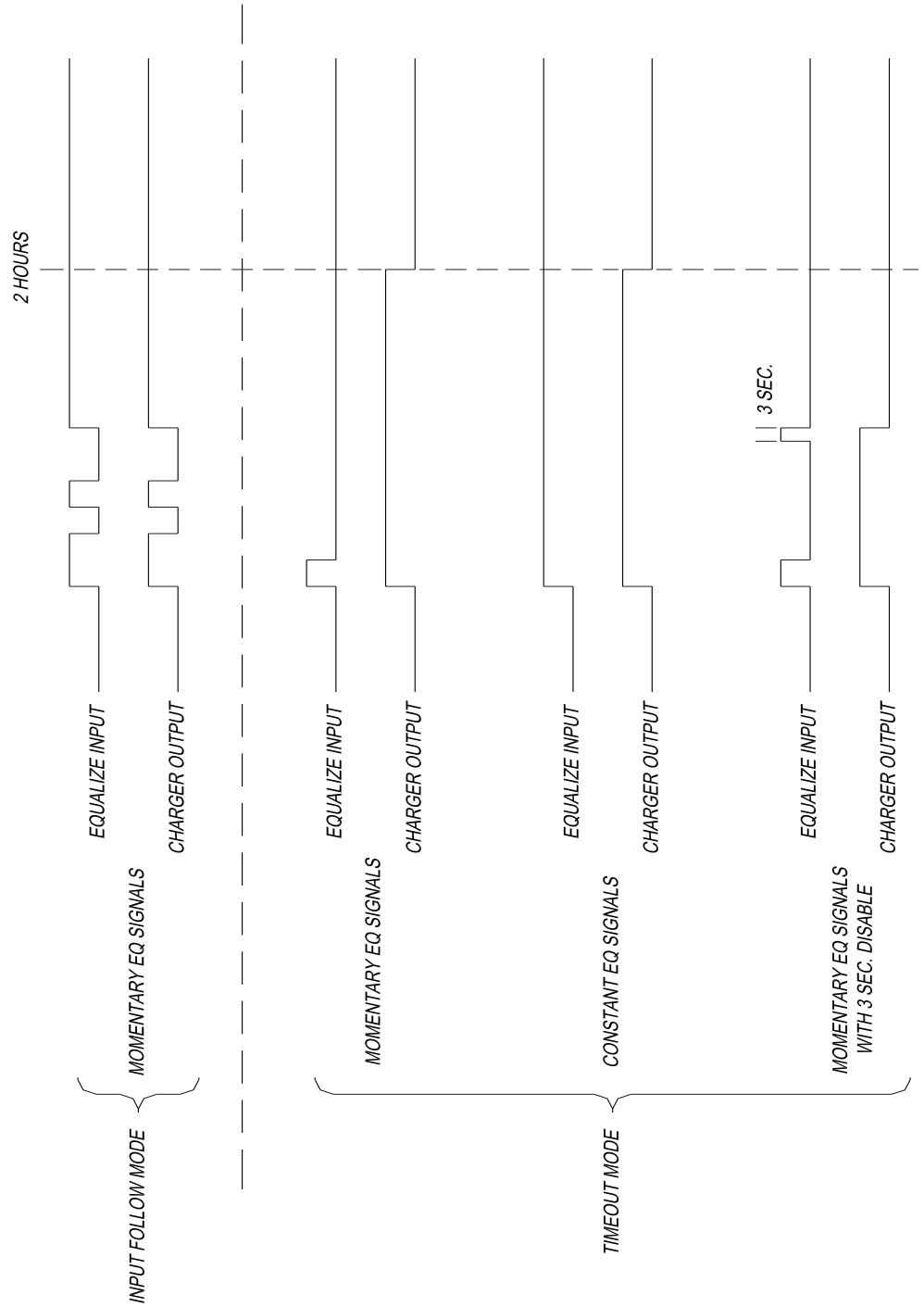
In Timeout mode, a pulse may be used to put the M3528 into Equalize mode and an internal timer will remove the M3528 from Equalize mode after two hours. If the Equalize input stays high for more than two hours, the 3528 will return to the normal full voltage after two hours. Timeout mode can be stopped at any time before the two hour timeout by giving the Equalize input a three second high pulse.

This mode is activated by the Equalize input.

Table 4-1: Equalize Mode Selection Jumper Details

3528C2 JUMPER	3528C3 JUMPER	JUMPER POSITION	MODE
J6	J3	ON	Timeout
		OFF	Input Follow

FIGURE 4-1: EQUALIZATION TIMING CHART



4.3. I/O AND FEATURES

Control and monitoring signals are available on the terminal strips marked TB3 and TB4 of the control boards. These are suitable for remote operation of the system.

