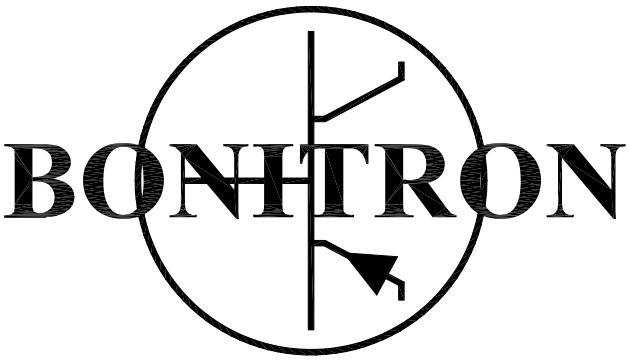


Model M3528

Charger Module

CE Listed

Customer Reference Manual

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

Bonitron, Inc.
Nashville, TN

An industry leader in providing solutions for AC drives.

ABOUT BONITRON

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

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

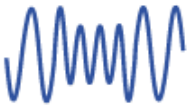
The Bonitron engineering team has the background and expertise necessary to design, develop, and manufacture the quality industrial electronic systems demanded in today's market. A strong academic background supported by continuing education is complemented by many years of hands-on field experience.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

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

AC Drive Options

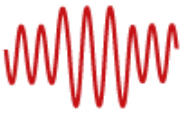
In 1975, Bonitron began working with AC inverter drive specialists at synthetic fiber plants to develop speed control systems that could be interfaced with their plant process computers. Ever since, Bonitron has developed AC drive options that solve application issues associated with modern AC variable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

World Class Products



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

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



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

Common Bus Solutions
Single Phase Power Supplies
3-Phase Power Supplies
Common Bus Sharing Diodes
Isolation Diodes
Bus Filter Capacitance

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

Portable Maintenance Solutions
Capacitor Formers
Battery Testers
Capacitor Testers
Capacitor Dischargers

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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 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 VERSION AND CHANGE RECORD

This is the original printing of the M3528 ACDC CE listed manual .

Figure 1-1: M3528 20 Amp and 10 Amp Chargers

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2. PRODUCT DESCRIPTION

Some industrial power systems require back up power for personnel safety or to save equipment from failure and downtime as a result of voltage loss. Any system requiring energy during a complete loss of input power will need some type of energy storage device. Batteries and Super Capacitors are used for this storage, but they are typically only available at low voltage levels, requiring the series addition of devices to obtain reasonable Voltage levels at higher power ratings. Standard chargers are common at low voltages, but have been fairly expensive for higher voltage systems, and tend to be designed for battery bank profiles, making them inoperative for Ultracap charging from zero volts. M3528 is UL Listed under UL508C standards for use with Ultracapacitors.

SYMBOLS USED ON THE M3528


Earth Ground


DC Voltage

2.1. RELATED PRODUCTS AND OPTIONS

When the M3528 is integrated as part of a complete system, Bonitron offers any of the following options for added system information:

2.5 INCH METER:

VOLTAGE METER:

This voltmeter option displays the bus voltage of the storage reservoir.

CURRENT METER:

This ammeter option displays the reservoir **Charge** and **Discharge** current. **Charge** current is a positive flow of current to the reservoir and will cause the meter to deflect to the right. **Discharge** current is a negative flow from the reservoir and will cause the meter to deflect to the left.

ASB 3528M1 BATTERY MONITOR BOARD:

The ASB 3528M1 board monitors the individual cell voltages 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.

OPEN BATTERY BYPASS OPTION:

The Automatic Open Battery Bypass option will automatically bypass an open cell without interrupting system operation.

M3628 DISCHARGER / TESTER:

For Ultracap banks:

- The M3628 quickly discharges storage reservoir voltage to safe levels for maintenance purposes.

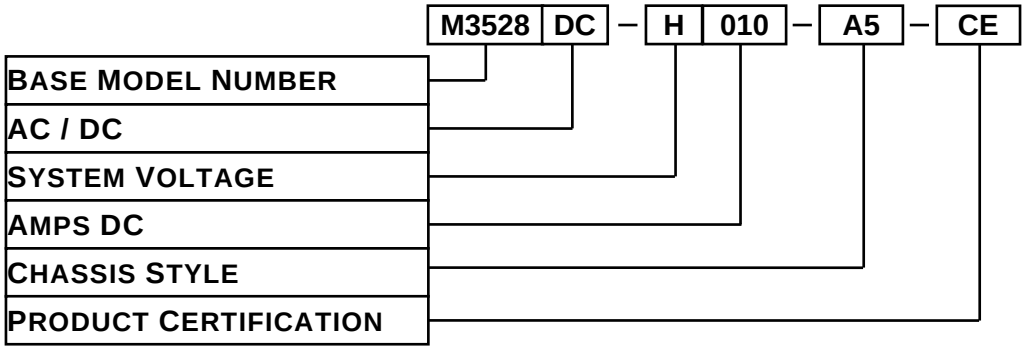
For battery storage:

- The M3628 is used to load test the battery bank.

M3534 OR M3460 BOOSTERS:
Voltage boosters are used to regulate the changing storage reservoir voltage to match the desired minimum drive bus level.

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
Indicate either AC or DC input.

SYSTEM VOLTAGE RATING
The System Voltage Rating indicates the nominal AC/DC voltage levels of the charger system.

The Model M3528 is available in several standard AC/DC voltages.

A code letter indicates the System Voltage.

Table 2-1: System Rating Codes

SYSTEM RATING CODE	AC VOLTAGE NOMINAL	TYPICAL STORAGE BANK NOMINAL
L	230VAC	150 - 300
E	380 – 415VAC	300 - 500
H	460VAC	375 - 600

AMPS (ADC)
The Amp Rating indicates the maximum charging current for the Model M3528DC. This rating is directly represented by a 3-digit value. For instance, the rating for a 10ADC system is indicated as **010**.

CHASSIS STYLE
The Model M3528 is supplied in a touch safe enclosure. The standard chassis size is determined by the ratings of the unit.

Table 2-2: Chassis Styles

AMPS	CHASSIS	CHASSIS SIZE H X W X D
10	A5 panel mount enclosure	18.6” x 5.1” x 9.4”
20	K8 panel mount enclosure	20.0” x 8.2” x 11.1”

2.3. GENERAL SPECIFICATIONS

Table 2-3: General Specifications Chart

PARAMETER	SPECIFICATION
Charger Model	M3528
AC Input Voltage	"L" Series 230VAC ±10% 50 / 60Hz "E" Series 400VAC ±10% 50 / 60Hz "H" Series 460VAC ±10% 50 / 60Hz
SCCR Rating	10,000 RMS Symmetrical Amps
DC Input Voltage	"L" Series 324VDC (See Table 6-1 for complete range) "E" Series 535VDC (See Table 6-1 for complete range) "H" Series 648VDC (See Table 6-1 for complete range)
Power Fusing	See Table 6-3
DC Charging Voltage	"L" Series adjustment range of 200 – 325VDC ±20% "E" Series adjustment range of 325 – 600VDC ±20% "H" Series adjustment range of 325 – 600VDC ±20%
Bulk Charge / Equalize Voltage	Adjustment range of approximately 2% - 9% above Charge Voltage
DC Charging Current	See Table 6-1 Tolerance of 20% on adjustment range
Status Indicators	Front Panel LEDs: • Power (PWR) • Overtemp (OT) • Current Limit (ILIM) • Charging (CHRG) • Discharging (DCHRG) (10 Amp only) • Bulk Charge / Equalize (20 Amp only)
Inputs	9 – 24VDC Enable (20mA max draw) 9 – 24VDC Battery Equalization Mode (20mA max draw)
Outputs	24V 100mA 3kV isolation • Overtemp (OT) • Current Limit (IL) (10 Amp only) • Charging (CHRG)
Enclosure	A5 panel mount enclosure 18.6"(H) x 5.1"(W) x 9.4"(D) K8 panel mount enclosure 20.0"(H) x 8.2"(W) x 11.1"(D)
Operating Temperature	40°C
Environmental	M3528 is for indoor use only Maximum Operating Altitude: 2000m 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 Installation/overvoltage category: II

2.4. GENERAL PRECAUTIONS AND SAFETY WARNINGS

DANGER!

- HIGH VOLTAGES MAY BE PRESENT!
- NEVER ATTEMPT TO SERVICE THIS PRODUCT WITHOUT FIRST DISCONNECTING INCOMING POWER AND BATTERIES. BATTERIES ARE ENERGY STORAGE DEVICES THAT CAN RETAIN LETHAL VOLTAGES FOR YEARS!
- FAILURE TO HEED THESE WARNINGS MAY RESULT IN SERIOUS BODILY INJURY OR DEATH!

CAUTION!

- CERTAIN COMPONENTS WITHIN THIS PRODUCT MAY GENERATE HIGH AMBIENT TEMPERATURES DURING OPERATION. ALWAYS ALLOW AMPLE TIME FOR THE UNIT TO COOL BEFORE ATTEMPTING SERVICE ON THIS PRODUCT!
- ALWAYS ALLOW AMPLE TIME FOR RESIDUAL VOLTAGES TO DRAIN BEFORE OPENING THE MODULE.
- NO USER-SERVICEABLE PARTS ARE CONTAINED WITHIN THIS PRODUCT. INOPERABLE UNITS SHOULD BE REPLACED OR RETURNED FOR EVALUATION AND/OR REPAIR BY QUALIFIED TECHNICIANS.
- BEFORE ATTEMPTING INSTALLATION OR REMOVAL OF THIS PRODUCT, BE SURE TO REVIEW ALL SYSTEM 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.
- IF USING AN OUTPUT CONTACTOR BETWEEN THE CHARGER AND THE STORAGE DEVICE, CONNECT THE ENABLE THROUGH AN AUX CONTACT SO THAT THE CONTACTOR CANNOT BE CLOSED WITH THE CHARGER OUTPUT AT VOLTAGE AND THE STORAGE DEVICE AT ZERO CHARGE.
- NEVER CONNECT THE CHARGER TO A BATTERY BANK IF THE VOLTAGE DIFFERENTIAL BETWEEN THEM IS GREATER THAN 20%!
- NEVER CONNECT THE CHARGER TO A CAPACITOR BANK IF THE VOLTAGE DIFFERENTIAL IS GREATER THAN 10%!

CAUTION!

- IF THE EQUIPMENT IS USED IN A MANNER NOT SPECIFIED BY THE MANUFACTURER, THE PROTECTION PROVIDED BY THE EQUIPMENT MAY BE IMPAIRED.

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

3. M3528 CHARGER MODULE INSTALLATION INSTRUCTIONS

WARNING!

Installation and/or removal of this product should only be performed by a qualified electrician in accordance with National Electrical Code or local codes and regulations.

Proper installation of the Model M3528 Charger Module should be accomplished following the steps outlined below. Please direct all installation inquiries that may arise during the installation and start up of this product to the equipment supplier or system integrator.

3.1. ENVIRONMENT

The installation site for the M3528 Charger module should be chosen with the following considerations in mind:

- The enclosed units have a NEMA open chassis rating
- Conduit access for field wiring is provided via gland plate on the bottom surface of the enclosure.
- Mounting provisions must be capable of supporting at least 25 lbs for 10 Amp, and at least 40 lbs for 20 Amp.
- The unit will require a minimum clearance of two (2) inches in all directions around it, and should not be mounted near a heat source.
- The mounting surface should be clean and dry.

3.2. UNPACKING

Upon receipt of this product, please verify that the product received matches the product that was ordered and that there is no obvious physical damage to the unit. If the wrong product was received or the product is damaged in any way, please contact the supplier from whom the product was purchased.

3.3. MOUNTING

Once the installation site has been selected as outlined above, the site should be prepared for installation of the unit. Mounting holes should be drilled and mounting studs or anchors installed at this time. Mounting hardware is not supplied with the unit. Refer to Figures 6-1 and 6-2 in Section 6 of this manual to determine the correct mounting dimensions and provisions for the unit.

CUSTOMER PROVIDED DISCONNECTS

The disconnect shall be in close proximity to the equipment and within easy reach of the operator.

3.4. WIRING AND CUSTOMER CONNECTIONS

3.4.1. POWER WIRING

Power wiring should be installed as per local codes and regulations; however it is recommended that 600V 65°C copper wire be used at a minimum.

Power wiring and signal wiring should be separated as much as practical to avoid cross coupling and noise interference within control circuits.

If recommended safety disconnect is used, install fuses now.

- For battery systems, use insulated fuse pullers and full protective gear as required by local codes when installing fuses.

