

Model M3628PD
Portable Ultra Capacitor Discharge Controller

Customer Reference Manual

Bonitron, Inc.



An Industry Leader in AC Drive Systems and Industrial Electronics

OUR COMPANY

Bonitron Inc. is an industrial electronics and electrical systems design, engineering, and manufacturing company founded in 1962 and located in Nashville, Tennessee. Bonitron designs and manufactures custom and standard product modules and systems for industry with the highest possible degree of quality and reliability.

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

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

TALENTED PEOPLE MAKING GREAT PRODUCTS

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

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

AC DRIVE OPTIONS

In 1975, Bonitron began working with the AC inverter drive specialists at synthetic fiber plants to develop speed control systems that could be interfaced to their plant process computers. Since that time, Bonitron has developed AC drive option modules that help overcome many of the problems encountered in applications of modern AC variable frequency drives. Bonitron's Ride-Thru module provides protection from AC line voltage sags while the Line Regen and Resistive Braking modules provide DC Bus regulation for over-voltage due to regenerated voltage. Today, many drive system integrators use Bonitron AC drive option modules with their variable frequency drives.

WORLD CLASS PRODUCTS

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

Some Bonitron products include:

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

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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 with any Capacitive Energy Storage System.

Please keep this manual for future reference.

1.2. PURPOSE AND SCOPE

This manual is a user's guide for the Model M3628PD. It will provide the user with the necessary information to successfully install, integrate, and use the M3628PD in a Capacitive Energy Storage System.

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

1.3. MANUAL VERSION AND CHANGE RECORD

This is the original printing of this manual (Rev 00a).

Figure 1-1: Typical M3628PD Shown Closed

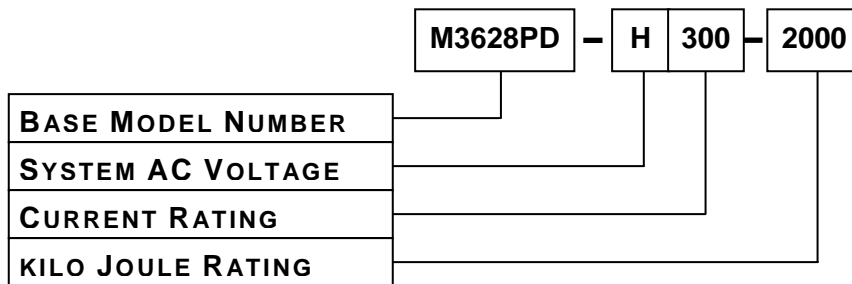


2. PRODUCT DESCRIPTION

The M3628PD portable discharger is designed to deplete energy stored in Ultra cap banks for industrial power use. The unit is self powered from the capacitor bus, or can be powered from the supplied 115vac line cord. (Recommended) This portable version contains the IGBT switch and resistor element, with 16' leads to the capacitor bus and an 18' power cord. The positive DC link is fused for safety. It is equipped with fans for cooling the resistor element, and is capable of a full discharge cycle every 15 minutes with the fans running. An annoying audible alarm is included so that the operator is kept aware that the unit is in discharge mode, thus decreasing the likelihood the unit is left "ON" when the power is re-applied to the capacitor bank. A voltmeter displays the DC voltage and provides indication the cap bank is discharging, and that the cabinet is safe for maintenance.

2.1. PART NUMBER BREAKDOWN

Figure 2-1: Example of Part Number Breakdown for M3628PD



BASE MODEL NUMBER

The Base Model Number for M3628 Portable Discharge Controllers is **M3628PD**.

SYSTEM AC VOLTAGE RATING

The System AC Voltage Rating indicates the voltage level needed to supply control power to the M3628PD. Voltage is indicated by a code letter. When 2 code letters are used, the voltage can be either. i.e. EH = 400 or 460.

Table 2-1: System Voltage Ratings

RATING CODE	AC SYSTEM VOLTAGE
U	115VAC
L	230VAC
E	400VAC
H	460VAC
C	575VAC

CURRENT RATING

The Current Rating is represented by a 3 digit code. i.e. the Current Rating Code for a 75 Amp unit would be 075.

KILO JOULE RATINGS

The Kilo Joule Rating indicates the maximum amount of energy the unit can handle in a single discharge cycle.