Figure 4-2: 3528C2 Control Board Layout

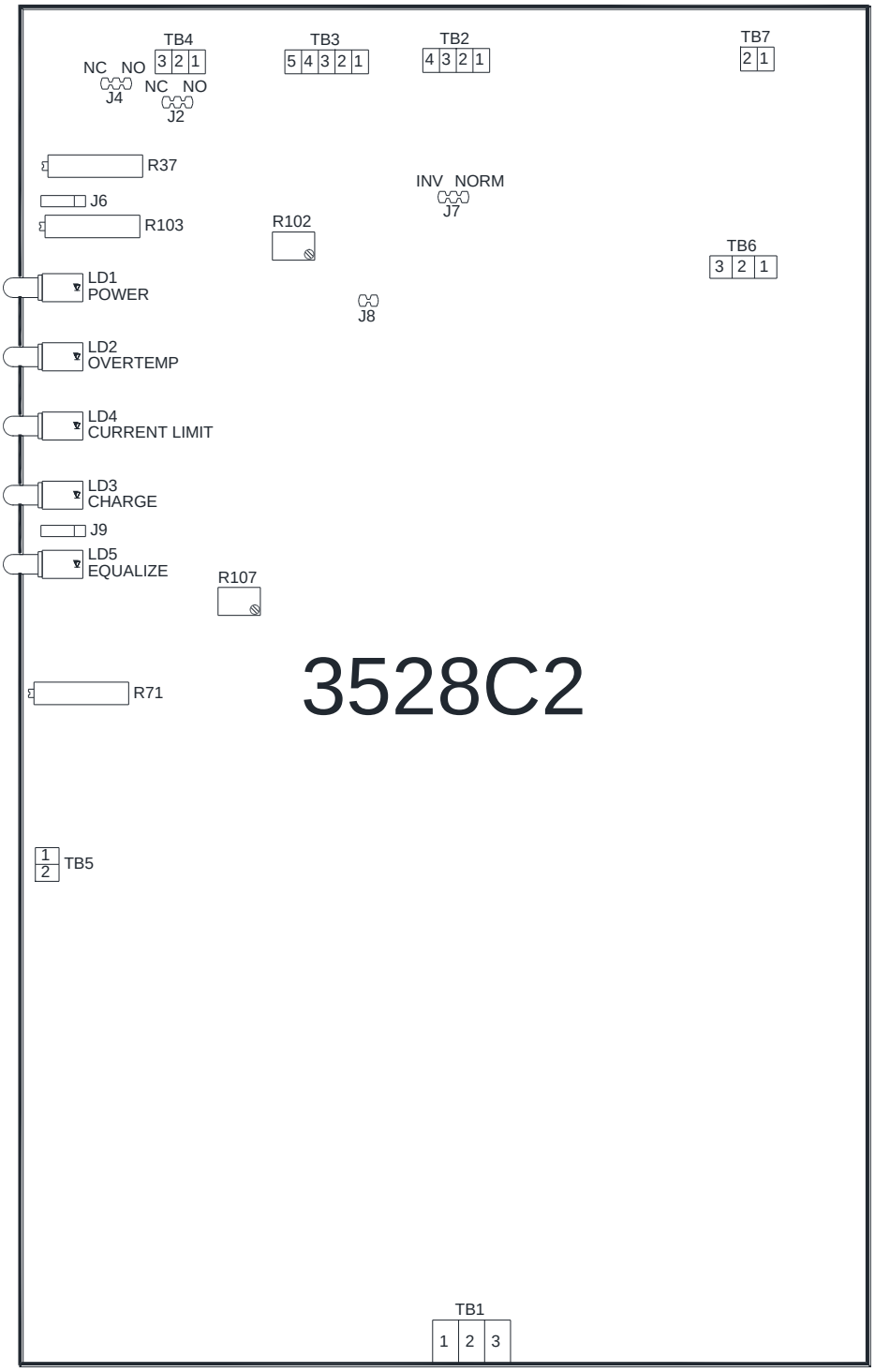
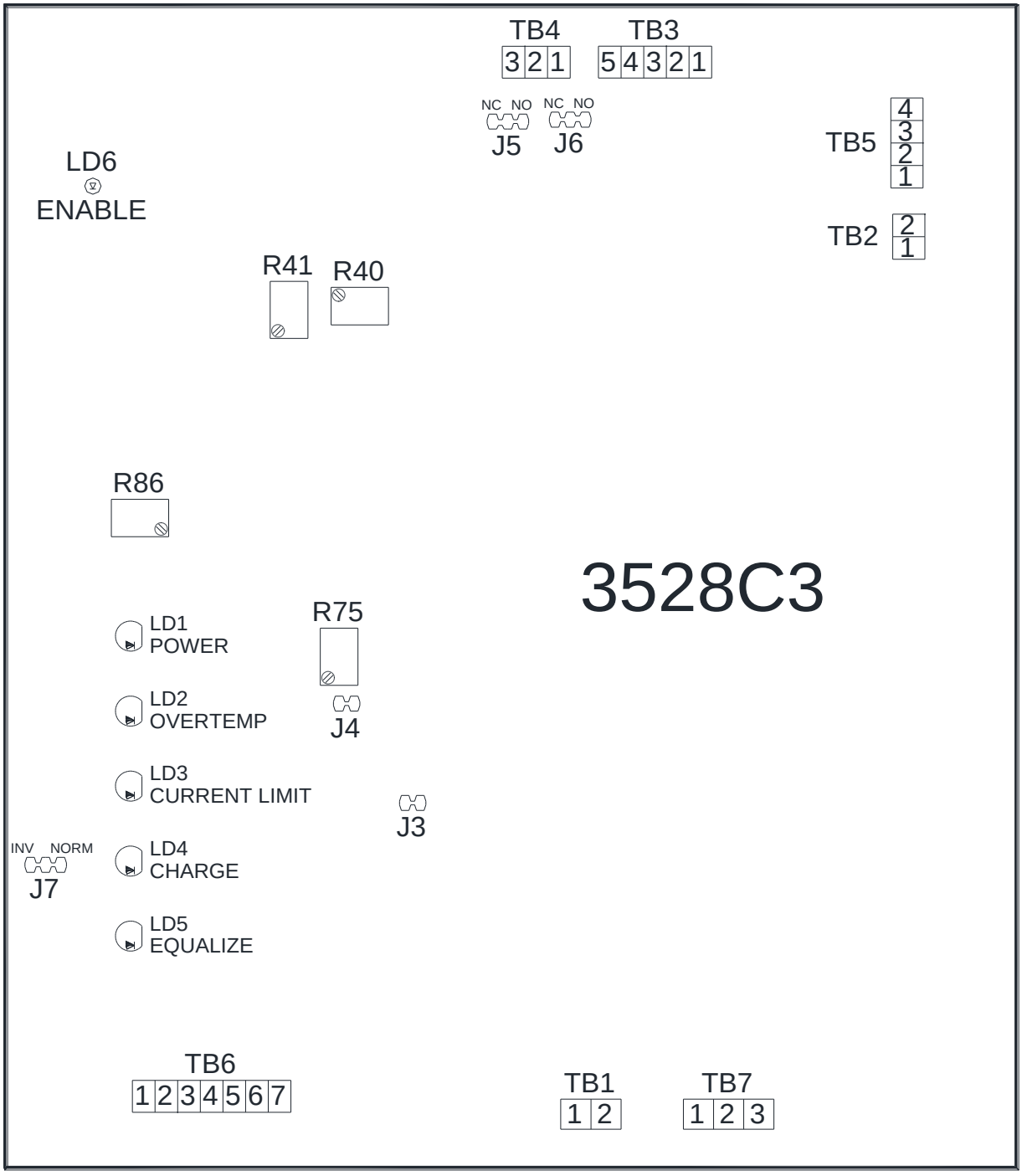