Figure 3-1: M3528AC 10 Amp Charger Field Connections

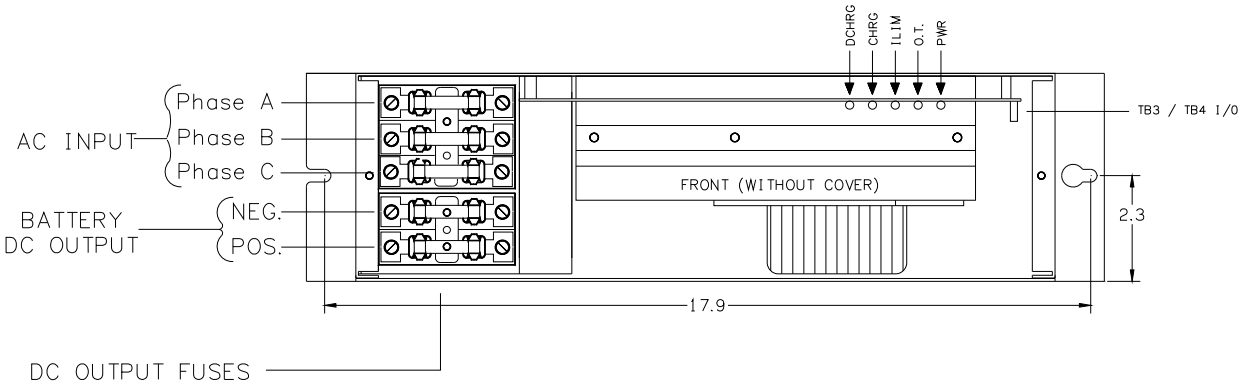


Figure 3-2: M3528DC 10 Amp Output Charger Field Connections

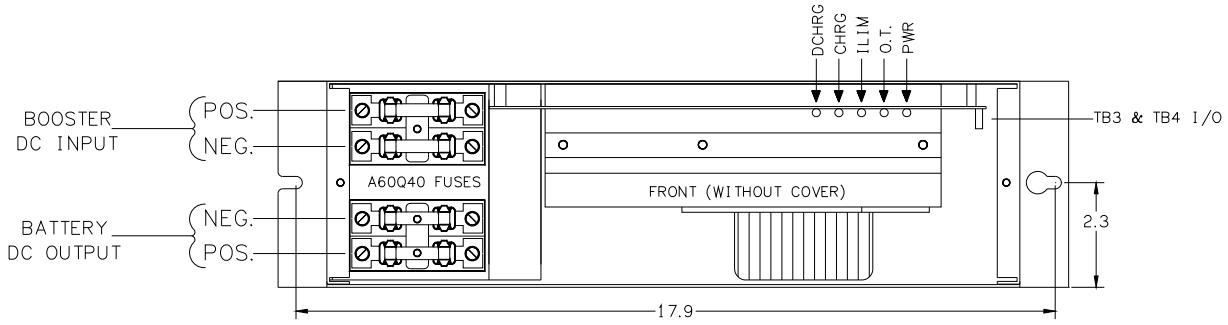


Figure 3-3: M3528AC and DC 10 Amp Side View

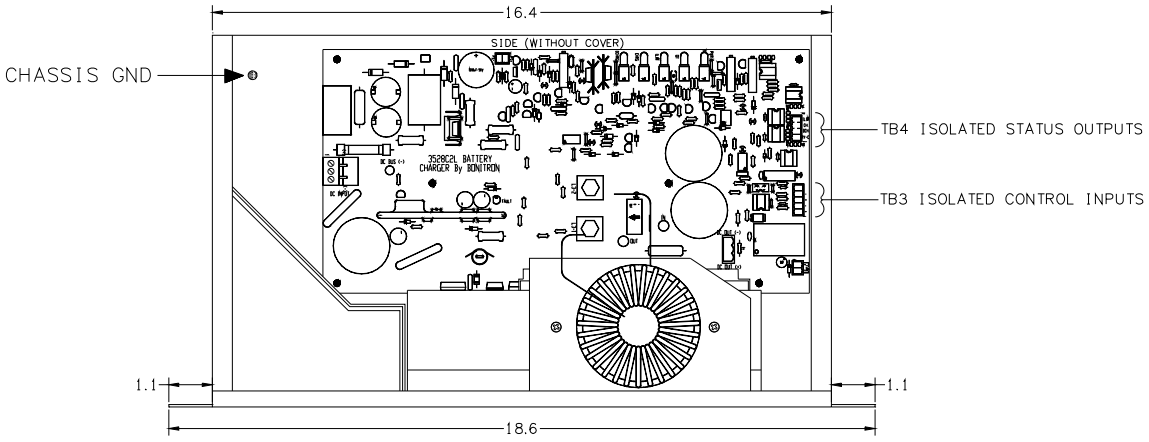


Table 3-1: M3528 10 Amp Terminal Block Specifications

10 AMP AC

TERMINALS	FUNCTION	ELECTRICAL SPECIFICATIONS		MIN WIRE	MAX WIRE	TORQUE
L1, L2, L3	AC Power Input	M3528AC-L010	208 – 250VAC 10A, 50-60hz	18 AWG	10 AWG	20 lb-in 2.259Nm
		M3528AC-E010 and M3528AC-H010	277 – 480VAC 10A, 50-60hz			
DC +/-	DC Output to Storage	M3528AC-L010	175 – 325VDC 10A,	18 AWG	10 AWG	20 lb-in 2.259Nm
		M3528AC-E010 and M3528AC-H010	325 – 600VDC 10A,			
GND	System Ground			Limited by Ring Lug, 3/8"	Limited by Ring Lug, 3/8"	

10 AMP DC

TERMINALS	FUNCTION	ELECTRICAL SPECIFICATIONS		MIN WIRE	MAX WIRE	TORQUE
DC +/-	DC Power Input	M3528DC-L010	250 – 375VDC 10A	18 AWG	10 AWG	20 lb-in 2.259Nm
		M3528DC-E010 and M3528DC-H010	375 – 700VDC 10A			
DC +/-	DC Output to Storage	M3528DC-L010	175 – 325VDC 10A	18 AWG	10 AWG	20 lb-in 2.259Nm
		M3528DC-E010 and M3528DC-H010	325 – 600VDC 10A			
GND	System Ground			Limited by Ring Lug, 3/8"	Limited by Ring Lug, 3/8"	

Figure 3-4: M3528AC 20 Amp Charger Field Connections

See Figure 3-7 for basic schematic.

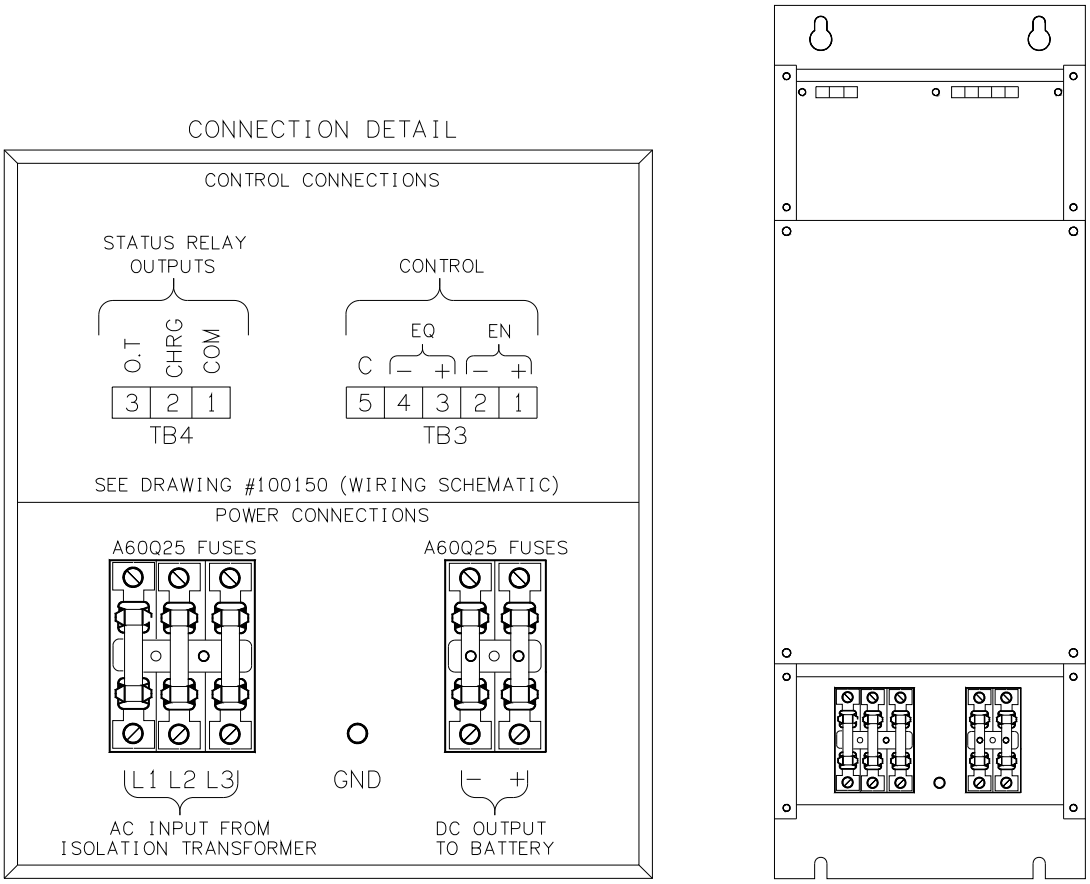


Table 3-2: M3528AC 20 Amp Terminal Block Specifications

TERMINALS	FUNCTION	ELECTRICAL SPECIFICATIONS		MIN WIRE	MAX WIRE	TORQUE
L1, L2, L3	AC Power Input	M3528AC-L020	208 – 250VAC 20A, 50-60hz	18 AWG	10 AWG	20 lb-in 2.259Nm
		M3528AC-E020 and M3528AC-H020	277 – 480VAC 20A, 50-60hz			
DC +/-	DC Output to Storage	M3528AC-L020	175 – 325VDC 20A,	18 AWG	10 AWG	20 lb-in 2.259Nm
		M3528AC-E020 and M3528AC-H020	325 – 600VDC 20A,			
GND	System Ground			Limited by Ring Lug, 3/8"	Limited by Ring Lug, 3/8"	

3.4.1.1. SOURCE CONSIDERATIONS

Suitable for use on a circuit capable of delivering not more than 10,000 rms symmetrical amperes, 480 volts maximum, when protected by semiconductor fuses as shown in Table 6-3 of this manual.

The source for these units can be either AC or DC based on the configuration of the system. For smaller systems, the 10 Amp Charger can be placed between the batteries and a Ride-Thru Module to simplify wiring. In this case, the charger uses the DC bus of the system as a source for charging, but during ride-through operation, the power transferred to the boost converter passes through the charger. This is acceptable for systems up to 40 amps. Above that current, the current used during ride-through operation is too high.

When the charger is used on larger systems, the charger is placed in parallel to the DC bus, and connects through an isolation transformer to the AC source of the system. The AC source must be able to supply full current at full charge voltage for the duration of the charge. For battery systems, transformer and feed should be sized for continuous rating. For Ultracap systems transformer and feed can be downsized for intermittent duty ratings. During ride-though operation, the charger will not carry any current.

See the typical system configuration drawings for details (Figures 6-3 and 6-4). An isolated AC source is required for AC systems.

3.4.1.2. GROUNDING CONSIDERATIONS

The Safety Ground – (PE) must be connected to system ground. Ground impedance must conform to the requirements of national and local industrial safety regulations and/or electrical codes. The integrity of all ground connections should be periodically checked.

I/O terminals labeled "Common" are not referenced to the safety ground (PE) terminal and are designed to greatly reduce common mode interference. Do not tie the common to ground.

Figure 3-5: M3528 10 Amp and 20 Amp Battery Charger Connections

10 Amp

20Amp

3.4.2. I/O WIRING

Power wiring and signal wiring should be separated as much as practical to avoid cross coupling and noise interference within control circuits.

Table 3-3: Terminal Block Specifications for the 10 Amp Charger

TERMINALS	FUNCTION	DESCRIPTION	SECTION	RATINGS	WIRE SIZE	TORQUE
TB4 - 1	Relay Common	For digital I/O	4.2.3.1	20-28VDC 100mA	28-16 AWG	1.947 lb-in .22 Nm
TB4 - 2	Discharge	Battery bank is discharging	4.2.3.2			
TB4 - 3	Charge	Charger has more than .25A output	4.2.3.3			
TB4 - 4	Overtemp	Indicates Charger is inhibited by Overtemperature	4.2.3.5			
TB3 - 1,2	Enable Input	24VDC Allows Charging	4.2.3.6	20mA@24VDC		
TB3 - 2,5				20-28VDC		
TB3 - 3,4	Bulk Charge / Equalize Input	Closed contact Initiates Bulk Charge / Equalize Cycle	4.2.3.7	20mA@24VDC		
TB3 - 4,5		24VDC Initiates Bulk Charge / Equalize Cycle		20-28VDC		

Table 3-4: Terminal Block Specifications for the 20 Amp Charger

TERMINALS	FUNCTION	DESCRIPTION	SECTION	RATINGS	WIRE SIZE	TORQUE
TB4 - 1	Relay Common	For digital I/O	4.2.4.1	20-28VDC 100mA	28-16 AWG	4.4 lb-in .5 Nm
TB4 - 2	Charge	System is charging	4.2.4.2			
TB4 - 3	Overtemp	Indicates charger has overheated	4.2.4.3			
TB3 - 1,2	Enable Input	24VDC Allows Charging	4.2.3.6	20mA@24VDC		
TB3 - 2,5				20-28VDC		
TB3 - 3,4	Bulk Charge / Equalize Input	Closed contact Initiates Bulk Charge / Equalize Cycle	4.2.3.7	20mA@24VDC		
TB3 - 4,5		24VDC Initiates Bulk Charge / Equalize Cycle		20-28VDC		

3.5. TYPICAL CONFIGURATIONS

Figure 3-6: Basic DC Power Schematic (32 hp and below)