2.2. GENERAL SPECIFICATIONS

Table 2-2: General Specifications for M3628PD Models

PARAMETER	SPECIFICATION
Duty Cycle:	1 discharge @ rated joules every 15 minutes with fans running
Control Voltage:	24VDC derived from 115V plug
Cooling:	Internal 115VAC fans included
Storage Temp Range:	-20°C to +65°C
Operating Temp Range:	0°C to +40°C
Humidity:	95% non-condensing
Altitude:	3000 ft
Ratings	See Table 6-1

Table 2-3: Discharge System Specifications for 460VAC Systems

CURRENT RATING (AMPS)	TYPICAL VOLTS DC	PEAK AMPS	LOAD RESISTOR	MAX CAP BANK @ 600V	POWER SOAKING PER CYCLE	DISCHARGER DIMENSIONS W x H x D
75A	600	75	8 ohms	3 farads	540 kilo joule	28 x 27 x 22
150A	600	150	4 ohms	6 farads	1 mega joule	28 x 27 x 22
200A	600	200	3 ohms	8 farads	1.4 mega joule	28 x 27 x 22
300A	600	300	2 ohms	12 farads	2.1 mega joule	28 x 27 x 22
600A	600	600	1 ohm	24 farads	4.3 mega joule	48 x 30 x 22

2.3. GENERAL PRECAUTIONS AND SAFETY WARNINGS



DANGER!

- **HIGH VOLTAGES MAY BE PRESENT!**
- **NEVER ATTEMPT TO DISCHARGE A CAPACITOR WITH THE SYSTEM POWER ON! ALWAYS REMOVE SYSTEM POWER BEFORE DISCHARGING!**
- **NEVER ATTEMPT TO OPERATE THIS PRODUCT WITH THE PANELS REMOVED!**
- **NEVER ATTEMPT TO SERVICE THIS PRODUCT WITHOUT FIRST DISCONNECTING POWER TO AND FROM THE UNIT AND DISCONNECTING FROM THE CAPACITOR BANK!**
- **FAILURE TO HEED THESE WARNINGS MAY RESULT IN SERIOUS BODILY INJURY OR DEATH!**



CAUTION!

- **BEFORE ATTEMPTING INSTALLATION OR REMOVAL OF THIS PRODUCT, BE SURE TO REVIEW ALL DRIVE AND/OR RESISTIVE LOAD DOCUMENTATION FOR PERTINENT SAFETY PRECAUTIONS.**
- **INSTALLATION AND/OR REMOVAL OF THIS PRODUCT SHOULD ONLY BE ACCOMPLISHED BY A QUALIFIED ELECTRICIAN IN ACCORDANCE WITH NATIONAL ELECTRICAL CODE OR EQUIVALENT REGULATIONS.**

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

3. INSTALLATION INSTRUCTIONS

3.1. ENVIRONMENT

- M3628PD may be used in any environment where the Ultra capacitor is located.

3.2. UNPACKING

- Inspect shipping crate for physical damage.
 - Notify shipping carrier if damage is found.
- Open discharger top.
- Inspect interior of unit for damage.

Figure 3-1: Clip-on Caster Instructions



3.3. WIRING AND CUSTOMER CONNECTIONS

3.3.1. SYSTEM WIRING

3.3.1.1. CONTROL POWER

Cut cable ties securing power and DC wires. Unwind power cord and plug into 115VAC outlet.

3.3.1.2. DC POWER

Cut cable ties securing DC wires and 115VAC power cord. Unwind DC wires and plug into connectors in the Ultra Capacitor cabinet.

3.3.1.3. SOURCE CONSIDERATIONS

- DC source for a M3628PD system is an Ultra Capacitor bank.
- M3628 systems are sized with the goal of draining the Ultra Cap bank below 50V in approximately 1 minute.
- M3628PD Models are sized to voltage and joule rating of the Ultra Capacitor bank.
- AC source for 115V control power must be able to supply 1 amp.