Figure 4-3: 3528C3 Control Board Layout



4.3.1. INPUT TERMINALS – TB3

The input terminals are located on TB3 of the 3528C2 or 3528C3 board. They can use an internal supply with a dry contact or an external 24VDC.

4.3.1.1. 24V+ SUPPLY - TB3-1, TB3-3

The internal supply is capable of supplying 50mA at 24VDC. It is intended to be used for the inputs of the M3528 locally, and should not be used as any other source. There is not sufficient power to serve as signaling for the output terminals.

If more power is required, the inputs can be driven from a separate 24VDC power source. When a separate power source is used, the negative or common of that power supply should be connected to TB3-5.

4.3.1.2. ENABLE INPUT - TB3-2

The enable input allows the M3528 charger module to charge the storage bank. 24VDC may be placed between TB3-2 and TB3-5 or a contact closed between TB3-1 and TB3-2 to enable the charger module.

4.3.1.3. EQUALIZE INPUT - TB3-4

The equalize input allows the M3528 charger module to enter equalize mode and charge to the equalize voltage setting. 24VDC may be placed between TB3-4 and TB3-5 or a contact closed between TB3-3 and TB3-4 to put the charger into equalize mode.

Both the Enable Input and the Equalize Input must be activated for the charger to operate in Equalize mode.

4.3.1.4. INPUT COMMON - TB3-5

This terminal is the common for the inputs only. If the internal power supply from TB3-1 is used, there is no connection to this terminal.

This common is not connected to ground, and should not be connected locally to avoid noise in the control circuits or ground loops.

It is also separate from the output common to allow the use of separate power supplies if desired.

4.3.2. OUTPUT TERMINALS – TB4

The status of the M3528 can be monitored from TB4 on the 3528C2 or 3528C3 board. The status outputs can be configured with jumpers to be normally open (NO) or normally closed (NC). In the descriptions below, the operation is described for the jumpers to be set in the normally open position, which is the default setting.

4.3.2.1. OUTPUT COMMON - TB4-1

This pin is common to both the Charging and Ready outputs.

This common is not connected to ground, and should not be connected locally to avoid noise in the control circuits or ground loops.

4.3.2.2. CHARGING OUTPUT - TB4-2

This output closes to the output common at TB4-1 when the M3528 is currently supplying current to the attached storage bank.

The output configuration can be set to normally open or normally closed with Jumper J2 on the 3528C2 board or J6 on the 3528C3 board.

4.3.2.3. READY OUTPUT - TB4-3

This output closes to the output common at TB4-1 when the M3528 internal power supply is operating properly and it is not in an overtemperature condition.

The output configuration can be set to normally open or normally closed with Jumper J4 on the 3528C2 board or J5 on the 3528C3 board.

Table 4-2: 3528 Status Output Signal Jumper Details

OUTPUT	ABBREVIATION	FIELD TERMINALS	3528C2 JUMPER	3528C3 JUMPER	FACTORY SETTING
Charging	CHG	TB4 - 2	J2	J6	Normally Open (N.O.)
Ready	RDY	TB4 - 3	J4	J5	

4.3.3. INDICATORS

The LED indicators are located on the front panel of the M3528 charger, and can be used to monitor the operation of the charger.

4.3.3.1. POWER

This light illuminates green the M3528 internal power supply is operating properly.