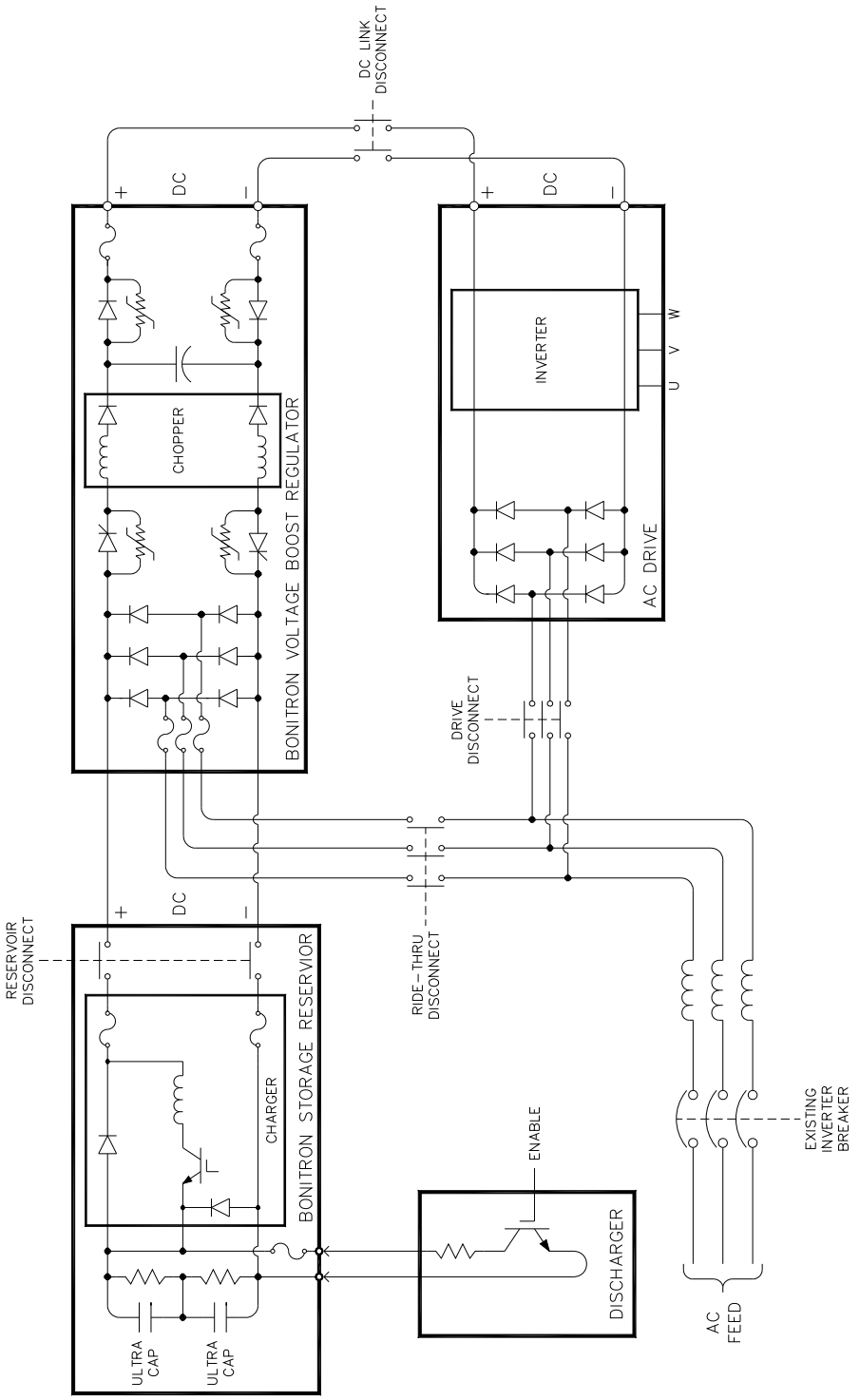
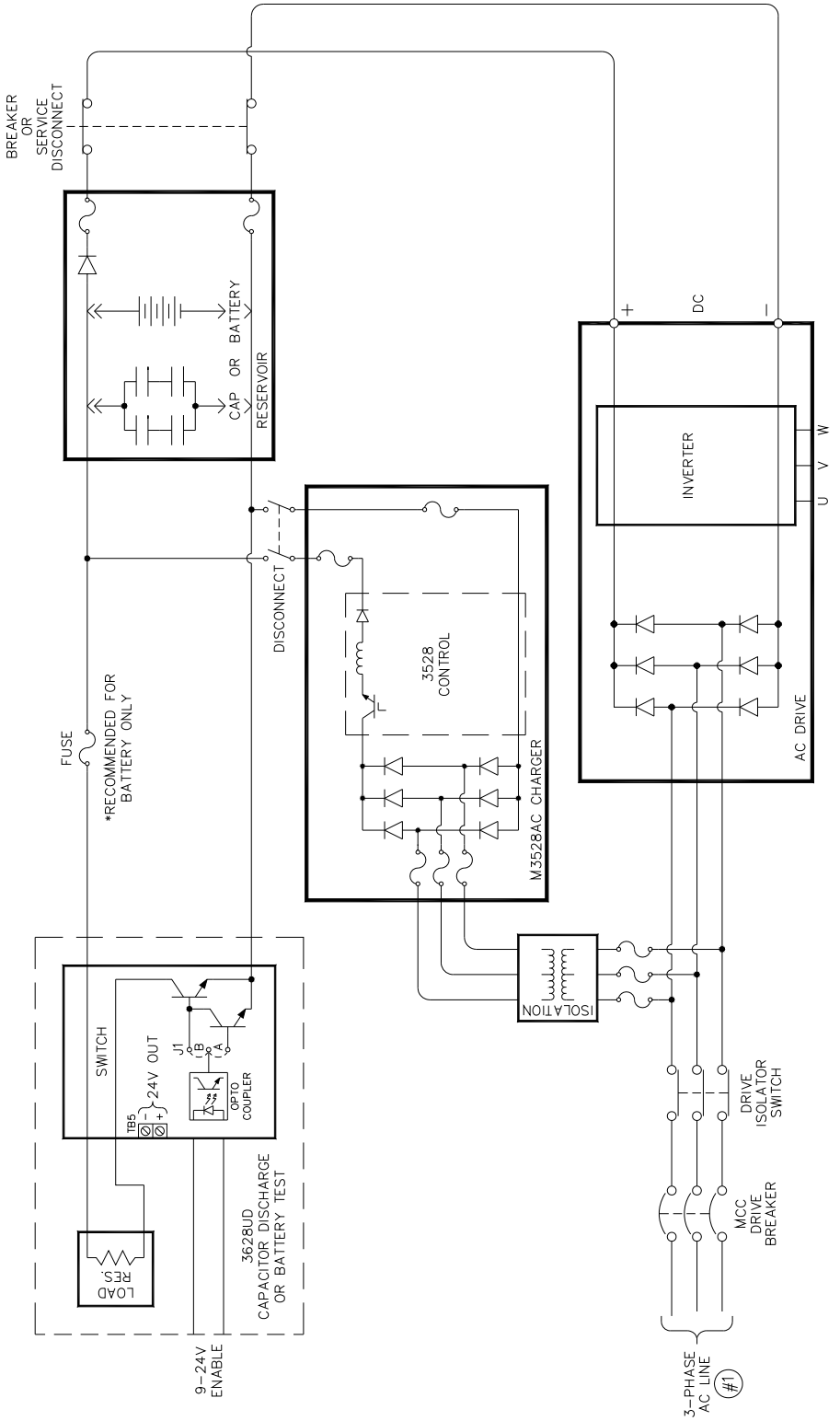


Figure 3-7: Basic AC Power Schematic (above 32 hp)



4. OPERATION

The Model M3528AC is a voltage and current limited power supply used to charge electrical energy storage devices such as battery banks or super capacitor reservoirs for industrial voltage levels of 240, 480, and 600V. The AC input should be derived from a 3-phase isolation transformer to allow battery bus common to be connected to drive bus common.

The M3528 may be used to charge an already live battery, or a completely drained Ultracapacitor. The M3528 charger does not test for battery impedance or voltage in order to start charging. Charging will begin when power is applied, and output is sensed to be below set-point. Once charged, the M3528 constantly monitors the reservoir voltage and will automatically recharge upon restoration of power.

A complete Ride-Thru System consists of one M3528 charger, one M3534 or M3460 booster, one ultracapacitor or battery storage reservoir, and one M3628 ultracapacitor discharger / battery tester.

Charging voltage, Bulk Charge / Equalize voltage, and Current Limits are factory set to order, but are field adjustable by properly trained personnel.

4.1. FUNCTIONAL DESCRIPTION

If the Enable command is NOT given, upon power-up the charger will precharge but will not output any charging current. If the Enable command is given, upon power-up the charger pre-charges its primary cap bank, and after a slight time delay begins switching, and will charge the energy storage reservoir at a linear rate until the reference voltage is reached.

The Current Limit and Charging LEDs will be ON while the bank is charging. As the output voltage approaches the internal reference, the Current Limit LED will turn OFF. Once the output voltage reaches the internal reference, the Charging LED will begin to dim and the charging relay will turn OFF. The circuit will slow down switching to a minimum frequency needed to sustain the storage reservoir. The storage reservoir is now ready for service.

When the Bulk Charge / Equalize command is given, the charger will increase its output voltage by an amount as set by the internal adjustment pot. Adjustment range is 2-9% above charge voltage set-point. The Bulk Charge / Equalize set-point can be jumper configured for a 2 hour time with momentary Bulk Charge / Equalize signal, or as real time coinciding with the Bulk Charge / Equalize input state.

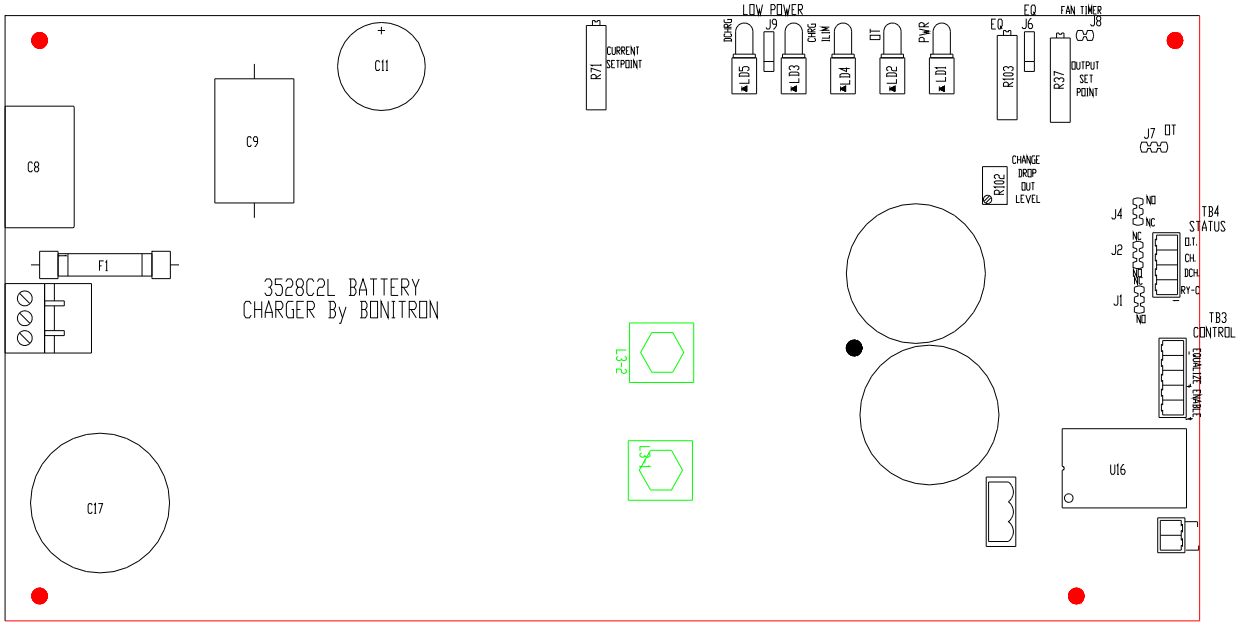
4.2. FEATURES

4.2.1. 10A CHARGER

4.2.1.1. ASB 3528C2 BOARD FEATURES

The ASB 3528C2 is the main control board of the 10 Amp Battery Charger module used in the M3528 Battery Charger Control System. Figure 4-1 below shows the locations of all major components of the board.

Figure 4-1: ASB 3528C2 10 Amp Charger Board Features



4.2.1.2. ASB 3528C2 ADJUSTMENT POTENTIOMETERS

The purpose and setting for each adjustment pot provided on the ASB 3528C2 Battery Charger board is described below. Please refer to Figure 4-1 above for the locations of each of the adjustment pots listed below.

CAUTION!

To avoid damage to storage bank, ensure maximum voltage and current limitations are not exceeded. Always check with manufacturer of the storage device for specifications.

R37 – CHARGE VOLTAGE ADJUSTMENT

This adjustment potentiometer is factory preset to 460VDC for a typical 375V battery bank. Field calibration of this setpoint may be necessary for other system voltages. Check storage bank manufacturer's recommendations before applying power. See Tables 4-9 and 4-10 for standard voltage settings.

It is recommended that the charger output voltage setpoint be verified before connecting to any energy storage bank unless the enable command is manned and ready to shutdown charger in case voltage exceeds that allowed by the storage bank.

- See Startup Procedure in Section 4.3.2

a. Voltage adjustment may be done with open circuit or fully charged storage bank.
b. If disconnect is used DO NOT close switch with more than 30V difference between the charger output and the storage bank.
c. Clockwise adjustment will increase the charge voltage.
d. Range of adjustment is 325 – 600VDC.

R103 – BULK CHARGE / EQUALIZE ADJUSTMENT

This adjustment is factory preset for 2.5% increase above float charge level. Field calibration may be needed to comply with storage bank manufacturer's recommendations.

a. Clockwise adjustment will increase the Bulk Charge / Equalize voltage.
b. Range of adjustment is +2% to +9% of charge voltage setpoint.

R71 – CHARGE CURRENT ADJUSTMENT

This adjustment potentiometer is factory preset to 10 amps. Field calibration of this set point may be necessary. Check storage bank manufacturer's recommendations before applying power.

- See Startup Procedure in Section 4.3.2.
  a. Clockwise adjustment will increase the charge current.
  b. Range of adjustment is 1 – 10 Amps.
  c. Load must be present in order to get current flow.

R102 – FULL CHARGE THRESHOLD

For battery charging applications this adjustment is factory set so that when the charge current drops below 500mA the charging relay drops out and the 30 minute fan timer begins.

For Ultracapacitor charging applications this adjustment is factory set so that when the charge current drops below 200mA the charging relay drops out and the 30 minute fan timer begins.

Default setting is for 500mA if the application is not known prior to shipment.

4.2.1.3. ASB 3528C2 JUMPERS

Table 4-1: 10 Amp Charger Jumpers

J #	FUNCTION
J1	Selects N.C. or N.O. contact of Discharging solid state FET relay U15; ships N.O.
J2	Selects N.C. or N.O. contact of Charging solid state FET relay U7; ships N.O.
J3	Not Used
J4	Selects N.C. or N.O. contact of Overtemp solid state FET relay U10; Ships N.C.
J6	Selects Bulk Charge / Equalize mode; ships ON for 2 hour EQ cycle
J7	Selects Logic state for Overtemp solid state FET relay U10; ships NORM
J8	Selects 30 sec or 30 minute fan run time; Ships OFF for 30 min
J9	Low power or unloaded adjustment mode selection; ships OFF for full power

4.2.1.4. 10 AMP UNIT TERMINAL STRIP I/O (3528C2 BOARD)

See Figure 4-1 for PCB layout, Figure 6-5 for the basic schematic of the I/O, and Tables 4-2, 4-3, and 4-4.

4.2.1.4.1. RELAY COMMON (RCOM) – TB4-1

This terminal is used for the common of all the outputs on TB4. It can be configured to switch voltage or a common depending on the installation.

4.2.1.4.2. DISCHARGING (DCHRG) – TB4-2

U15's normally open contact closes to Rcom when the unit is discharging through the module. Typically, this is only used when the charger is configured to get input power from a boost converter in a M3534 Ride Thru system. See Figure 6-3.

4.2.1.4.3. CHARGING (CHRG) – TB4-3

U7's normally open contact closes to Rcom when the unit is charging. When charging is near complete (95-99%) this contact will open. The charger is now in **trickle charge** mode.

4.2.1.4.4. OVERTEMPERATURE (OT) – TB4-4

Standard factory set up with J7 in INV position makes U10's normally open contact close to Rcom when power is applied and the charging unit is operating within normal temperature range. When an overtemp or power loss occurs the relay will drop out.
With J7 in the NORM position U10 will normally be de-energized, and pull in when there is an overtemp condition.

4.2.1.4.5. ENABLE INPUT (EN) – TB3-1&2

An external 24VDC enable signal (EN) at TB3-2&5 is needed in order to begin charging. An internal isolated supply is available at TB3-1 so that an unisolated contact between TB3-1&2 can be used. This enable is factory jumpered between TB3 1&2 for automatic charge mode at time of production.

4.2.1.4.6. BULK CHARGE / EQUALIZE INPUT (EQ) – TB3-3&4

An external 24VDC Bulk Charge / Equalize signal (EQ) at TB3-4&5 is used to raise the charging voltage for the purpose of "equalizing" the batteries in a series string. An internal isolated supply is available at TB3-3 so that an unisolated contact between TB3-3&4 can be used.
Bulk Charge / Equalize can be set for "real time" input by removing J8, or may be set for an automatic 2 hour time by installing J8. In automatic mode, the 2 hour timer starts when the Bulk Charge / Equalize signal becomes active. Once the Bulk Charge / Equalize 2 hour timer is started, it can be reset by cycling the Bulk Charge / Equalize input OFF and then ON, holding ON for 3 seconds. The charger will remain in Bulk Charge / Equalize mode for 2 hours with a momentary ACTIVE, or if the input remains ACTIVE for more than 2 hours. (See Figure 6-7)
R103 is used in conjunction with the Bulk Charge / Equalize signal to set the actual voltage level. This is factory set for an increase of

approximately 2.5% above nominal float charge voltage, and can be adjusted to increase the float charge level between 2 – 9%.