3.3.1.4. GROUNDING REQUIREMENTS

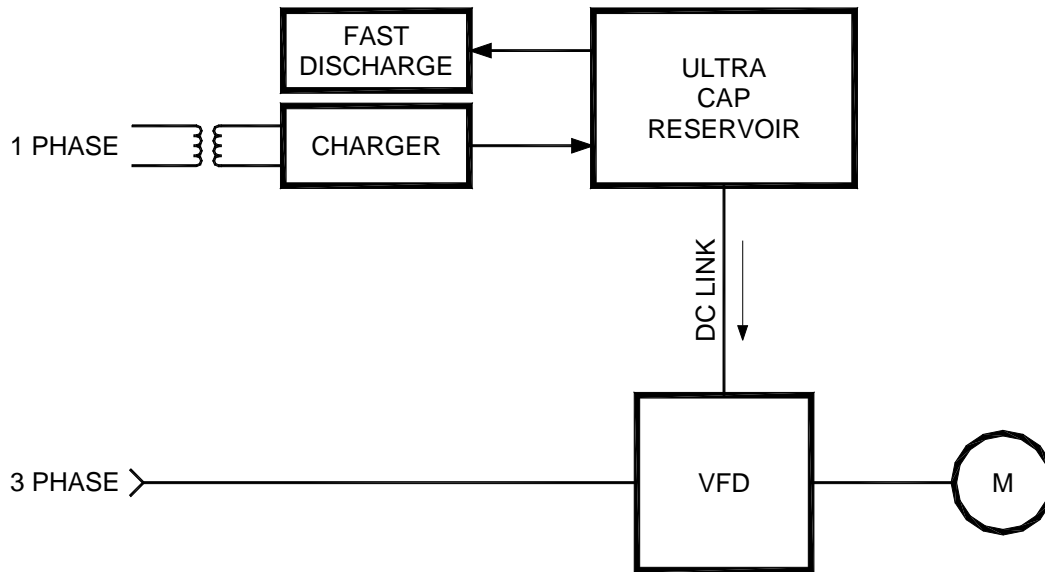
Earth Ground provided through 115VAC power cord.

3.3.2. CONTROL INTERFACE WIRING

There are no external control connections.