4.3.3.2. OVERTEMP

This light illuminates red when the M3528 heatsink is above 65°C (150°F). When this light is on, the M3528 will not operate. This light will turn off when the M3528 heatsink temperature returns to a safe level.

4.3.3.3. CURRENT LIMIT

This light illuminates amber when the M3528 is operating at full current or in constant current mode. This is a normal condition, and will stay on until the charger output begins to reach the voltage setpoint.

4.3.3.4. CHARGE

This light illuminates green when the M3528 is actively charging.

4.3.3.5. EQUALIZE

This light illuminates amber when the M3528 is in Equalize mode.

4.4. OPERATIONAL ADJUSTMENTS


DANGER!

THESE ADJUSTMENTS MUST ONLY BE MADE BY QUALIFIED PERSONNEL. TECHNICIANS WILL BE EXPOSED TO LETHAL VOLTAGES AND EXTREME CARE MUST BE USED WHEN MEASURING AND ADJUSTING THE OUTPUTS.
THE CONTROL BOARD IS REFERENCED TO THE HIGH VOLTAGE DC BUS OF SYSTEM.
FAILURE TO OBSERVE SAFETY PRECAUTIONS CAN LEAD TO INJURY AND DEATH!

The full voltage, equalize voltage, and current limit settings are typically customized to every order. However, field calibration may be necessary. Table 4-3 shows the potentiometer associated with each possible field calibration.

Table 4-3: Adjustment Potentiometers

POTENTIOMETER		DESCRIPTION
3528C2 (10 AMP)	3528C3 (20 AMP)	
R37	R41	Full Voltage
R103	R40	Equalize Voltage
R71	R75	Current Limit

4.4.1. FULL VOLTAGE ADJUSTMENT


DANGER!

- ***IMPROPER SETTING OF THE FULL VOLTAGE FOR BATTERIES CAN CAUSE OVERCHARGING, OVERHEATING AND/OR HYDROGEN GAS PRODUCTION AND RELEASE. THIS CAN LEAD TO BATTERY DAMAGE, EXPLOSIONS, PROPERTY DAMAGE AND DEATH. FOLLOW BATTERY BANK RECOMMENDATIONS FOR PER CELL FULL VOLTAGES AND PROCEDURES.***
- ***IMPROPER SETTING OF THE FULL VOLTAGE FOR CAPACITORS CAN CAUSE OVERCHARGING AND RESULT IN INTERNAL BREAKDOWN AND DAMAGE TO CAPACITOR BANKS. THIS CAN LEAD TO CAPACITOR DAMAGE, CATASTROPHIC FAILURE, PROPERTY DAMAGE AND DEATH. FOLLOW CAPACITOR BANK RECOMMENDATIONS FOR MAXIMUM ALLOWABLE CHARGING VOLTAGE.***


CAUTION!

- ***CHECK STORAGE BANK MANUFACTURER'S RECOMMENDATIONS BEFORE APPLYING POWER.***
- ***THE FULL VOLTAGE SETTING SHOULD BE VERIFIED BEFORE CONNECTING TO ANY ENERGY STORAGE BANK.***
- ***VOLTAGE ADJUSTMENT MAY BE DONE WITH OPEN CIRCUIT OR FULLY CHARGED STORAGE BANK. IF THE STORAGE BANK IS NOT COMPLETELY CHARGED, THE FINAL VOLTAGE WILL NOT BE KNOWN.***
- ***THE FULL VOLTAGE SETTING CANNOT BE SET ABOVE THE RECTIFIED INPUT OF THE M3528.***

The full voltage setting can be adjusted with R37 on the 3528C2 board or R41 on the 3528C3 board. Adjusting the potentiometer clockwise increases the voltage setting and adjusting the potentiometer counter-clockwise decreases the voltage setting.

4.4.2. EQUALIZE VOLTAGE ADJUSTMENT

DANGER!

IMPROPER SETTING OF THE EQUALIZE VOLTAGE SETTING CAN CAUSE OVERCHARGING, OVERHEATING AND/OR HYDROGEN GAS PRODUCTION AND RELEASE. THIS CAN LEAD TO BATTERY DAMAGE, EXPLOSIONS, PROPERTY DAMAGE AND DEATH. FOLLOW BATTERY BANK RECOMMENDATIONS FOR PER CELL FULL VOLTAGES AND PROCEDURES.

The equalize voltage is factory preset for 2.5% increase above full voltage setting. This can be adjusted from 2 - 9% above full voltage setting. Adjust R103 on the 3528C2 board or R40 on the 3528C3 board. Adjusting the potentiometer clockwise increases the voltage setting and adjusting the potentiometer counter-clockwise decreases the voltage setting.

4.4.3. CURRENT LIMIT ADJUSTMENT

DANGER!

IMPROPER SETTING OF THE CURRENT LIMIT SETTING CAN CAUSE OVERHEATING IN BATTERIES, RESULTING IN DECREASED BATTERY LIFE. FOLLOW BATTERY BANK RECOMMENDATIONS FOR CHARGE CURRENT SPECIFICATIONS.

CAUTION!