Table 4-2: 10A Status Signal Component Details- 3528C2 Control Board

FAULT/STATUS COMPONENTS	FAULT / STATUS SIGNAL COMPONENT ID		
	OVERTEMP (OT)	CHARGING (CHRG)	DISCHARGE (DCHRG)
Jumper	J4	J2	J1
Opto Coupler	U10	U7	U15
Contact Ratings	20-28VDC 100mA	20-28VDC 100mA	20-28VDC 100mA
Indicator	LD2	LD3	LD5
Control Board Terminations	TB4-1 & 4	TB4-1 & 3	TB4-1 & 2

Table 4-3: 10A Control Status Signal Component Specifications – 3528C2 Board

TERMINAL TYPE	FUNCTION	ELECTRICAL SPECIFICATIONS	MIN WIRE AWG	MAX WIRE AWG	TORQUE LB-IN
Phoenix plug TB4	Status	20-28VDC 100mA	22	16	2 lb-in
TB3 - 1,2	Enable	20mA@24VDC	22	16	2 lb-in
TB3 - 2,5		20-28VDC			
TB3 - 3,4	Bulk Charge / Equalize	20mA@24VDC	22	16	2 lb-in
TB3 - 4,5		20-28VDC			

Table 4-4: 10A Fault / Status Contact Logic Details – 3528C2 Board

CHARGER STATUS CONDITION	FRONT PANEL					JUMPER POSITIONS & CONTACT STATES							
	POWER	OVERTEMP	I LIMIT	CHARGING	DISCHARGE	U15(DISCHG)		U7 (CHRG)		J7= INV U10 (OT)		J7= NORM U10 (OT)	
	LD1	LD2	LD3	LD4	LD5	J1 ON N.C.	J1 ON N.O.	J4 ON N.C.	J4 ON N.O.	J4 ON N.C.	J4 ON N.O.	J4 ON N.C.	J4 ON N.O.
Power on, trickle charge	X	O	O	O	O	X	O	X	O	O	X	X	O
Overtemp condition	X	X	O	O	O	X	O	X	O	X	O	O	X
I Limit (Full Charge)	X	O	X	X	O	X	O	O	X	O	X	X	O
Absorption Charge	X	O	X O	O	O	X	O	O	X	O	X	X	O
Bulk Charge / Equalize Charge	X	O	X O	O	O	X	O	O	X	O	X	X	O
Discharge (DC Input only)	X	O	O	O	X	O	X	X	O	O	X	X	O
Power Off	O	O	O	O	O	X	O	X	O	X	O	X	O

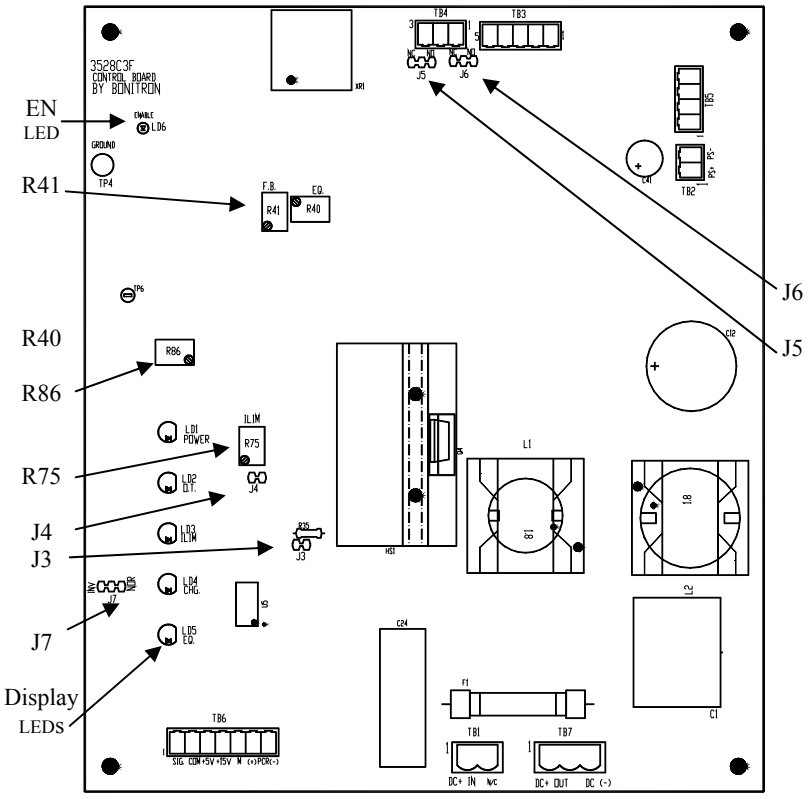
- When the relay is at rest the N.O. contact is OPEN.
- When the relay is pulled in the N.O. contact will be closed.
- **X** indicates that an LED is illuminated or that the relay is closed. **XO** indicates the LED will flash.

4.2.2. 20A CHARGER

4.2.2.1. ASB 3528C3 20A CHARGER BOARD FEATURES

The ASB 3528C3 is the main control board of the 20 Amp Battery Charger module used in the M3528 Battery Charger Control System. Figure 4-2 below shows the locations of all major components of the board.

Figure 4-2: ASB 3528C3 20A Charger Board Features



4.2.2.2. ASB 3528C3 ADJUSTMENT POTENTIOMETERS

The purpose and setting for each adjustment pot provided on the ASB 3528C3 Battery Charger board is described below. Please refer to *Figure 4-2* above for the locations of each of the adjustment pots listed below.

CAUTION!

To avoid damage to storage bank, ensure maximum voltage and current limitations are not exceeded. Always check with manufacturer of the storage device for specifications.

R41 – CHARGE VOLTAGE ADJUSTMENT

This adjustment potentiometer is factory preset according to system voltage specified at time of order, and is labeled on front of the charger when shipped. Field calibration of this setpoint may be necessary for other system voltages. Check storage bank manufacturer's recommendations before applying power. See Tables 4-9 and 4-10 for standard voltage settings.

It is recommended that the charger output voltage setpoint be verified before connecting to any energy storage bank (unless the enable command is manned and ready to shutdown charger in case voltage exceeds that allowed by the storage bank).

- See Startup Procedure in Section 4.3.2.
  a. Voltage adjustment may be done with open circuit or fully charged storage bank.
  b. For open circuit adjustment during start up voltage may appear unstable. Place low power mode jumper J9 ON to help stabilize during adjustment. Remember to remove J9 when placing back into operation at full power.
  c. If disconnect is used DO NOT close switch with more than 30V difference between the charger output and the storage bank.
  d. Clockwise adjustment will increase the charge voltage.
  e. Range of adjustment is 325 – 600VDC.

R40 – BULK CHARGE / EQUALIZE ADJUSTMENT

This adjustment is factory preset for 2.5% increase above float charge level. Field calibration may be needed to comply with storage bank manufacturer's recommendations.

a. Clockwise adjustment will increase the Bulk Charge / Equalize voltage.
b. Range of adjustment is +2% to +9% of charge voltage setpoint.

R75 – CHARGE CURRENT ADJUSTMENT

This adjustment potentiometer is factory preset to 20 amps. Field calibration of this set point may be necessary. Check storage bank manufacturer's recommendations before applying power.

- See Startup Procedure in Section 4.3.2.
  a. Clockwise adjustment will increase the charge current.
  b. Range of adjustment is 5 – 20 amps.
  c. Load must be present in order to get current flow.

R86 – FULL CHARGE THRESHOLD

For battery charging applications this adjustment is factory set so that when the charge current drops below 500mA the charging relay drops out and the 30 minute fan timer begins.

For Ultracapacitor charging applications this adjustment is factory set so that when the charge current drops below 200mA the charging relay drops out and the 30 minute fan timer begins.

Default setting is for 500mA for a typical 460VAC system if the application is not known prior to shipment.

4.2.2.3. ASB 3528C3 JUMPERS

Table 4-5: 20 Amp Charger Jumpers

J #	FUNCTION
J3	Selects Bulk Charge / Equalize mode; ships ON for 2 hour EQ cycle
J4	Selects 30 sec or 30 minute fan run time; Ships OFF for 30 min
J5	Selects N.C. or N.O. contact of Overtemp solid state FET relay U11; Ships N.C.
J6	Selects N.C. or N.O. contact of Charging solid state FET relay U10; ships N.O.
J7	Selects Logic state for Overtemp solid state FET relay U10 ; ships NORM

4.2.2.4. 20 AMP UNIT TERMINAL STRIP I/O (3528C3 BOARD)

See Figure 4-2 for PCB layout, Figure 6-6 for the basic schematic of the I/O, and Tables 4-6. 4-7, and 4-8.

4.2.2.4.1. RELAY COMMON (RCOM) – TB4-1

This terminal is used for the common of all the outputs on TB4. It can be configured to switch voltage or a common depending on the installation.

4.2.2.4.2. CHARGING (CHRG) – TB4-2

U7's normally open contact closes to Rcom when the unit is charging. When charging is complete, this contact will open. J6 selects the N.O or N.C. contact.

4.2.2.4.3. OVERTEMPERATURE (OT) – TB4-3

J7 in INV position makes U10's normally open contact close to Rcom when power is applied and the charging unit is operating within normal temperature range. When an overtemp or power loss occurs the relay will drop out.

Standard factory set up with J7 in the NORM position U10 will normally be de-energized, and pull in when there is an overtemp condition.

J5 selects the N.O or N.C. contact.

4.2.2.4.4. ENABLE INPUT (EN) – TB3-1&2 OR 2&5

An external 24VDC enable signal (EN) at TB3-2&5 is needed in order to begin charging. An internal isolated supply is available at TB3-1 so that an unisolated contact between TB3-1&2 can be used. This enable is factory jumpered between TB3-1&2 for automatic charge mode at time of production.

4.2.2.4.5. BULK CHARGE / EQUALIZE INPUT (EQ) – TB3-3&4 OR 4&5

An external 24VDC Bulk Charge / Equalize signal (EQ) at TB3-4&5 is used to raise the charging voltage for the purpose of "equalizing" the batteries in a series string. An internal isolated supply is available at TB3-3 so that an unisolated contact between TB3-3&4 can be used.

This can be set for "real time" input by removing J3, or may be set for an automatic 2 hour time by installing J3. In automatic mode, the 2 hour timer starts when the signal becomes active. Once the 2 hour timer is started, it can be reset by cycling the input OFF and then ON, holding ON for 3 seconds. The charger will remain in Bulk Charge / Equalize mode for 2 hours with a momentary ACTIVE, or if the input remains ACTIVE for more than 2 hours. (See Figure 6-7)

R40 is used in the Bulk Charge / Equalize signal to set the actual voltage level. This is factory set for an increase of approximately 2.5% above nominal float charge voltage, and can be adjusted to increase the float charge level between 2 – 9%.

Table 4-6: 20A Status Signal Component Details- 3528C3 Control Board

FAULT/STATUS COMPONENTS	FAULT / STATUS SIGNAL COMPONENT ID	
	OVERTEMP (OT)	CHARGING (CHRG)
Jumper	J5	J6
Optocoupler Contact Ratings Isolation	U10 100mA @ 24VAC 3000VAC	U7 100mA @ 24VAC 3000VAC
Indicator	LD2	LD4
Control Board Terminations	TB4 - 1&3	TB4 - 1&2

Table 4-7: 20A Control Status Signal Mechanical Specifications – 3528C3 Board

TERMINAL TYPE	FUNCTION	ELECTRICAL SPECIFICATIONS	MIN WIRE AWG	MAX WIRE AWG	TORQUE LB-IN
Phoenix plug TB4	Status	20-28VDC 100mA	22	16	2 lb-in
TB3 - 1,2	Enable	20mA@24VDC	22	16	2 lb-in
TB3 - 2,5		20-28VDC			
TB3 - 3,4	Bulk Charge / Equalize	20mA@24VDC	22	16	2 lb-in
TB3 - 4,5		20-28VDC			

Table 4-8: 20A Fault / Status Contact Logic Details – 3528C3 Board

CHARGER STATUS CONDITION	FRONT PANEL INDICATORS					JUMPER POSITIONS & CONTACT STATES					
	POWER	OVERTEMP	I LIMIT	CHARGING	BULK CHARGE / EQUALIZE	U7 (CHRG)		J7 = INV U10 (OT		J7 = NORM U10 (OT)	
	LD1	LD2	LD3	LD4	LD5	J6 ON N.C.	J6 ON N.O.	J5 ON N.C.	J5 ON N.O.	J5 ON N.C.	J5 ON N.O.
Power on, trickle charge	X	O	O	O	O	X	O	O	X	X	O
Overtemp condition	X	X	O	O	O	X	O	X	O	O	X
I Limit (Full Charge)	X	O	X	X	O	O	X	O	X	X	O
Absorption Charge	X	O	O	XO	O	O	X	O	X	X	O
Bulk Charge / Equalize	X	O	O	XO	X	O	X	O	X	X	O
Power Off	O	O	O	O	O	X	O	X	O	X	O

- When the relay is at rest the N.O. contact is OPEN.
- When the relay is pulled in the N.O. contact will be closed.
- **X** indicates that an LED is illuminated or that the relay is closed. **XO** indicates the LED will flash.

4.2.3. 10A AND 20A INDICATORS

4.2.3.1. SYSTEM INTERFACE DISPLAY FEATURES

The Model M3528 Battery Charger can be equipped with an optional Battery Voltage or Current Meter. This display provides the user with current system status information. Figure 4-3 below shows the display as it appears on the enclosure. Details for each feature of the display are provided below.

4.2.3.2. ASB 3528C STATUS INDICATORS

The purpose and function of each status indicator provided on the ASB 3528C Battery Charger board is described below. Please refer to Figure 4-1 (10 Amp) or Figure 4-2 (20 Amp) at the beginning of this section for the locations of each of the indicators listed below.

The following can be seen on the Display Panel:

LD1 – POWER (PWR):
The green LD1 PWR indicator turns ON to show the presence of control power within the M3528 Battery Charger module.

LD2 – OVERTEMP (OT):
The red LD2 OT indicator turns **ON** to show the presence of an Overtemp fault condition within the M3528 Battery Charger module. When the module is in Overtemp, charging is disabled.

LD3 (10A) LD4 (20A) CHARGING (CHRG):
The green LD3 CHRG indicator turns ON when the M3528 Battery Charger module is actively charging the Energy Storage Reservoir.

LD4 (10A) LD3 (20A) – CURRENT LIMIT (ILIM):
The amber LD4 ILIM indicator turns ON to show the presence of a current limit condition within the M3528 Battery Charger module. This is a normal condition indicating the charger is operating in Constant Current mode.

LD5 – DISCHARGING (DCHRG) (10 AMP MODEL ONLY):
The amber LD5 DCHRG indicator turns ON when the Energy Storage Reservoir is discharging back through the M3528 Battery Charger module. This LED will only illuminate on the DC input versions of the module.

LD5 – BULK CHARGE / EQUALIZE (EQ) (20 AMP MODEL ONLY):
The amber LD5 EQ indicator turns ON when the Bulk Charge / Equalize input command is given and remains ON until the Bulk Charge / Equalize timer resets.

The following can be seen when the front panel is off:

LD6 – ENABLE (EN) (20 AMP MODEL ONLY):
The red LD6 EN indicator turns ON whenever the Enable input command is given.