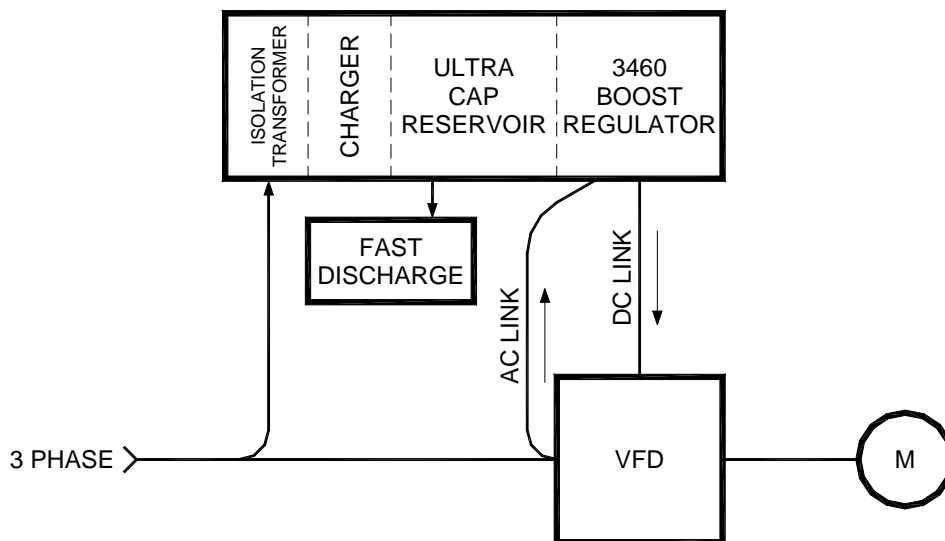
3.4. TYPICAL CONFIGURATION

Figure 3-2: Ride-Thru System Configuration 18



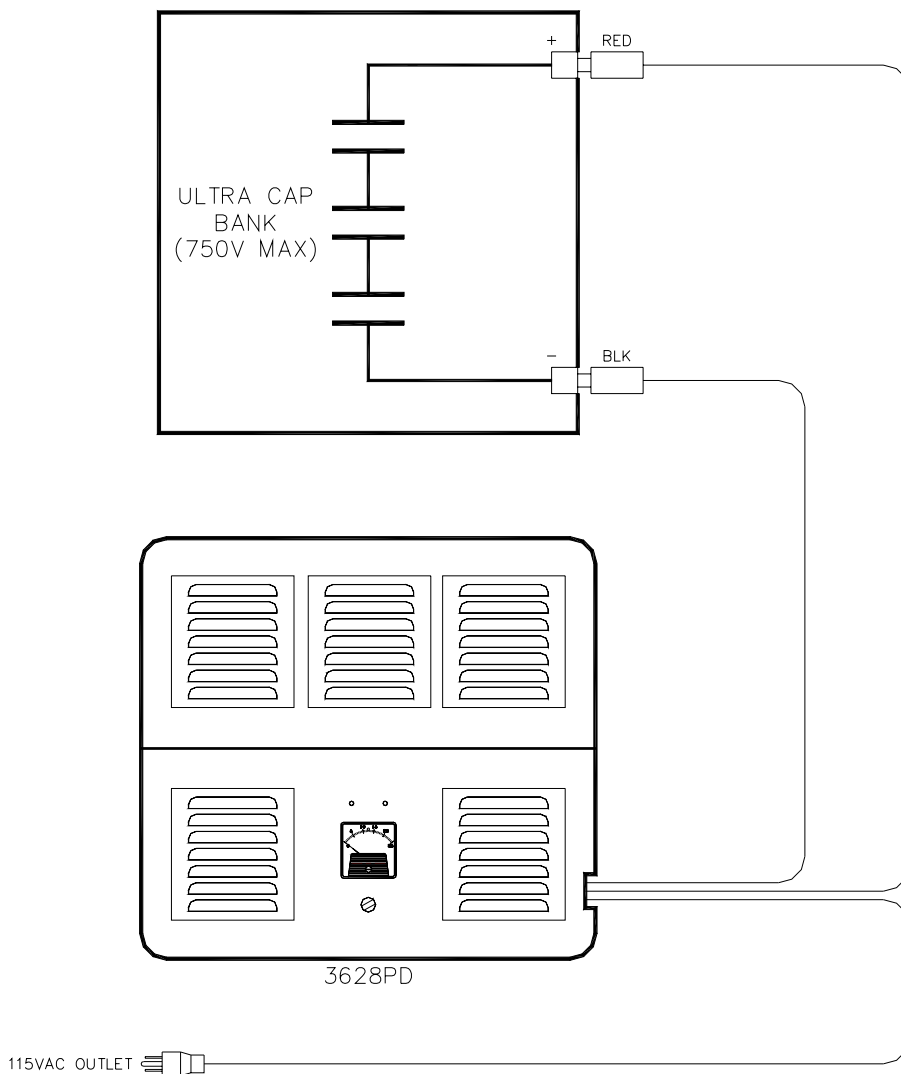
ABOVE 25KW, 0.5 - 2 SECOND, 100% OUTAGE PROTECTION
USING ULTRA CAP RESERVOIR
SINGLE CABINET POWERED FROM AC LINE

Figure 3-3: BPS Ride-Thru System Configuration 2



ABOVE 50KW, 0.5 - 2 SECOND, 100% OUTAGE PROTECTION
USING DC BOOSTER WITH ULTRA CAP RESERVOIR
SINGLE CABINET POWERED FROM AC LINE

Figure 3-4: Portable Discharge System Connections



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4. OPERATION

4.1. FUNCTIONAL DESCRIPTION

The M3628PD module is powered by plugging in the 115V line cord. Once powered, the DC LED will be on and the module is ready for operation. As the Red and Black 2 AWG wires are plugged into the charged capacitor bank, the internal voltmeter will display the bank voltage. When the discharge switch is placed in the "discharge" position, the active LED will turn on and the cap bank voltage will begin to decrease. Once the cap bank is completely drained, the discharge switch can be placed in the "cool" position until the exhaust air from the discharger is close to ambient room temperature.

4.2. FEATURES

- Ensures safety of maintenance crews
- 3 position DISCHARGE switch
- Over-Temp feedback contact for shut down
- Ability to abort drain cycle
- Self powered or 115VAC powered for overnight drainage
- LED indicators
- Clip on casters for easy movement and storage
- Voltmeter

See Section 7.1 for additional information.

4.2.1. INDICATORS

- DC Power – means DC bus is present. Intensity varies with bus level unless 115V power cord is plugged into hot outlet.
- ACTIVE – means IGBT switch has gate voltage.

4.2.2. BUS VOLTAGE

- 0-1mA 750V meter displays DC voltage.
 - Connected to red and black power leads.