- ***CHECK STORAGE BANK MANUFACTURER'S RECOMMENDATIONS BEFORE APPLYING POWER.***
- ***THE CURRENT LIMIT SETTING SHOULD BE VERIFIED BEFORE CONNECTING TO ANY ENERGY STORAGE BANK.***
- ***THE CURRENT LIMIT SETTING MUST BE CHECKED WITH A DISCHARGED BATTERY BANK. IF THE BATTERY BANK IS NOT DISCHARGED, THE M3528 CURRENT REQUIRED TO CHARGE THE BATTERY BANK WILL NOT BE THE FULL CURRENT LIMIT SETTING.***

The current limit is factory preset to full output current unless otherwise marked. Many battery manufacturers recommend a low charging current for batteries with high discharge current availability. Capacitor banks typically can be charged at full current.

To change the current limit, there must be a load sufficient to dissipate the current setpoint. This can be done with a discharged load or with a static resistive load.

The current limit setting can be adjusted with R71 on the 3528C2 board or R75 on the 3528C3 board. Adjusting the potentiometer clockwise increases the current setting and adjusting the potentiometer counter-clockwise decreases the current setting.

5. START-UP PROCEDURES, MAINTENANCE, & TROUBLESHOOTING

5.1. START-UP PROCEDURE FOR USE WITH BATTERIES

CAUTION!

- ***THE M3528 CURRENT LIMIT SETTING MUST BE CHECKED WITH A DISCHARGED BATTERY BANK. IF THE BATTERY BANK IS NOT DISCHARGED, THE M3528 CURRENT REQUIRED TO CHARGE THE BATTERY BANK WILL NOT BE THE FULL CURRENT LIMIT SETTING.***
- ***THE M3528 SHOULD BE POWERED ON AND THERE SHOULD BE LESS THAN 50VDC DIFFERENCE BETWEEN THE VOLTAGE AT THE STORAGE BUS TERMINALS OF THE M3528 AND THE VOLTAGE AT THE BATTERY BANK. WHEN THE DISCONNECT OR CONTACTOR IS CLOSED.***
- ***IF THE M3528 OUTPUT IS GREATER THAN 50VDC HIGHER THAN THE BATTERY VOLTAGE, CONNECT THE BATTERY BANK DISCONNECT BEFORE TURNING THE M3528 ON AND ENABLING.***
- ***FAILURE TO HEED THIS WARNING COULD RESULT IN DAMAGE TO THE SYSTEM!***

1. Verify proper wiring and ensure the disconnect or contactor between the M3528 and battery bank is open.
2. Apply input power to M3528 and activate the Enable Input. (see Section 4.3.1.2.) Verify the output voltage of the M3528 is appropriate for the battery bank being used. See Section 4.4 and adjust if necessary.
3. Activate the Equalize Input (see Section 4.3.1.3.) Verify the equalize voltage of the M3528 is appropriate for the battery bank being used. See Section 4.4 and adjust if necessary.
4. Remove Equalize Input and place a DC current clamp on the output wiring to the battery bank.
5. Ensure that there is less than a 50VDC difference between the M3528 Storage Bus voltage and battery bank voltage and close the disconnect or contactor between the M3528 and battery bank. The M3528 will begin to supply current to the battery bank. The amount of current depends on the charge level of the battery bank. It is likely that the Current Limit light will come on. The Power and Charge lights will be on.
6. If the M3528 output is greater than 50VDC higher than the battery voltage, connect the battery bank disconnect before turning the M3528 on and enabling.
7. Ensure that the charge current is appropriate for the battery bank being used. See Section 4.4 and adjust if necessary.
8. Record the voltage and current settings in Section 5.3.

5.2. START-UP PROCEDURE FOR USE WITH CAPACITORS

CAUTION!

THE M3528 AND STORAGE BANK SHOULD NOT BE CONNECTED IF THERE IS A VOLTAGE DIFFERENCE GREATER THAN 50VDC BETWEEN THE STORAGE BUS TERMINALS OF THE M3528 AND THE STORAGE BANK VOLTAGE. FAILURE TO HEED THIS WARNING COULD RESULT IN DAMAGE TO THE SYSTEM!

1. Verify proper wiring and remove Storage Bus fuses inside M3528.
2. Apply input power to M3528 and activate the Enable Input (see Section 4.3.1.2.)
3. Verify the output voltage of the M3528 is appropriate for the storage bank being used. This can be done by measuring the DC voltage at the inside terminals to the Storage Bus fuse block inside the M3528. See Section 4.4 and adjust if necessary.
4. Remove Enable Input, remove input power from M3528, and allow all voltages to drain to a safe level.
5. Replace Storage Bus fuses and place a DC current clamp on the output wiring to the storage bank.
6. Apply input power to M3528, ensure the storage bank is discharged, and activate the Enable Input.
7. Ensure that the charge current is appropriate for the storage bank being used. See Section 4.4 and adjust if necessary.
8. Record the current and voltage settings in Section 5.3.

5.3. MAINTENANCE

The M3528 is designed to require no maintenance. However, every M3528 charger module should be tested during initial start up to verify the Full Charge Voltage, Equalize Voltage, and Current Limit settings. These settings should be noted for future reference.