4.3. M3528 CHARGER START-UP PROCEDURE FOR BATTERIES

4.3.1. PRE-POWER CHECKS

TEST EQUIPMENT:

- DC current probe with RMS measurement
- Voltage meter

Ensure that the Model M3528 Battery Charger system has been properly installed and wired as previously outlined in the Installing the M3528 Charger Module and Wiring the M3528 Charger Module sections of this manual.

Keep output to storage bank open to check and adjust the M3528 charging voltage by removing the output fuses or opening disconnect if used.

DANGER!

Connecting charged storage bank to unpowered charger or charger at voltage difference greater than 20% may cause fuses to blow. Use disconnect with precharge or NTC surge limiting devices if system requires this.

ATTENTION!

The values for charge voltages and currents listed in Tables 4-7 thru 4-9 are typical values. Bonitron recommends using the manufacturer's recommended values.

4.3.2. STARTUP PROCEDURE AND CHECKS

1. Ensure storage bank is disconnected.
2. Apply power and enable to charger and observe:
   - Power is ON.
   - Overtemp LED is OFF.
   - Current Limit LED is OFF.
   - Charge LED is ON.
   - Discharge LED is OFF (10 Amp model only).
   - Bulk Charge / Equalize LED is OFF (20 Amp model only).

Output voltage will be limited to factory preset charge voltage (see Table 4-8).

Please note that the M3528 modules use thermistors in its start-up circuitry. If these thermistors are still warm from a previous run when power is applied there may be a delay of a few seconds before the power up sequence above occurs.

ATTENTION!

To check and adjust the M3528 Charger Module charging voltage the battery bank should be disconnected in case preset voltage is higher than storage bank rating.

Table 4-9: Typical Battery Bank Voltages

Not to replace manufacturer's recommendations.

SYSTEM AC VOLTAGE	208	230	380	375	415	460
Nominal voltage	216	240	408	420	432	480
Full or Float Charge voltage	243	270	459	473	486	540
Bulk Charge / Equalize Voltage	249	277	470	484	498	554
Eq V Range (Charger Only)	247-260	276-288	468-491	482-506	495-520	550-577
Discharged voltage (1.67VDC)	180	200	340	350	360	375

3. Check or adjust voltage limit

ATTENTION!

On 10 Amp units, output voltage may be unstable with no load. Add 150k, 10W resistor to stabilize.

- Determine maximum charge voltage as required by battery bank specifications. See Table 4-7 for general guidelines.
- Monitor DC voltage output from charger.
- Adjust voltage to match battery manufacturer's recommendations (R37 for 10A, R41 for 20A):
  - Adjust CW to increase voltage.
  - Adjust CCW to decrease voltage.

4. Check or adjust Bulk Charge / Equalize voltage limit:
   - Ensure that J3 (20A) has been removed. (J8 for 10A)
   - Apply 9-24VDC to Bulk Charge / Equalize input.
   - Adjust equalizing voltage according to battery manufacturer's recommendations (R103 for 10A, R40 for 20A):
     - Adjust CW to increase voltage.
     - Adjust CCW to decrease voltage.
   - Remove Bulk Charge / Equalize command.
   - Place J3 (20A) in desired state. (J8 for 10A). (See Sections 4.2.3 and 4.2.4)
5. Place a DC current clamp on the output wiring.

ATTENTION!

*Connecting charged battery to powered-down charger may cause fuses to blow or damage to charger. Use disconnect with precharge or NTC surge limiting device if system requires this***.**

6. With less than 20% difference between charger output voltage and battery voltage, connect the battery bank.
   - Charger will immediately begin supplying current upon connection of battery bank.
7. Check or adjust current limit.
   - Determine maximum charge current accepted by battery bank. See Table 4-9 for general guidelines; see manufacturer's specifications for details. *** **Do not adjust to exceed the chargers current rating!**

ATTENTION!

Values in Table 4-9 are for a single series string. For parallel strings, increase charge amount accordingly. Example: for CSB strings in parallel, set charge current for 2.7 amps.

   - Batteries must be discharged in order to check or set current levels.
   - Monitor storage bank current during initial charge while ILIM LED is **ON.**
   - Adjust current to match or stay below manufacturer's recommendations (R71 for 10A, R75 for 20A):
     - Adjust CW to increase current.
     - Adjust CCW to decrease current.

4.4. M3528 CHARGER START-UP PROCEDURE FOR ULTRACAPACITORS

4.4.1. PRE-POWER CHECKS

TEST EQUIPMENT:

- DC current probe with RMS measurement
- Voltage meter

Ensure that the Model M3528 Battery Charger system has been properly installed and wired as previously outlined in the *Installing the M3528 Charger Module* and *Wiring the M3528 Charger Module* sections of this manual.

NOTE: Chargers are shipped with the DC Output fuses removed.

Keep output to storage bank open to check and adjust the M3528 charging voltage. Install the fuses AFTER setting voltage in step 3, if no disconnect is used between the cap bank and charger.

ATTENTION!

DO NOT c*onnect a powered-up charger already at full voltage to a discharged capacitor bank! Power down & allow charger DC output to drop before connecting capacitor bank.*

ATTENTION!

The values for charge voltages and currents listed in Table 4-8 are typical values. Bonitron recommends using the manufacturer's recommended values.

4.4.2. STARTUP PROCEDURE AND CHECKS

1. Ensure capacitor storage bank is disconnected.
2. Apply power and enable to charger and observe:
   - Power is ON.
   - Overtemp LED is OFF.
   - Current Limit LED is OFF.
   - Charge LED is ON.
   - Discharge LED is OFF (10 Amp model only).
   - Bulk Charge / Equalize LED is OFF (20 Amp model only).

   Output voltage will be limited to factory preset charge voltage (Table 4-8).

Please note that the M3528 Modules use thermistors in its start-up circuitry. If these thermistors are still warm from a previous run when power is applied there may be a delay of a few seconds before the power up sequence above occurs.

ATTENTION!

To initially check and adjust the M3528 charging voltage, the capacitor bank should be disconnected in case preset voltage is higher than storage bank rating.

Table 4-10: Typical Capacitor Bank Voltages

Not to replace manufacturer's recommendations.

SYSTEM AC VOLTAGE	208	230	375	460
Nominal voltage	270	300	450	600
Full or Float Charge voltage	256	285	427	570
Discharged voltage	185	150	275	300

3. Check or adjust voltage limit.

ATTENTION!

On 10 Amp units, output voltage may be unstable with no load. Add 150k, 10W resistor to stabilize.

- Determine maximum charge voltage as required by capacitor bank specifications. See Table 4-8 for general guidelines.
- Monitor DC voltage output from charger at the output fuse block.
- Adjust voltage to match or stay below ultracapacitor manufacturer's recommendations (R37 for 10A, R41 for 20A):
  - Adjust CW to increase voltage.
  - Adjust CCW to decrease voltage.

4. Power down charger and allow output voltage to drain.
5. Place a DC current clamp on the output wiring.

ATTENTION!

Connecting powered-up charger to a discharged capacitor may cause fuses to blow or damage to charger. Ensure voltage differential is less than 50V before connecting.

6. Connect capacitor bank by installing DC Output fuses.
7. Re-apply power to charger and check or adjust current limit.
   - Charger will immediately begin supplying current after a slight delay upon re-application of power.
   - Determine maximum charge current accepted by capacitor bank. See Table 4-6 for general guidelines; see manufacturer's specifications for details. *** **Do not adjust to exceed the chargers current rating!**
     - Typically Ultracaps can charge as fast as they can be discharged so current limit will be set to the limits of the charger.
     - Monitor storage bank current during initial charge while ILIM LED is **ON.**
   - Adjust current to match or stay below manufacturer's recommendations (R71 for 10A, R75 for 20A):
     - Adjust CW to increase current.
     - Adjust CCW to decrease current.

Table 4-11: Typical Storage Bank Charge Currents

Not to replace manufacturers recommendations.

MANUFACTURER	STORAGE	CHARGE CURRENT	DISCHARGE CURRENT
(Other)	Cap or Battery	See manufacturer's recommendations	See manufacturer's recommendations
Yuasa	NP4-12	1.25 Amps	40 Amps
CSB	GP1245	1.35 Amps	40 Amps
Elit Ultracap	150PP	150 Amps	150 Amps
Maxwell Ultracap	HTM0125 P063	750 Amps	750 Amps

4.5. OPERATIONAL ADJUSTMENTS

If current or voltage levels are out of tolerance, follow the instructions in Section 4.3 or 4.4 to adjust.

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 MAINTENANCE PROCEDURES FOR M3528 CHARGER MODULE

The Bonitron Charger is designed to be low maintenance. Bonitron recommends a yearly test of the system in order to ensure the electronics package is operating. The following steps can be taken to ensure reliability and give comfort that the system is still able to recharge a depleted storage reservoir.

Each Bonitron charging system should be tested during initial start up to verify the current limit, charge voltage, and Bulk Charge / Equalize adjustments. These voltage and current levels should be noted for future reference.

Full charge voltage: _____
Full charge current: _____
Bulk Charge / Equalize voltage: _____
Charge LED flash rate @ float charge level: _____

TO VERIFY TRICKLE CHARGE CAPABILITY

1. Monitor 3528C2 or C3 Control Board LEDs as system sits in trickle charge mode (idle or standby):
   - PWR LED should be ON.
   - OVERTEMP LED should be OFF.
   - CURRENT LIMIT LED should be OFF.
   - CHARGE LED should be FLASHING.
     - A change in the flash rate over a period of time may indicate impedance change within the storage bank.
   - DISCHARGE LED should be OFF (10 amp models only).
   - BULK CHARGE / EQUALIZE LED should be OFF (20 amp models only).
   - Fan should be OFF.
2. Verify storage reservoir DC float charge voltage level.
   - Should be at fully charged level (see Table 4-4 or 4-5 for typical charge levels).

TO VERIFY FULL CHARGE CAPABILITY USING DRIVE SYSTEM

1. Remove energy from storage bank by opening the AC disconnect to the drive and charger (if equipped). Allow Ride-Thru system to run from storage bank for 25% of time as specified.
   - The storage bus voltage should immediately drop to its loaded level, then continue dropping as energy is depleted.
   - DISCHARGE LED should be ON (10 amp, DC input models only when used in 32hp or below systems).
   - Drive system should run as normal.
2. Restore power to drive system. Recharging should begin as soon as power is restored.
   - The storage bus voltage should begin to rise until it reaches charged level.
   - CHARGE relay should be ON until unit approaches charged level.
   - CHARGE LED begins to dim as unit reaches charged level.

- CURRENT LIMIT LED should be ON until unit is no longer running at maximum current level.
- Fan should be ON, and then shut OFF after bank is fully charged.
- Drive system should run as normal.

TO VERIFY FULL CHARGE CAPABILITY USING THE M3628 DISCHARGING SYSTEM

1. Remove energy from storage bank by causing the M3628T discharge module to turn on.
   - The storage bus voltage should drop as energy is depleted.
   - CHARGE LED should be ON for duration of discharge enable signal.
   - CURRENT LIMIT LED should be ON for duration of discharge enable signal.
   - Fan should be ON.
   - Drive system should run as normal.
2. Remove enable command from discharge module. Recharging should begin as soon as ENABLE is removed.
   - The storage bus voltage should begin to rise until it reaches charged level.
   - CHARGE LED should be ON until unit reaches charged level.
   - CURRENT LIMIT LED should be ON until unit is no longer running at maximum Bulk Charge / Equalize level.
   - Fan should be ON, and then shut OFF after bank is fully charged.
   - Drive system should run as normal.

TO VERIFY BULK CHARGE / EQUALIZE CAPABILITY (FOR BATTERY BANKS ONLY)

1. Apply an EQ command at TB3 on the 3528C control PCB.
   - The storage bus voltage should begin to rise until it reaches the equalizing level.
   - BULK CHARGE / EQUALIZE LED should be ON (20 amp models only).
   - CHARGE LED should be ON until unit reaches Bulk Charge / Equalize level.
   - CURRENT LIMIT LED may or may not be ON depending on impedance of battery bank.
   - Fan should be ON.
2. Leave Bulk Charge / Equalize command active for length of equalization time as required by battery manufacturer.
3. Remove Bulk Charge / Equalize command.
   - The storage bus voltage should drop until it reaches float charge level.
   - BULK CHARGE / EQUALIZE LED should be OFF (20 amp models only).
   - CHARGE LED should be OFF until unit reaches float charge level.
   - CURRENT LIMIT LED will be OFF.
   - Fan should be ON, and then shut OFF after a period of no activity.

This completes the maintenance procedure.

5.2. MAINTENANCE ITEMS

5.2.1. CAPACITOR REPLACEMENT RECOMMENDATIONS

5.2.1.1. CAPACITOR REPLACEMENT CRITERIA

Bonitron Model M3528 Charger 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 M3528 typically is in a standby mode waiting to recharge storage reservoir.

With typical operating conditions of 35 deg C, 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.)

5.2.1.2. CAPACITOR TESTING PROCEDURE

With power applied, 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 cap1=290V, cap2 = 250V.

5.2.1.3. CLEANING

Cleaning cycle depends entirely upon surrounding environment and quality of air inside cabinet.

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

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

5.2.1.4. FANS

- Fans run only while the M3528 is charging and should have a life of 20 years under normal conditions.
- To check operation of fan, initiate a CHARGE cycle.
  - Fan should run for 2-3 minutes after charging.
- If fan does not run, replace with equivalent 24V fan.
- If fan does not stop when charging slows, check control board.