4.2.3. CONTROLS

The portable discharge unit has an internal 3 position switch to control discharge:

DISCHARGE:

- The IGBT switch will turn on and connect the internal resistor across the Red and Black 2 AWG wires, draining energy out of whatever is connected.
- An audible alarm will indicate the unit is in DISCHARGE mode so that the user does not forget the unit is on when power is restored to the cap bank.
- The fans run to begin cooling of the resistor element.

OFF:

- The IGBT switch is turned off.
- The audible alarm is turned off.
- The fans do not run.

COOL:

- The IGBT switch is held off.
- The audible alarm is off.
- The fans run for continued cooling of the resistor element. Cooling back to room temperature may take up to 30 minutes after one full discharge cycle.

4.3. STARTUP

4.3.1. PRE-POWER CHECKS

- Ensure DC red and black wires are securely fastened to plug.
- Ensure DC bus polarity is correct.
- Plug power cord into hot 115VAC outlet.
- Cycle discharge switch and ensure ACTIVE LED comes on in DISCHARGE position **only**.
- Turn switch to **OFF** position.

4.3.2. DISCHARGE PROCEDURE



Applying enable with system power on can cause excessive heating in electronic switch and resistor bank due to prolonged availability of current! Unit is designed for 1 minute drain of properly sized storage bank.



*Ensure M3628PD switch is in the **OFF** or **COOL** position **BEFORE** connecting discharge cables to system. Connect cables one at a time, keeping one hand on the plug and the rest of your body away from any other potential or grounded surface. For additional safety, stand on insulated surface when connecting plugs.*

1. Remove AC power from system.
2. Turn switch to DISCHARGE position..
 - ACTIVE LED should illuminate.
 - Storage bus should begin to decrease in voltage.
 - Load resistor will begin to heat up.
 - In approximately 1 minute the storage bank voltage should be around 50V.
 - The M3628PD will continue to drain cap bank as long as the unit is in DISCHARGE mode.
3. If excessive heat is noticed, the discharge cycle can be aborted by turning the DISCHARGE switch to COOL position at any time during the discharge cycle.
 - Internal temp sensor will automatically shut down IGBT switch in case of over temperature.
4. When the DISCHARGE switch is unplugged, the bank will begin to slowly build up a residual charge. At this point a shorting bar, low amperage fuse, or low ohm resistor can be placed across capacitor terminals to keep residual charge from building.



If IGBT switch is connected to external 115VAC or 24VDC supply, module will keep load drained as long as DISCHARGE switch is in DISCHARGE position.

4.4. OPERATIONAL ADJUSTMENTS

None

4.5. CALIBRATION

If calibration of the voltage meter output is needed:

1. Remove cover to access the control PCB 3628D1.
2. Adjust R16 until meter reads accurately.
 - CW increases deflection.
 - CCW decreases deflection.

NOTE: Circuit is designed for 0 – 750V meter scale.

5. MAINTENANCE AND TROUBLESHOOTING

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

5.1. PERIODIC TESTING

None is required, although the M3628 units may be used to periodically test capacitor bank for storage capacity.

5.2. MAINTENANCE ITEMS

Set screws on superior plugs can become loose after repeated use. Check tightness before each use.

5.3. TROUBLESHOOTING

Table 5-1: Discharge System Troubleshooting

SYMPTOM	ACTION
Unit will not discharge storage reservoir	<ul style="list-style-type: none"> • Ensure switch is in the DISCHARGE position • Ensure storage bank is properly connected • Ensure DC POWER LED is ON <ul style="list-style-type: none"> • See NO DC POWER LED • Check temperature sensors for proper operation <ul style="list-style-type: none"> • See OVER-TEMP
Unit will not allow storage reservoir to charge	<ul style="list-style-type: none"> • Ensure switch is in the COOL or OFF position • Ensure gate lead connector is in place at TB3 on 3628D control pcb
No DC POWER LED	<ul style="list-style-type: none"> • Ensure power cord is plugged in to a hot 115VAC outlet • Check incoming DC POWER to be above 150VDC • Ensure DC POWER LED wires are properly terminated • Ensure all connectors are in place on 3628D control pcb • Check LED for proper operation
No ACTIVE LED	<ul style="list-style-type: none"> • Ensure switch is in the DISCHARGE position • Check Temp (See OVER-TEMP) • Ensure Enable LED wires are properly terminated • Ensure all connectors are in place on 3628D control pcb • Check IGBT gate for short • Check LED for proper operation
OVER-TEMP	<ul style="list-style-type: none"> • Measure temperature of box at rear of left side: <ul style="list-style-type: none"> • If above 50°C, allow time to cool • Replace sensor if temp is below 35°C