Full Charge Voltage: _____

Equalize Voltage: _____

Current Limit: _____

5.4. TROUBLESHOOTING

Table 5-1: Troubleshooting Guide

SYMPTOM	ACTION
No Panel Indicators Lit	Check incoming voltage. If no voltage, check input fuses within the charger. If the incoming fuses are blown, contact Bonitron for assistance before replacing fuses. This can be an indication of further damage to the charger. Check 24V power supply at TB3-1 and TB3-3. If there is no voltage, contact Bonitron for further assistance.
Fuses blow at power up	Check for proper size & type fuses. Make sure the voltage differential between the output of the charger and the battery bank is below 50V before connecting the charger to the storage bank. Ensure charger is isolated from the drive system. Failure to use an isolation transformer can cause a return path through the charger that can produce high currents. If problem persists, contact Bonitron.
Charger does not charge	Check panel indicators. If the Power indicator is not on, go to top symptom. Make sure the "Enable" input is activated. The "Charge" indicator must be on. If the "Charge" indicator is on, repeat the startup procedure to check the voltage setpoint and current limits. If the unit is enabled and the "Current Limit" indicator is on, the current limit may be set too low.
Storage Bank will not fully charge	Check the input voltage, and verify that it is at least 50V higher than the desired charge voltage. If the "Charge" indicator is on, repeat the startup procedure to check the voltage setpoint and current limits. If the unit is enabled and the "Current Limit" indicator is on, the current limit may be set too low.
Overtemp condition	This indicates that the charger is above 150°F (65°C). Make sure the fan is operating and airflow is unrestricted. Make sure the ambient temperature is below 100°F (40°C).
Cannot Bulk Charge / Equalize battery bank	Make sure the Charge and Enable inputs are both active. If the Charging and Equalize indicators are both on, make sure the input voltage to the charger is at least 50V higher than the Equalize Voltage. Verify the Equalize voltage is correct.
Bulk Charge / Equalize stays on after removing command	Ensure equalize mode jumper is in the correct position.
Bulk Charge / Equalize will not stay on after removing command	Ensure equalize mode jumper is in the correct position.
Voltage fluctuates during open circuit test	Connect 150kΩ resistive load to DC output to stabilize.

CAUTION!

REPAIRS OR MODIFICATIONS TO THIS EQUIPMENT ARE TO BE PERFORMED BY BONITRON APPROVED PERSONNEL ONLY. ANY REPAIR OR MODIFICATION TO THIS EQUIPMENT BY PERSONNEL NOT APPROVED BY BONITRON WILL VOID ANY WARRANTY REMAINING.

5.5. TECHNICAL HELP – BEFORE YOU CALL

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

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

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

6. ENGINEERING DATA

6.1. RATINGS

Table 6-1: M3528 Ratings

MODEL	AC INPUT VOLTAGE RANGE			DC INPUT VOLTAGE RANGE			OUTPUT VOLTAGE SETPOINT		CURRENT SETPOINT		SCCR RATING
	MIN VAC	NOM VAC	MAX VAC	MIN VDC	NOM VDC	MAX VDC	MIN VDC	MAX VDC	RANGE AMPS	CONTINUOUS AMPS	
M3528DC-L010	-	-	-	250	324	375	175	325	2-12	10	10kA①
M3528DC-E010	-	-	-	375	537	713	325	600			
M3528DC-H010	-	-	-	375	648	713	325	600			
M3528AC-C005	346	575	600	-	-	-	406	675			10kA①
M3528AC-L010	160	230	253	-	-	-	175	325			10kA②
M3528AC-E010	277	380	506	-	-	-	325	600			
M3528AC-H010	277	460	506	-	-	-	325	600			
M3528AC-L020	160	230	253	-	-	-	175	325	4-24	20	
M3528AC-E020	277	380	506	-	-	-	325	600			
M3528AC-H020	277	460	506	-	-	-	325	600			

① Suitable for use on a circuit capable of delivering not more than 10,000 RMS symmetrical amperes, 600 volts maximum when protected by recommended fuses.

② Suitable for use on a circuit capable of delivering not more than 10,000 RMS symmetrical amperes, 480 volts maximum when protected by recommended fuses.

Table 6-2: Battery Bank Typical Values

Not to replace manufacturer's recommendations.

SYSTEM VOLTAGE	MINIMUM BATTERY VOLTAGE (IUV LEVEL)	NOMINAL BATTERY VOLTAGE	FULL / FLOAT BATTERY VOLTAGE	EQUALIZE BATTERY VOLTAGE
230 - 240VAC	200VDC	240VDC	270VDC	277VDC
380 - 415VAC	340VDC	408VDC	459VDC	470VDC
460 - 480VAC	400VDC	480VDC	540VDC	554VDC
575 - 600VAC	500VDC	600VDC	675VDC	692VDC

6.2. EFFICIENCY / POWER CONSUMPTION

Table 6-3: M3528 Watt Loss Chart

MODEL	STANDBY OPERATION	CHARGING
5 Amp	15W	300W maximum
10 Amp	15W	300W maximum
20 Amp	20W	600W maximum

6.3. CERTIFICATIONS

6.3.1. UNDERWRITERS LABORATORIES LISTING

The M3528 is UL Listed under UL-508C standards for use with ultracapacitors for Land H voltage classes.

The M3528 is UL Listed under UL-1017 for use with battery banks for L and H voltage classes.