5.3. TECHNICAL HELP – BEFORE YOU CALL

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

- Model number of unit
- Serial number of unit
- Name of original equipment supplier
- Brief description of the application
- Drive and motor Hp or kW
- The line to line voltage on all 3 phases
- The DC Bus voltage
- KVA rating of power source
- Source configuration Wye/Delta and grounding

5.4. TROUBLESHOOTING

Table 5-1: Troubleshooting

SYMPTOM	ACTION
No Panel LEDs	Check incoming voltage • If no voltage check line fuses and replace Check power supply on 3528C for 24V • If input voltage is present and no 24V, replace unit
Panel LEDs flash on and off	Normal condition for 10 amp unit with charged storage bank and no incoming power For 20 amp unit, remove incoming voltage and allow 5 minutes for start-up circuits to cool, then re-apply power
Fuses blow at power up	Check for proper size & type fuses Ensure contactor is pulled in at the correct time Ensure charger is isolated from the drive system If problem persists, replace unit
System Control Power sees high voltage with charger connected	Ensure the charger internal 24VDC supply is NOT connected to system control power
Storage Bank won't charge at all	Ensure incoming voltage is present Ensure open circuit voltage set-point is correct Ensure current limit pot is not fully CCW Ensure 9-24V enable command is given • Check Enable - LD6 on 3528C3 (20 amp model) If all the above are correct, replace unit
Storage Bank won't fully charge	Ensure open circuit voltage set-point is correct Ensure input DC is 50V above desired charge voltage
Overtemp condition	Check output current • Should be zero in OT condition Ensure airflow is good • Replace fan if no or low airflow Allow time to cool • If output current is zero, airflow is OK, and OT condition persists, replace temp sensor on end of heatsink or replace unit
Voltage fluctuates during open circuit test	Connect 150k load (or lower) to DC output to stabilize
Cannot Bulk Charge / Equalize battery bank	Ensure 9-24V Bulk Charge / Equalize command is given • Check for EQ LD5 on 3528C3 (20 amp model) Ensure input DC is 50V above desired Bulk Charge / Equalize voltage Ensure open circuit voltage Bulk Charge / Equalize set-point is correct
Bulk Charge / Equalize stays on after removing command	Ensure jumper J3 is OFF on 3528C3 Ensure jumper J8 is OFF on 3528C2
Bulk Charge / Equalize will not stay on after removing command	Ensure jumper J3 is ON on 3528C3 Ensure jumper J8 is ON on 3528C2

6. ENGINEERING DATA

6.1. RATINGS

Table 6-1: M3528 Ratings Chart

MODEL	AC INPUT VOLTAGE RANGE			DC INPUT VOLTAGE RANGE			OUTPUT VOLTAGE SETPOINT		CURRENT SETPOINT		SCCR RATING
	MIN	NOM	MAX	MIN	NOM	MAX	MIN	MAX	ADJ RANGE	MAX CONTINUOUS	
M3528DC-L010				250	324	375	175	325	2-12	10	10kA
M3528DC-E010				375	565	713	325	600			
M3528DC-H010				375	648	713	325	600			
M3528AC-L010	160	230	253				175	325			
M3528AC-E010	277	400	506				325	600			
M3528AC-H010	277	460	506				325	600			
M3528AC-L020	160	230	253				175	325	4-24	20	
M3528AC-E020	277	400	506				325	600			
M3528AC-H020	277	460	506				325	600			

6.2. WATT LOSS

Table 6-2: M3528 Watt Loss Chart

MODEL	STANDBY LOSS	FULL POWER CHARGE EFFICIENCY
10 Amp	≤ 15 W	≥ 95% efficient
20 Amp	≤ 20 W	≥ 95% efficient

6.3. CERTIFICATIONS

M3528 is UL Listed under UL508C standards for use with Ultracapacitors.

6.3.1. 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 comply with the EN standards listed below when installed according to the M3528 Charger Installation Instructions and this M3528 Charger User Manual.

6.3.1.1. CE DIRECTIVES

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

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

6.3.1.1.2. EMC DIRECTIVE (2004/108/EC)

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

6.3.1.1.3. 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 5 (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 "GND." All power wiring to the charger must use cables housed in metal conduit, or equivalent shielding must be provided.

6.3.1.1.4. 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. FUSE / BREAKER SIZING AND RATING

Suitable for use on a circuit capable of delivering not more than 10,000 rms symmetrical amperes, 480 volts maximum, when protected by semiconductor fuses as shown in Table 6-3.

Table 6-3: M3528 Fusing

MODEL	INTERNAL FUSING STANDARD		RECOMMENDED EXTERNAL FUSING	
	INPUT	OUTPUT	INPUT	OUTPUT
10 Amp AC Input	yes	yes	A60Q15	A60Q15
10 Amp DC Input	yes	yes	A60Q40	A60Q40
20 Amp AC Input	yes	yes	A60Q25	A60Q25

6.5. DIMENSIONS AND MECHANICAL DRAWINGS

Figure 6-1: M3528AC 10 Amp Charger Module A5 Chassis Dimensional Outline

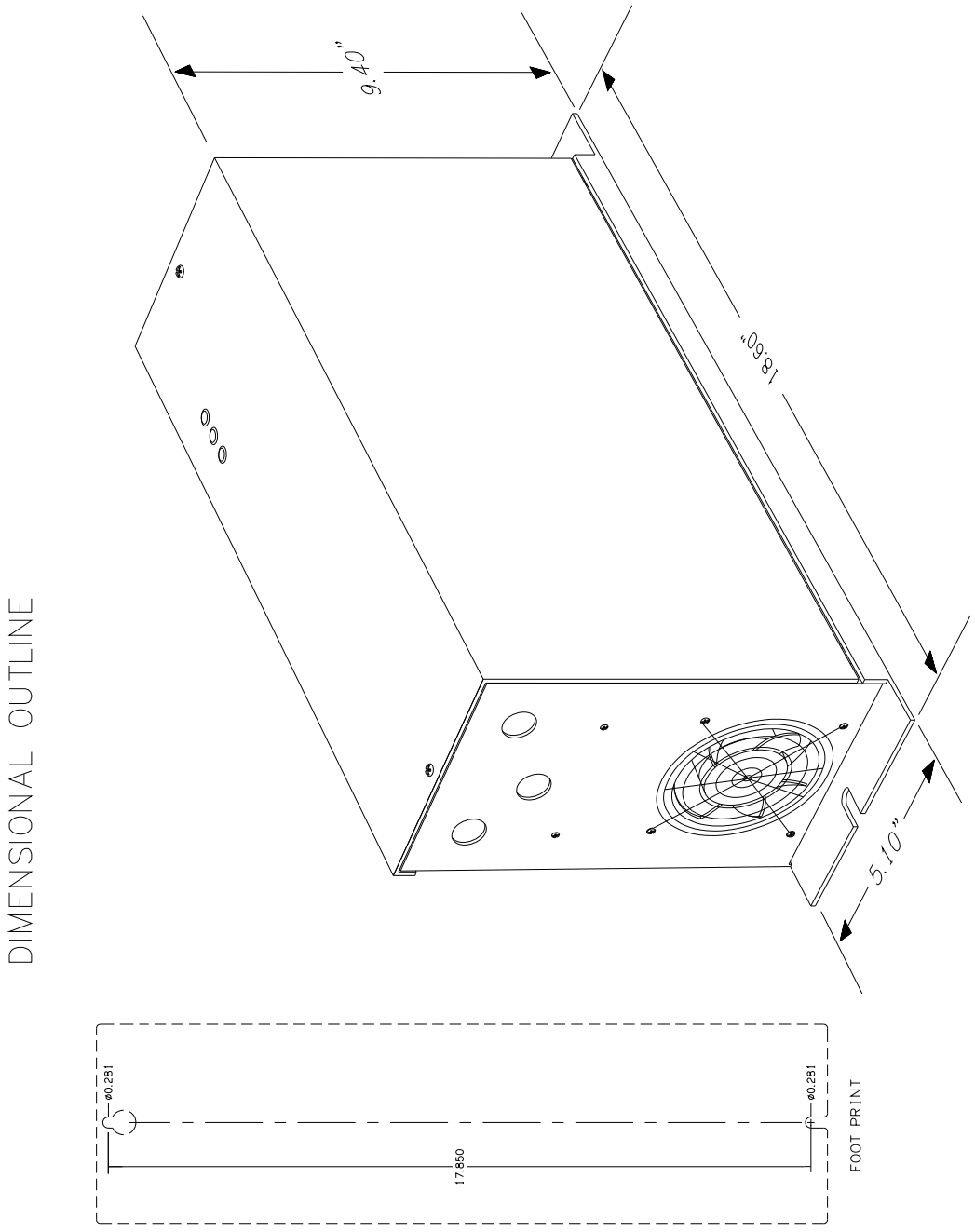
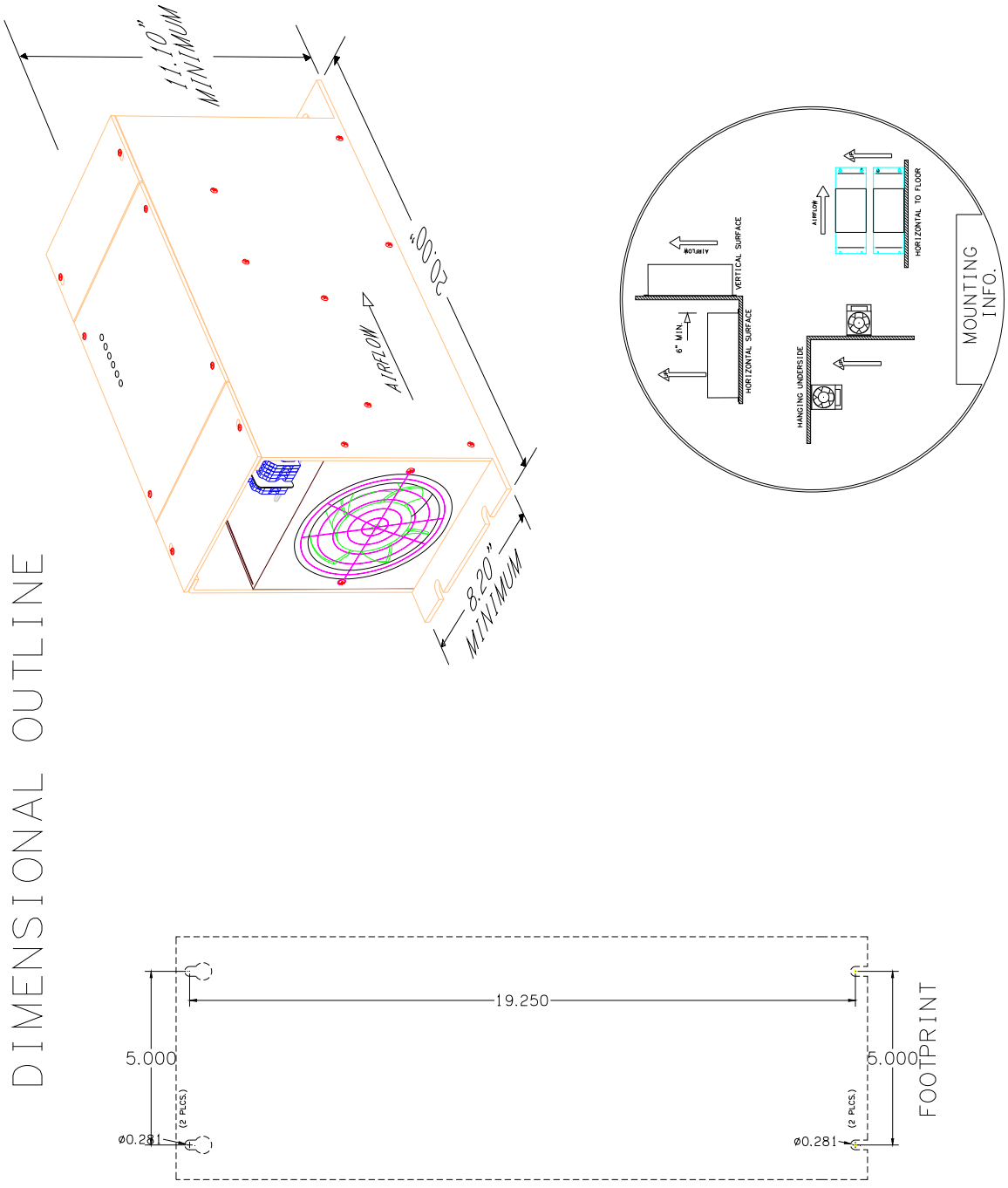


Figure 6-2: M3528 20 Amp Charger K8 Chassis Mounting and Dimensional Outline



6.6. BLOCK DIAGRAMS

Figure 6-3: 10 Amp Typical DC Charging System Wiring (32 hp and below)

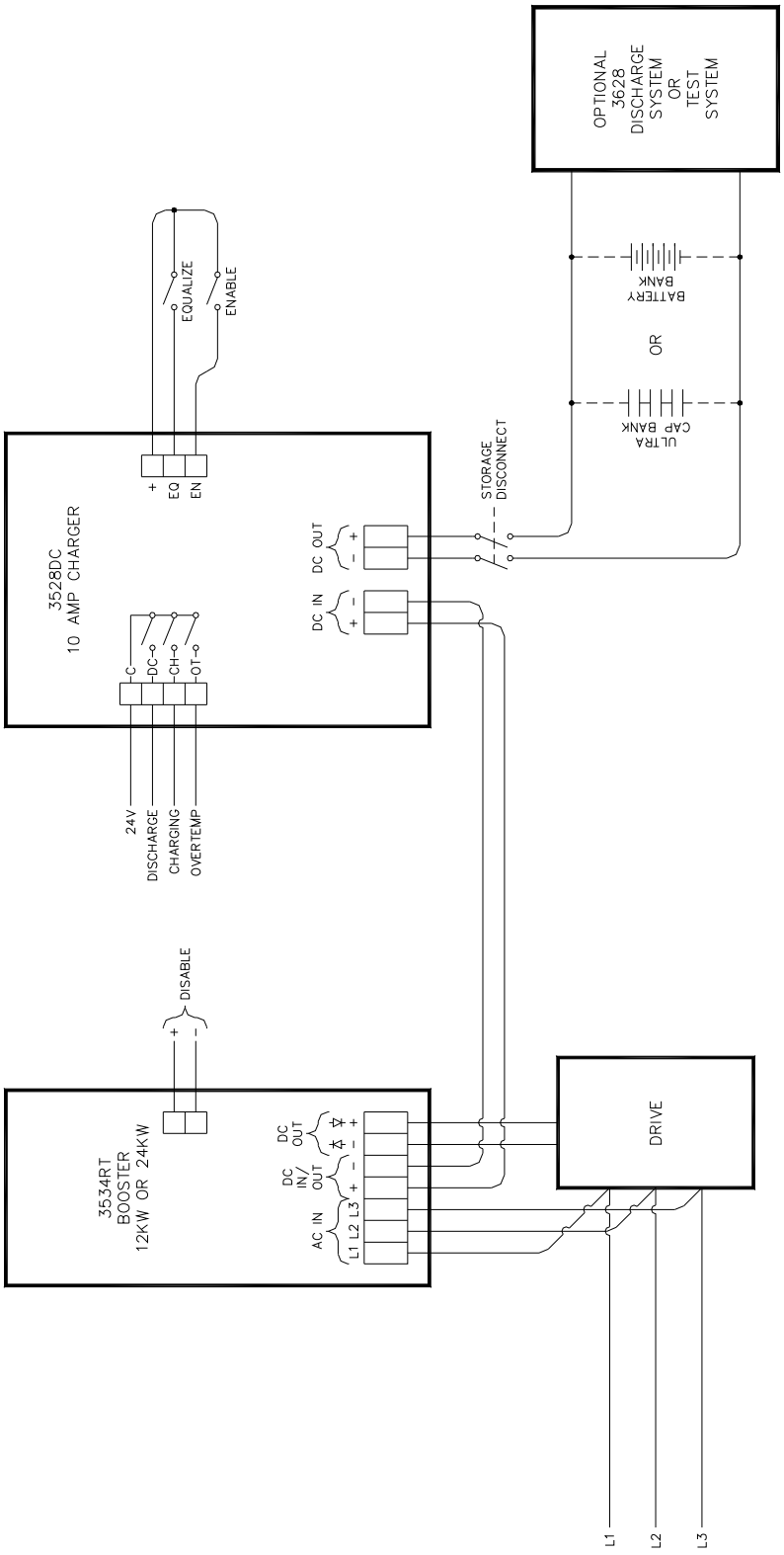
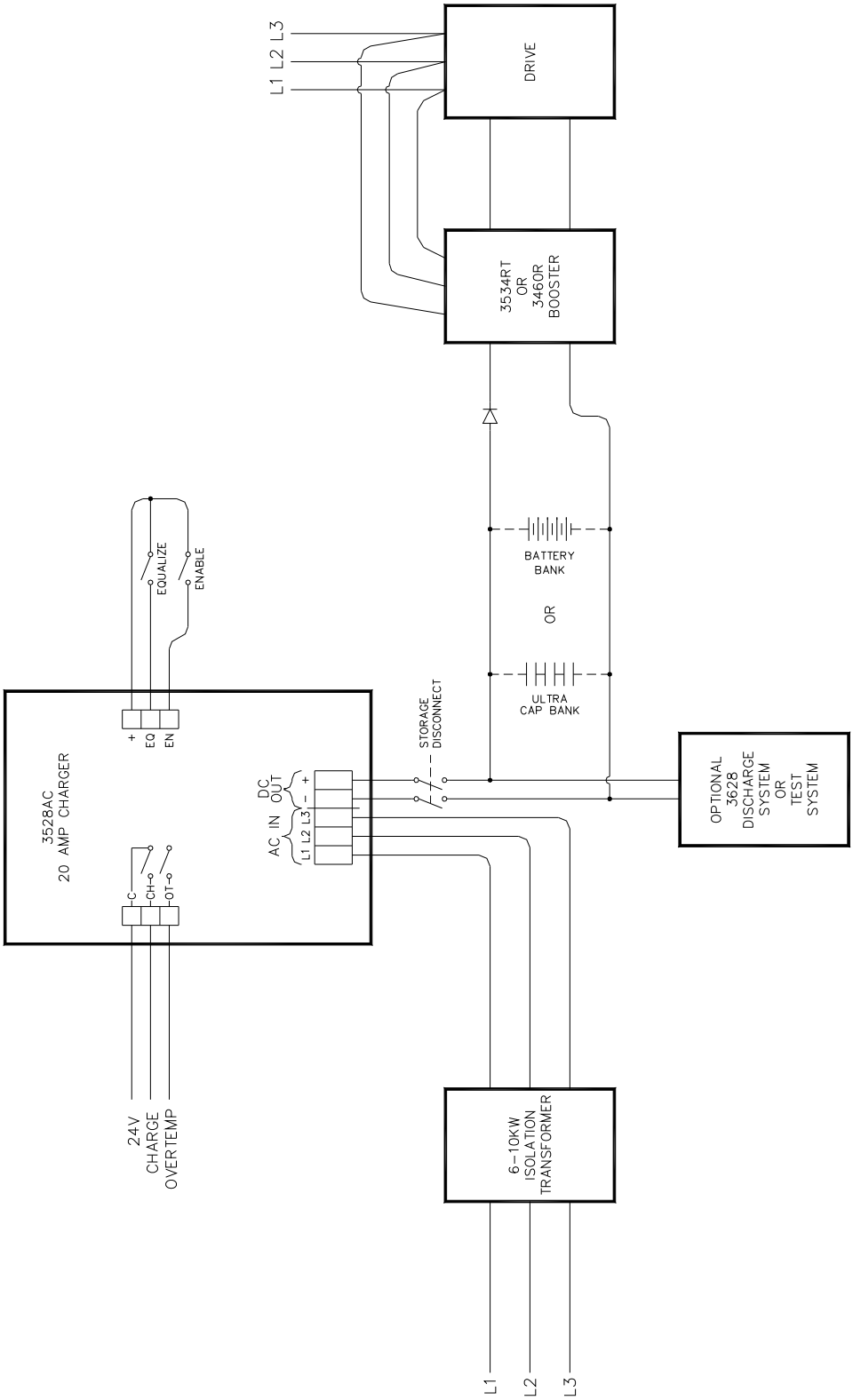