6. ENGINEERING DATA

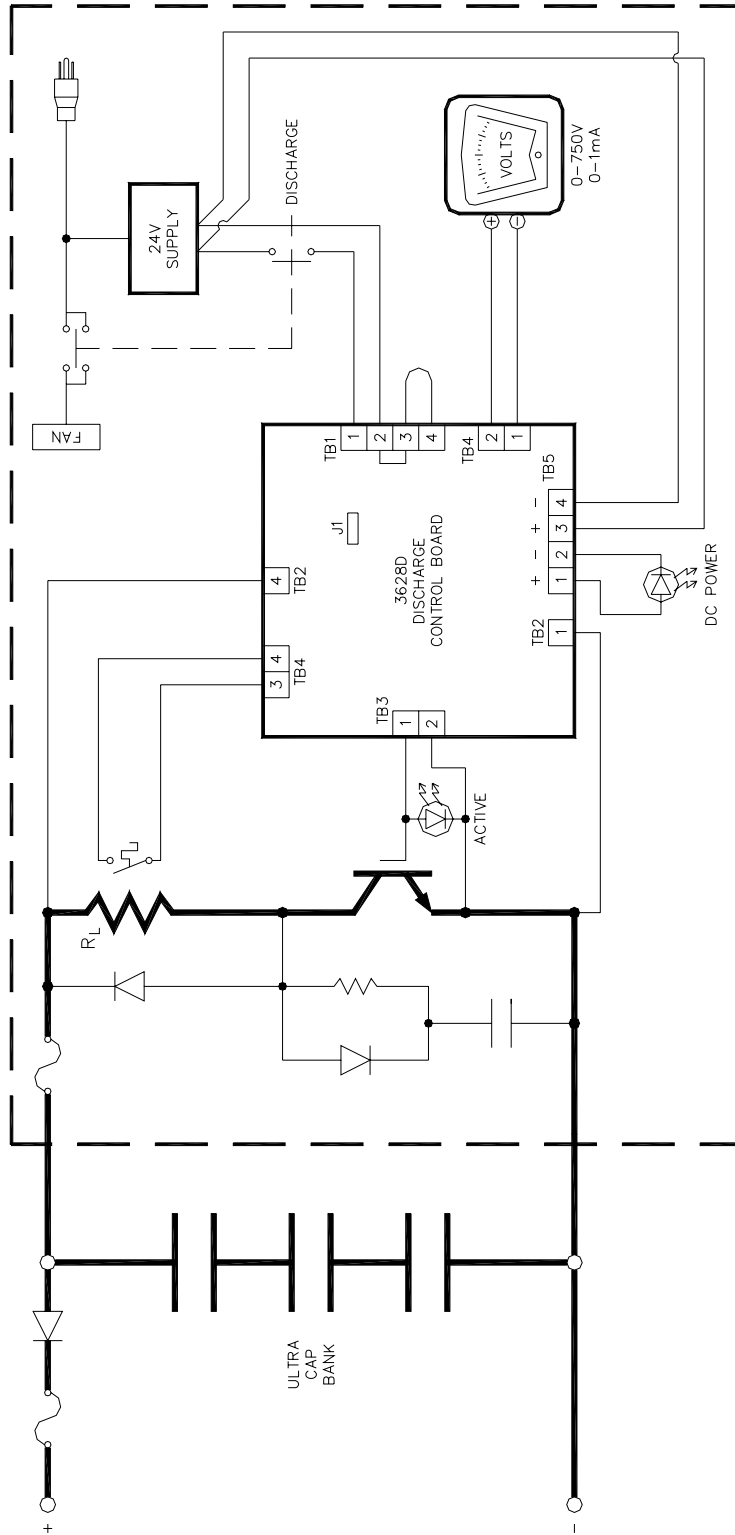
6.1. RATINGS CHARTS

Figure 6-1: Portable Modules for Ultra Capacitor Discharge

MODEL	SYSTEM AC VOLTAGE	CAP BANK				RESISTOR					
		VOLTAGE	FARADS	JOULES	PEAK CURRENT	PEAK POWER	RMS POWER	RESISTOR	SIZE	WEIGHT GOAL	
M3628PD-H300-2000	460	480	17	2,000	300	1440kW	52kW	HVR	28x27x19	150 lbs	
M3628PD-H1600-4000	460	585	23	4,000	600	3840kW	141kW	HVR	36x24x29	200 lbs	