6.3.2. CE CONFORMITY

Compliance with the Low Voltage Directive and Electromagnetic Compatibility Directive has been demonstrated using harmonized European Norm (EN) standards published in the Official Journal of the European Communities. M3528 chargers for L, E, and H voltage classes comply with the EN standards listed below when installed according to the M3528 charger installation instructions and this M3528 charger user manual. This is

6.3.2.1. LOW VOLTAGE DIRECTIVE (2006/95/EC)

EN 61010-1:2010 – Safety requirements for electrical equipment for measurement, control, and laboratory use.

6.3.2.2. EMC DIRECTIVE (2004/108/EC)

EN 61326-1:2006 – Electrical Equipment for measurement, control and laboratory use.

6.3.2.3. RADIATED EMC SHIELDING

Control wiring must employ cable with a braided shield providing 75% or greater coverage or equivalent shielding must be provided. Control wiring must be looped around Fair-Rite 0444176451 five times through or greater coverage or equivalent shielding must be provided. Braided shielded cable can be grounded at the ground terminal on the fuse plate marked ⏚. All power wiring to the charger must use cables housed in metal conduit, or equivalent shielding must be provided.

6.3.2.4. CONDUCTED EMC FILTERING

To meet CE conformity for conducted emissions a line filter (Roxburgh KMF325) must be used, or equivalent filtering must be provided.

6.4. BRANCH CIRCUIT PROTECTION AND WIRE SIZING

The following information is supplied for assistance in selecting the appropriate field wiring sizes and power source fuse ratings for the M3528:

- Wire size must be coordinated with circuit protection devices and IR drop of wire.
- For branch circuit protection, steady state Class J Time Delay or equivalent fusing should be used. The recommended minimum current rating for the power source fusing is listed in Table 6-4, based on the model type of the M3528.
- The field wiring sizes listed in Table 6-4 ensure a ≤10V drop for wire lengths of ≤100 feet and are compatible with the recommended steady state circuit branch protection fusing listed. The wire gauge selected for field wiring to the M3528 should be equal to or greater than that listed in Table 6-4.
- Use copper wiring rated 75°C or equivalent for field wiring terminals.

Table 6-4: M3528 Power Wiring Sizes and Fusing

MODEL TYPE	MINIMUM CIRCUIT BRANCH PROTECTION FUSING	RECOMMENDED FIELD WIRING SIZES
10A DC Input	A60Q40	10 AWG
5A AC Input	A60Q10	
10A AC Input	A60Q15	
20A AC Input	A60Q25	

Note: C class AC chargers does not include DC output fuses.