Figure 6-4: 20 Amp Typical AC Charger System Wiring



6.7. SUPPLEMENTAL DRAWINGS

Figure 6-5: M3528 10 Amp Charger Control Connection Schematic

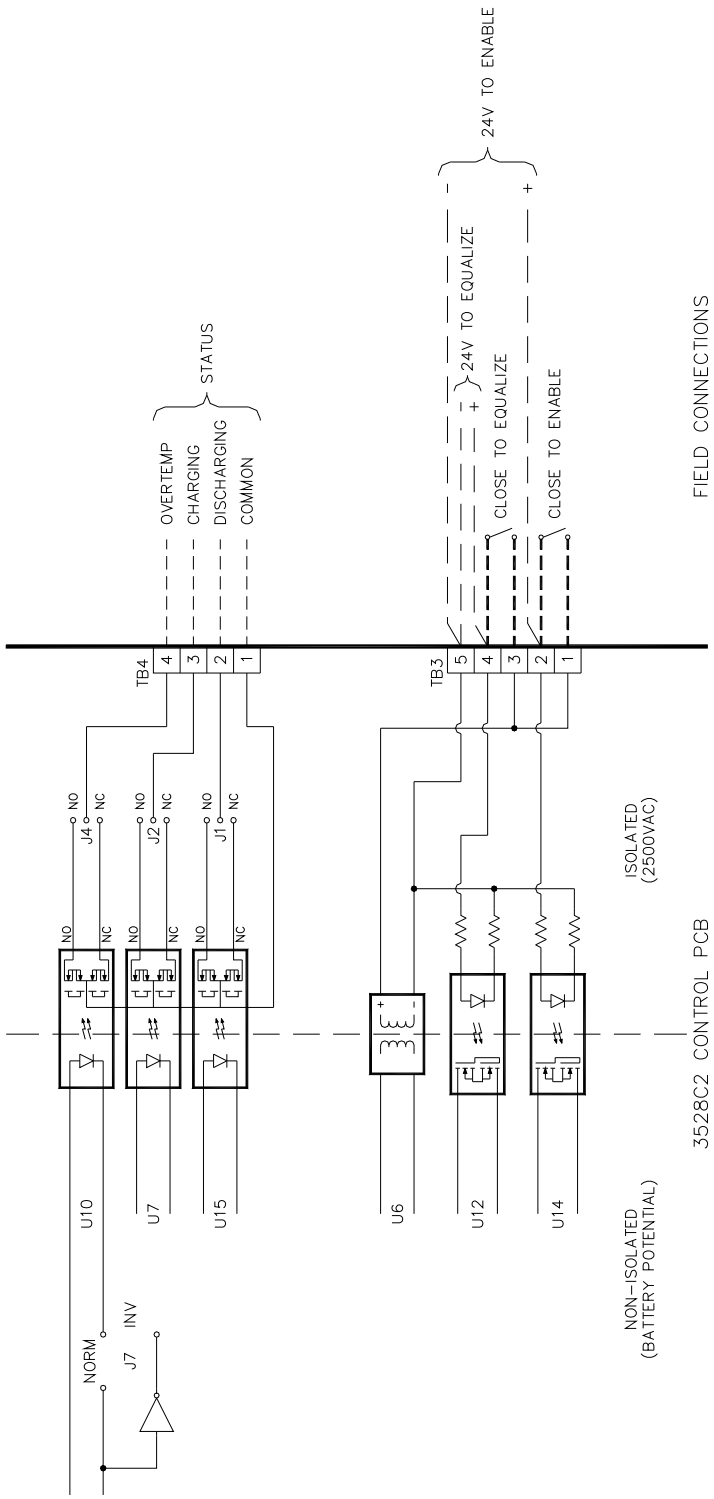


Figure 6-6: M3528 20 Amp Charger Control Connection Schematic

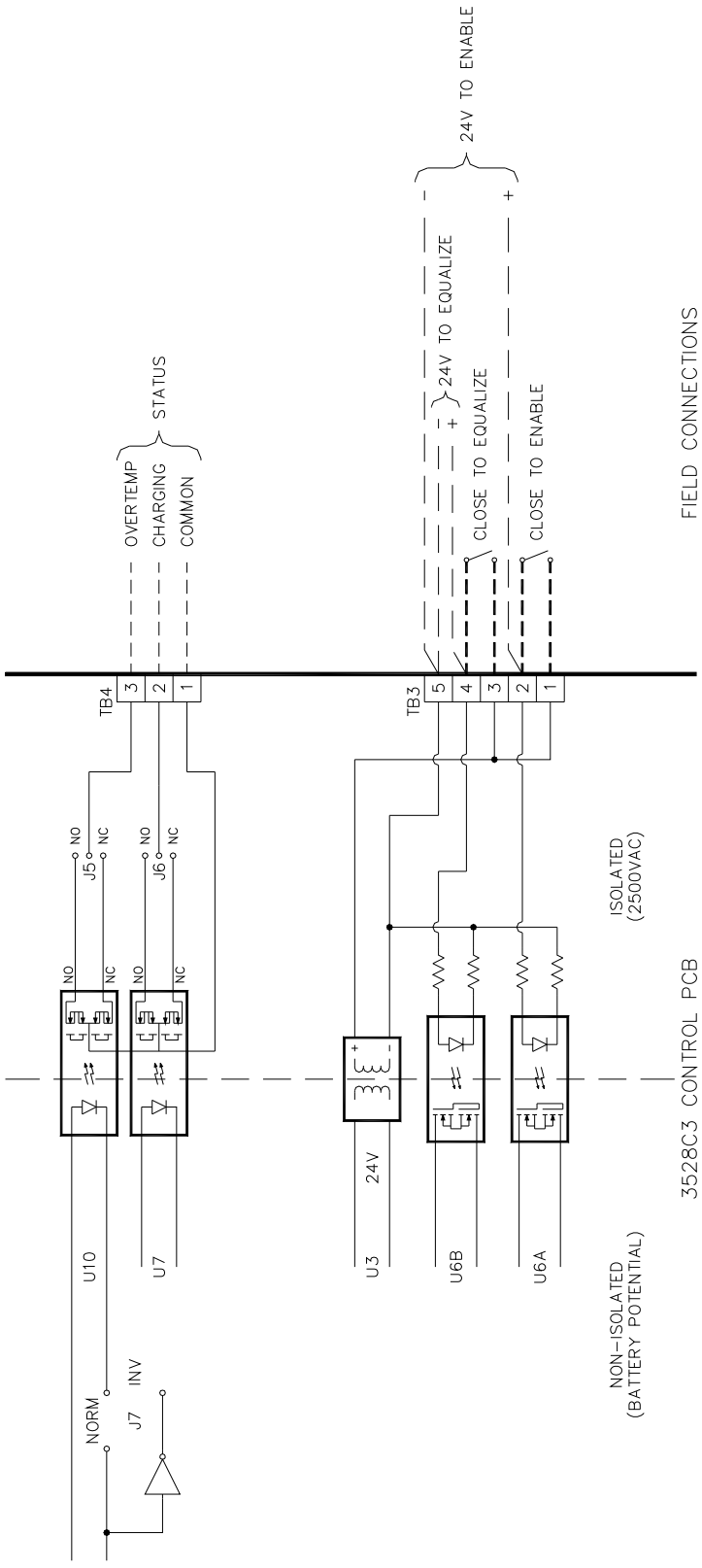


Figure 6-7: Bulk Charge / Equalize Mode Truth Table

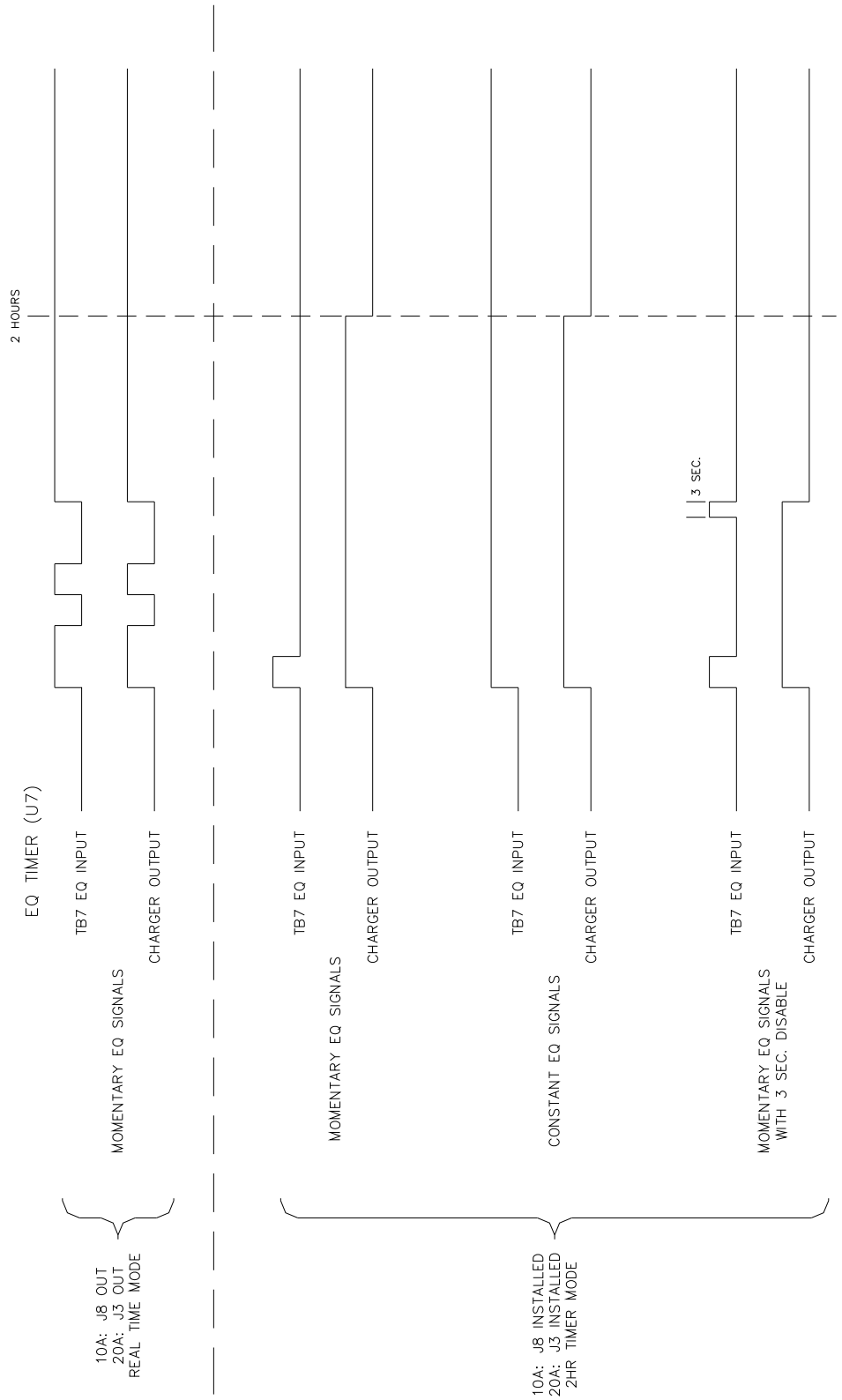


Figure 6-8: 10 Amp Typical DC Charger & Battery System Wiring with Diode Sharing

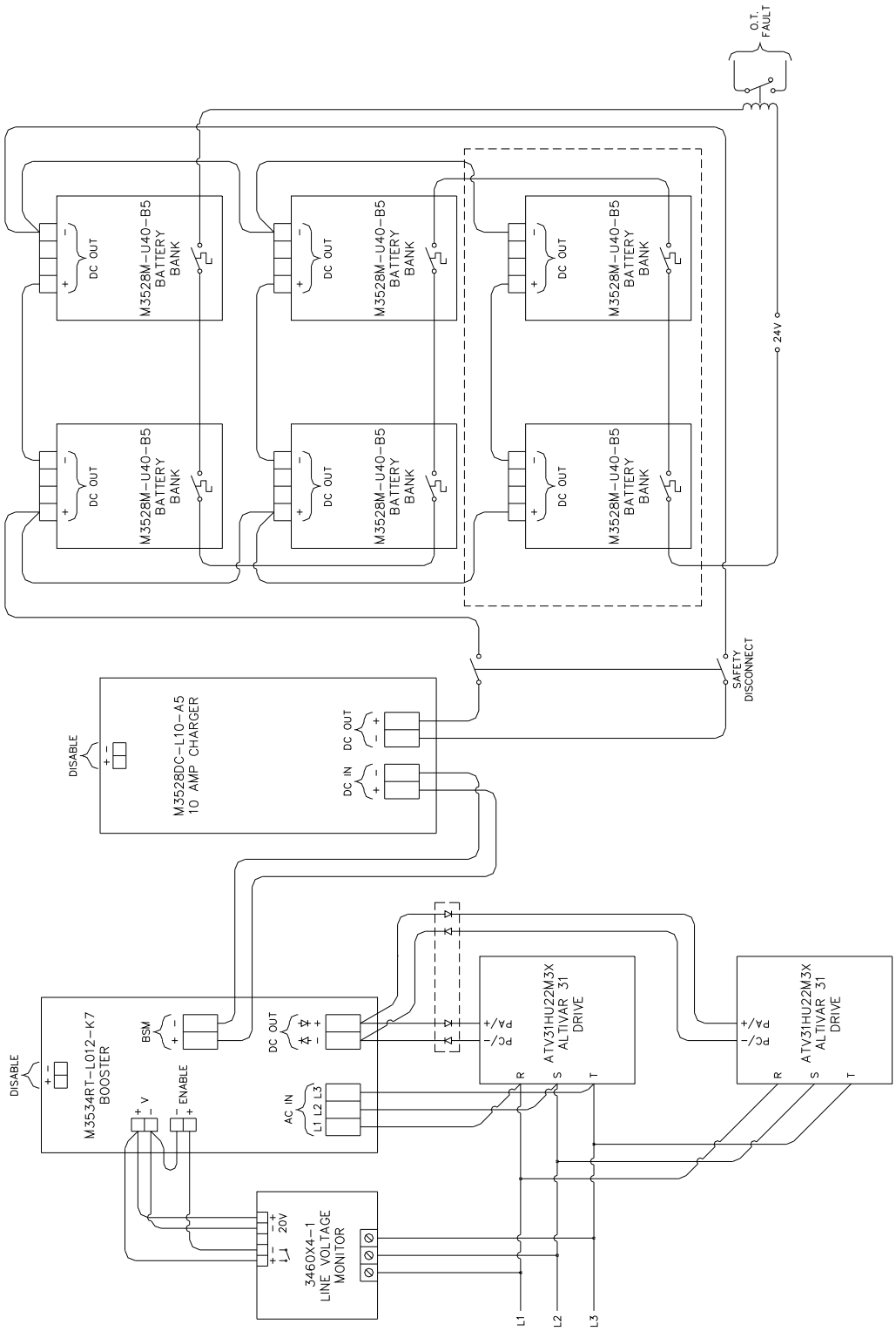
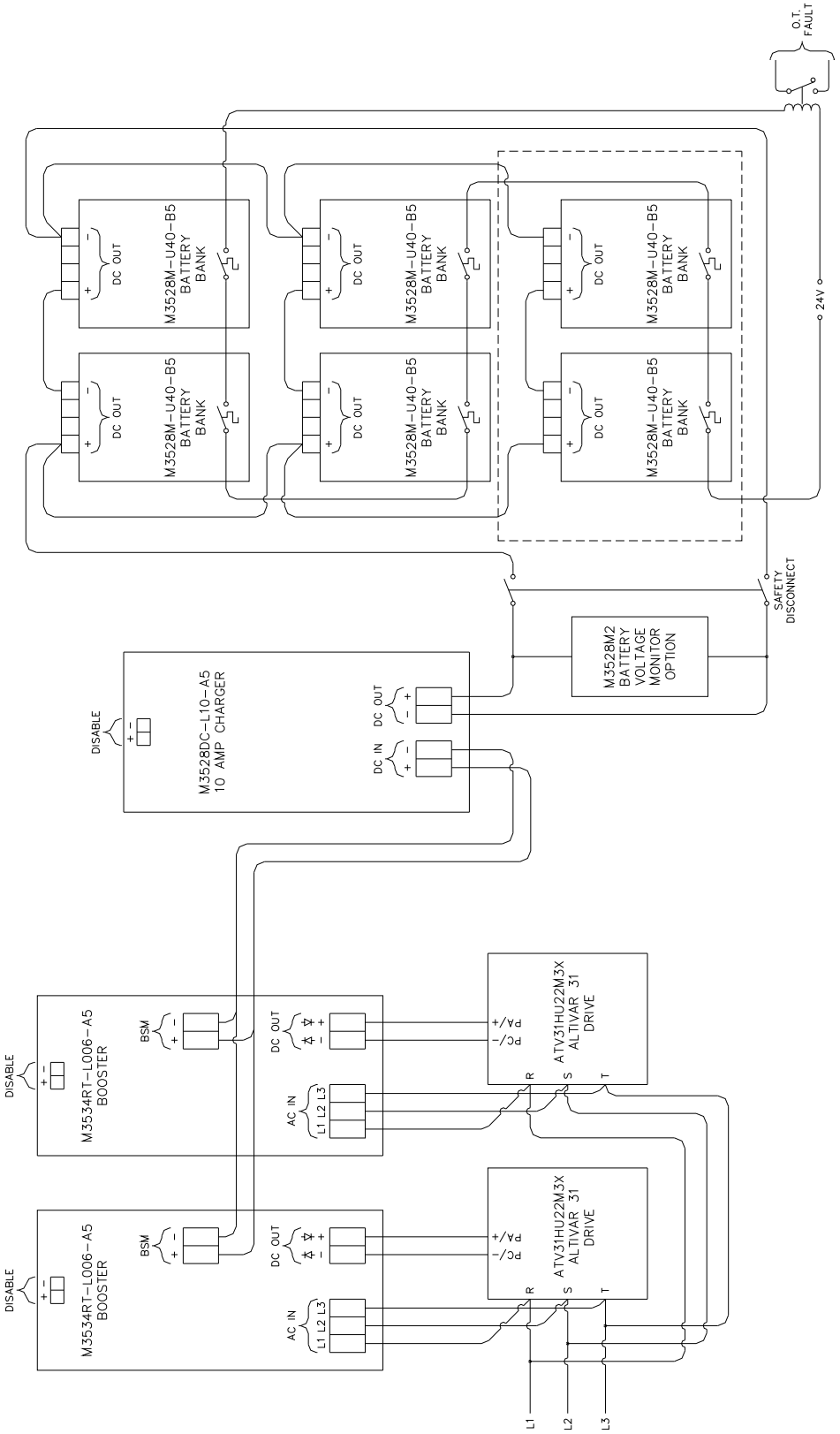


Figure 6-9: 10 Amp Typical DC Charger & Battery System with Dual Boosters



6.8. RECOMMENDED SPARE PARTS

SPARE PARTS LIST

PART NUMBER	PART DESCRIPTION	QUANTITY		
		M3528AC-X010	M3528DC-X010	M3528AC-X020
FN 3.6-24DC-62	3.6 inch 24VDC fan	**1**	**1**	
FN 4.7-24DC-120	4.7 inch 24VDC fan			**1**
FS A60Q15-2	15 amp 600V fuse	**5**		
FS A60-Q40-2	40 amp 600V fuse		**4**	
FS A60Q25-2	25 amp 600V fuse			**3**
FWP-25	25 amp 700V fuse			**2**

7. APPENDIX

7.1. APPLICATION NOTES

7.1.1. APPLICATION NOTES FOR CHOOSING BONITRON MODEL 3528 CHARGERS

Bonitron uses two basic model types of chargers, AC input or DC input:

The basic rule of thumb is that for M3534 Ride-Thru systems 24kW (32hp) and below connected to a single drive, the DC charger can be used. For M3460 systems or multi-drive / diode sharing set ups, the AC charger with voltage isolation is recommended.

* 10A charger TB5 and 20A charger TB6 are voltage outputs. The commons ARE connected to battery bank and drive neg DC bus. These should NOT be connected to any other power source and should only be used for local display purposes.

NON-ISOLATED OPERATION

The DC input chargers are designed for use with Model 3534 boosters. These 3534 boosters have an on board rectifier that can supply the charger input with power, and for single drive applications the energy can be taken back out from the storage bank, through the charger. Peak currents from the 32hp boosters are not enough to damage the internal charger rectifier diodes.

ISOLATED OPERATION

For larger hp applications the "AC charger" should be used along with an isolation transformer. The Ride-Thru system is basically a parallel device and there can be current flow from charger negative rectifier diodes, through booster, to drive. If we do not isolate or "soften up", the charger feed, the larger 3460 boosters will have current peaks much larger than the charger rectifier can handle.

7.1.2. APPLICATION NOTES WHEN USING OUTPUT DISCONNECT OR CONTACTOR

Basic rule of thumb when using output disconnects or contactors between charger and storage bank is DO NOT close contactor if voltage differential of charger output and storage bank is greater than 20% with batteries, or 10% with Ultracapacitors. See below for more detailed notes.

A safety disconnect should be used for battery storage banks because energy is ALWAYS present, but is not needed for ultracapacitor systems because energy can be drained.

7.1.3. BATTERY OPERATION

To avoid extreme surge currents when connecting battery bank to 10 amp unit, DO NOT connect battery bank to charger if the voltage differential between the charger and battery is greater than 20%.

If the charger is fed from a M3534R booster module, the booster internal capacitor will cause large peak currents when the battery is connected without power already applied to the charger. This may cause blown fuses or damage to charger.

The 20 amp charger model includes blocking diode before filter capacitor so battery may be connected first without causing high current levels.

RECOMMENDED POWER UP SEQUENCE FOR CHARGERS ON BATTERY SYSTEMS:

1. Power up charger and enable.
2. Set charger output voltage to equal recommended battery bank float charge voltage.
3. Connect battery bank.
   - Charging will commence upon connection to battery bank.
   - For 10 amp charger, connecting battery bank first may result in large peak currents from the battery, through the charger, to the booster filter caps.
   - For 20 amp charger, connecting battery bank first is OK.

7.1.4. 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. Basically it charges them to a higher than normal voltage, and then backs off when the battery is full. If charging to the float charge voltage as when using a 2 stage charger, the charge current will begin to drop off as the float charge voltage is approached, and because the charge power is decreased, the amount of time to get the full power into the battery is increased.