6.4. BLOCK DIAGRAMS

Figure 6-3: 75-600A Fast Discharge Basic Schematic



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7. APPENDIX

7.1. APPLICATION NOTES

For many years batteries have been the primary source of stored energy to maintain equipment performance during power outage conditions. Batteries can store much energy, but have poor voltage regulation, and cannot be depleted of energy without damage to the battery itself. While voltage regulation problems can be solved using one of Bonitron's boost regulators, batteries must always retain their voltage, and as such high voltage banks remain a danger to maintenance personnel long after system power is removed.

Due to the changing nature of power disturbance protection, and the lowering cost of "Ultra Capacitor" cells, high voltage ultra capacitor packages are beginning to replace batteries for industrial energy storage needs. When used with a voltage boost regulator such as Bonitron's M3460 or M3534 series, 75% or more of the stored energy can be utilized making an Ultra Capacitor Ride-Thru system a cost effective, long term solution. Compared to electrolytic capacitors, ultra capacitors can store large amounts of energy in much smaller packages, making capacitance a suitable option for short term power loss requirements. One advantage ultra caps have over batteries is that ultra caps can be discharged to zero volts for safe shipping and safe maintenance. Since they are rated for 100k or more full discharge cycles, ultra caps are not only safer than batteries, they require no maintenance, and their life cycle is much longer.

BONITRON MODEL M3628 PORTABLE DISCHARGER SYSTEMS

Bonitron Ultra Cap discharge systems can be implemented in two ways. Each Ultra Cap cabinet system can have a permanently mounted IGBT switch, with the resistor inside the cabinet or outside. The main advantage to this method is the discharger is always on site, and immediately available for use. The disadvantages are that the cost to implement is high if the site has more than 3 cabinets, a separate 115VAC source is needed to keep the IGBT switch on for extended periods, and any failure of the discharge switch or enable signal can result in overheating the cabinet, or overloading the system.

Option 2 is to add connectors in each cabinet and use a portable discharge unit. The advantages are: a lower cost to implement if there are more than 3 cabinets on site, there is no danger of overheating the Ultra Cap system cabinet, and an external 115VAC supply can be used for permanent power to the IGBT switch. The disadvantages are local codes may not allow opening the cabinet until AFTER the voltage is drained, the portable unit takes up storage space, and the unit must be found after a couple years of storage..

BONITRON MODEL M3528 CHARGER SYSTEMS

Bonitron Model 3528 Charger is designed to increase the life of an ultra capacitor bank. Ultra capacitors must be charged under controlled conditions to limit the rate of energy transfer. They are diode isolated from the DC bus to avoid excessive ripple and damage from over voltage.

M3528 is a charger for any system using ultra capacitors or batteries. M3528 provides a constant charge current to an electrical energy storage bank until it reaches max voltage set-point. Once maximum voltage is reached, the charger cuts back to maintain bank voltage, keeping it at optimum state and ready for use.

Charging current is adjustable between 2 - 20 amps for 10 Amp, or 4 - 20 amps for 20 Amp, while maximum voltage is adjustable between 300 and 650VDC. Charging and discharging is automatic. The charger is available in DC or AC input models.

M3528DC is a charger for system current ratings under 40 amps. The charger may use energy from the existing equipments DC bus to charge the caps, and then will allow energy to come back during power loss condition for simple 2 wire connection.

M3528AC is a charger for system current rating over 40 amps. The charger must use an isolation transformer and capacitor bank must be diode coupled to the drive DC bus to prevent drive bus energy from reaching the caps or charger.

CONCLUSION:

To make best use of high voltage ultra capacitor products, an electronic controller (M3528) should be used to control charge and limit voltage level to caps.

To make the system safe for maintenance, an electronic discharger (M3628) is needed to bring the cap bank voltage down below 50V in a reasonable time period.

To better leverage capacitor storage energy making a complete ultra capacitor system less expensive and smaller in size, adding a voltage boost regulator (M3534 or M3460) should be considered.