6.5. DIMENSIONS AND MECHANICAL DRAWINGS

Figure 6-1: A6 Chassis Dimensional Outline

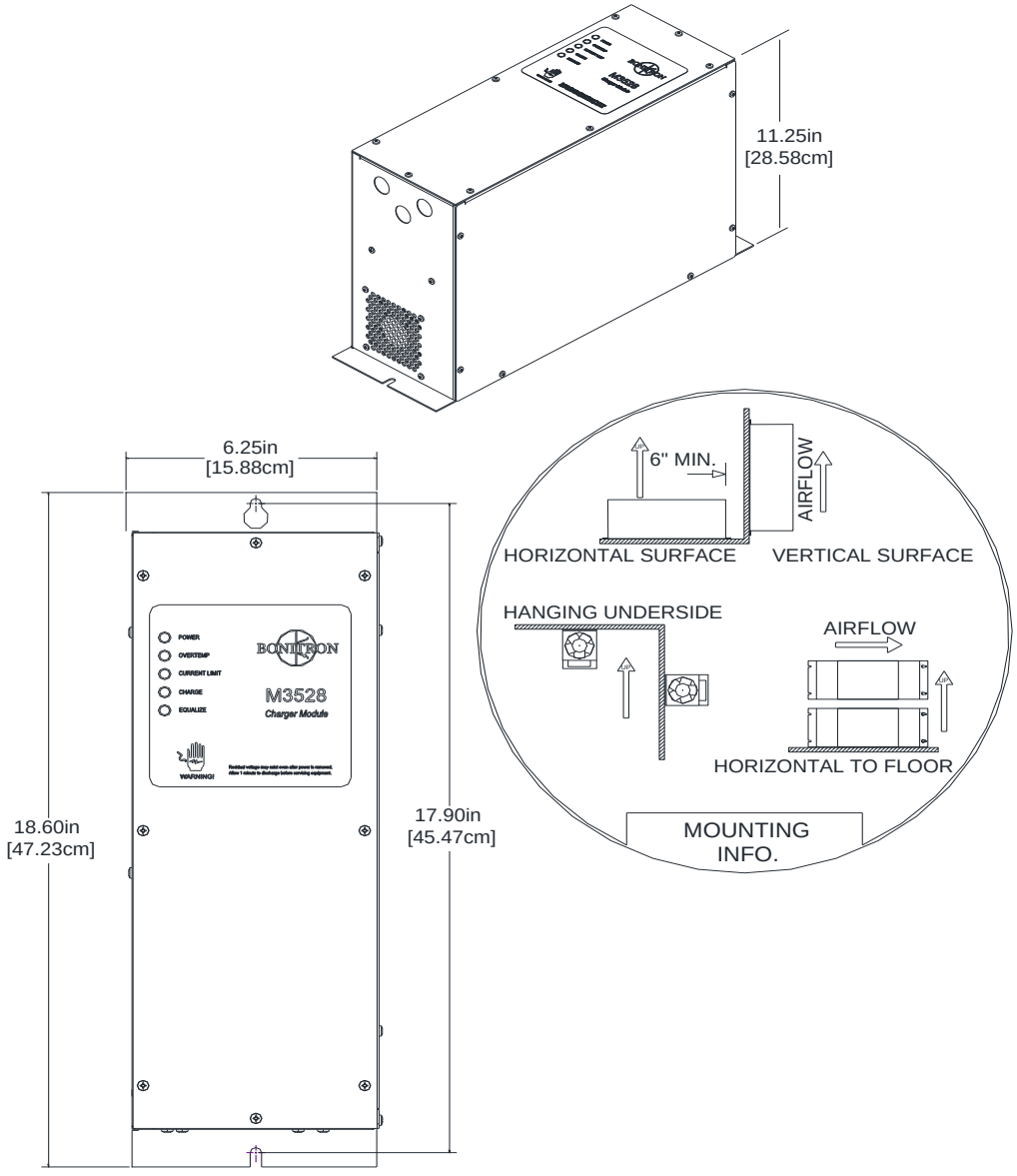
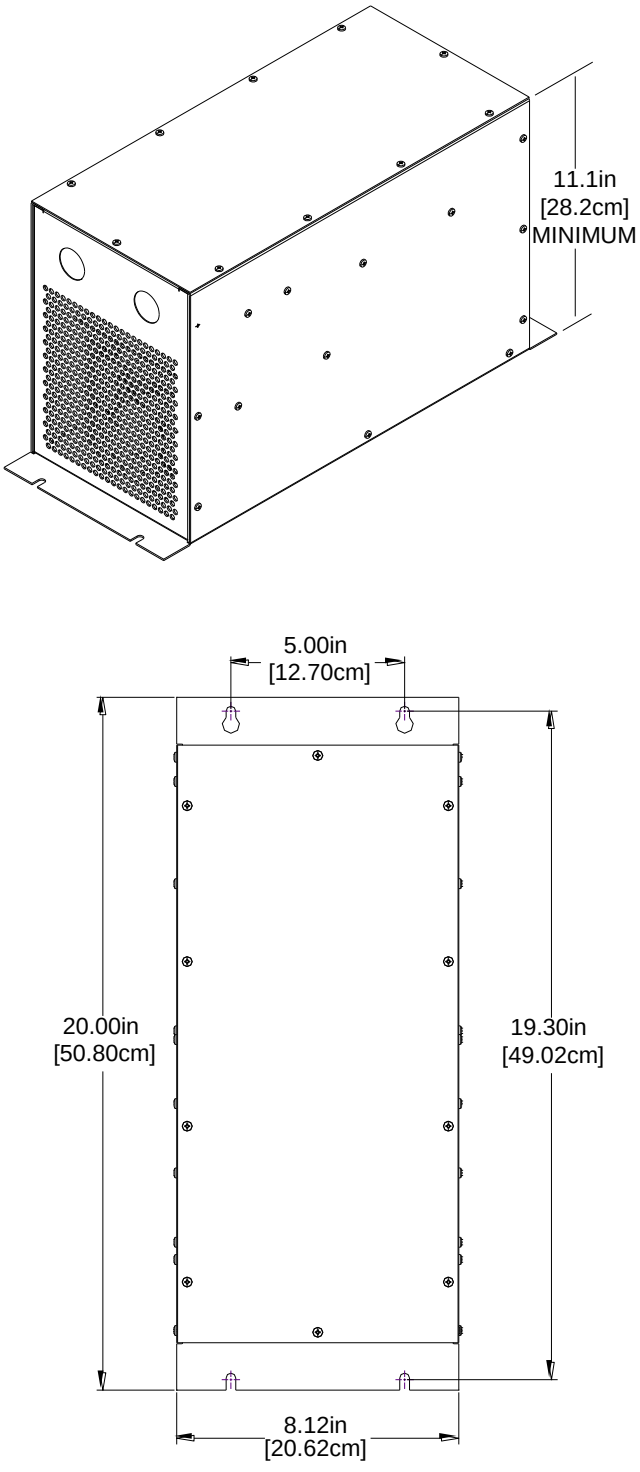


Figure 6-2: K8 Chassis Dimensional Outline



7. APPENDICES

7.1. APPLICATION NOTES

7.1.1. CHOOSING AN M3528 INPUT TYPE

There are two input types of M3528 chargers, AC input or DC input.

For M3534 20A and 40A ride-thru systems connecting to a single drive, the DC input charger can be used. For all other ride-thru systems, the AC input charger with an isolation transformer is recommended.

7.1.2. BULK OR FAST CHARGING BATTERY BANKS

Bulk charging a battery is a method used to get the full charge into the battery as fast as possible. In this mode, the Equalize voltage is used to set the target voltage higher than normal. This allows the battery bank to slightly overcharge, which allows the battery bank to come to full charge more quickly.

This can be a dangerous practice, however, as batteries can overheat and/or release explosive hydrogen gas, permanently damaging the battery bank.

If this method is used, it is critical that there be an external supervisory system or PLC that monitors the battery temperature and voltage to stop the battery charging if there is an issue to ensure that the battery bank is not damaged.

Please consult with the battery manufacturer's instructions regarding this practice.

NOTES

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