When in bulk charge mode the charging voltage target is increased so the full charge current will keep flowing longer, which keeps the full charge power going longer, which cuts down on the charge time. When the charge current begins to drop off, or when a certain time delay is reached, the charger leaves Bulk charge mode, and enters float charge mode, where the battery is maintained.

Bulk charge voltage is typically set for about 17-20% above the VRLA nominal voltage, and float charge is about 11-13% above the battery nominal voltage.

If the battery is kept at the Bulk charge level, it will overheat, emit hydrogen gasses, and dry up causing permanent damage.

Each Battery design may have a slightly different recommended Bulk charge voltage. Be sure to consult with battery manufacturer before using Bulk charge mode.

Bonitron Chargers have a separate Bulk charge/Equalize input so the customer has control over the bulk charge mode. Typical Ride Thru installations are not hard pressed for a fast recharge time and for that reason in general Bonitron does not use the bulk charge mode except for battery equalization.

7.1.5. ULTRACAPACITOR OPERATION

To avoid extreme surge currents when connecting the ultracapacitor bank to charger, DO NOT connect the capacitor if the voltage differential between the charger and the cap is greater than 10%.

Connecting a completely drained capacitor to a powered up and enabled charger will result in extremely high peak currents. This may cause blown fuses (if properly sized) or damage to charger.

RECOMMENDED POWER UP SEQUENCE FOR CHARGERS ON ULTRACAPACITOR SYSTEMS:

1. Power up charger and enable.
2. Set charger output voltage to equal recommended capacitor bank voltage.

3. Power down charger and allow voltage to drain below 50VDC.
4. Connect capacitor bank.
   - For 10 amp units, connecting already charged capacitor bank to powered down charger may result in blown fuses or damage to charger.
   - For 10 & 20 amp units, connecting a powered up and enabled charger to a discharged capacitor bank may result in blown fuses or damage to charger.
   - Cap may be disconnected while voltage is present, but should not be reconnected with a voltage differential of more than 10%.
5. Power up charger and enable.
   - Charging will commence upon power up and enable command.
   - Incoming power or enable can be removed and re-applied at any time during the charging cycle, so long as the charger and capacitor remain connected.

7.1.6. HOW TO CHOOSE A DISCHARGE SWITCH AND RESISTOR

Bonitron Ultracap discharge packages are based on the industrial standard of draining the energy storage bank down to below 50V in 1 minute. Discharge down to 15V will occur in less than 3 minutes.

- C = Capacitance in Farads
- V = Voltage
- R = Resistance
- J = Joules
- I = Current
- Capacitor banks are rated in voltage and Farads
- Resistors are rated in joules and peak voltage
- IGBT discharge switches are rated in voltage and peak current.

7.1.6.1. STEPS TO SIZING

1. Learn the specifications of the Ultracap storage bank
   a. Full charged voltage
   b. Capacitance

   Example: An ultracap bank with ten series 48V, 165F caps will have a bank voltage of 480VDC (48V x 10 series), and a total capacitance or 16.5 Farads (165F ÷ 10 series).
2. Figure joules stored
   a. ½ CV^2 = J
   b. .5 x 16.5F x $480V^2$ = 1.9 mega joules or 1900kjoules of energy stored
3. Choose resistor bank with more energy absorption than the cap bank stores
   a. Resistor bank M3628R-H2000 (2000kjoules) will be needed to handle 1.9mjoules
4. Match IGBT switch with 2000kjoule resistors
   a. See M3628R&T manual for more detail
      - Based on discharge to 50V in 1 minute
      - Based on 150-800VDC cap banks
   b. 300 amp rating will be needed to get 1.9mjoules bank down to 50VDC in 1 minute.

5. Choose resistor ohmic value to match IGBT peak current rating @ cap voltage level
   a. R = V ÷ I
   b. 480V ÷ 300 amps = 1.6 ohms
6. Select 2000kjoule resistor that is equal to or one size lower in ohmic value. In this case 1.5 ohms along with a 300 amp switch will drain a 1.9mjoules, 16.5F, 480VDC ultracap bank down to 50VDC in 1 minute.

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