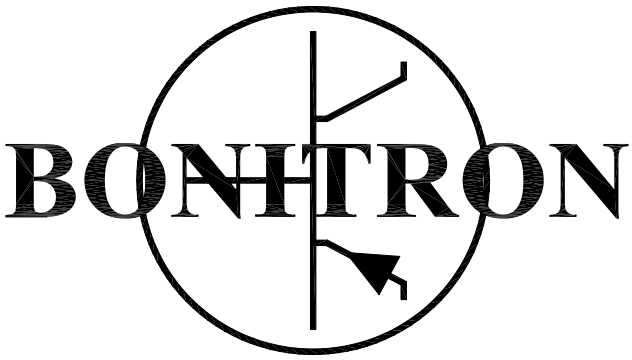


Model M3628PCT
Portable Capacitor Tester

Customer Reference Manual

TEL. (615) 244-2825 • FAX (615) 244-2833 • www.bonitron.com

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 our 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

Table of Contents

1. INTRODUCTION

1.1. WHO SHOULD USE

This manual is intended for use by trained personnel responsible for maintaining or testing capacitor banks.

Please keep this manual for future reference.

1.2. PURPOSE AND SCOPE

This manual is a user's guide for the Model M3628PCT. It will provide the user with the necessary information to successfully connect and operate the M3628PCT.

In the event of any conflict between this document and any publication and/or documentation related to any associated hardware (capacitor bank, etc.), the latter shall have precedence.

1.3. MANUAL VERSION AND CHANGE RECORD

Rev00b corrects formatting and verbiage.

Figure 1-1: M3628PCT

2. PRODUCT DESCRIPTION / FEATURES

The M3628PCT is designed for testing of capacitor banks. Electrolytic capacitors undergo physical changes when stored for long periods. Depending on the ambient conditions of the storage, this can be from six months to two years. If the capacitors are rapidly taken to their rated voltage, excessive leakage current may cause them to overheat and fail.

As capacitors age and wear, their internal chemistries change, leading to changes in their capacitance. It is important to be able to measure this capacitance, and thus estimate the remaining useful life of your capacitor bank.

The Bonitron M3628PCT is a portable digitally-controlled capacitor tester. The digital display allows the user to charge a capacitor bank to a specified voltage, and then discharge the bank. The display will then show the calculated capacitance of the bank. This product may be used for many purposes, including charging, discharging and forming of capacitors, as well as serving general DC power needs.

2.1. RELATED PRODUCTS

M3528 ULTRA CAPACITOR/ BATTERY CHARGER

The M3528 Charger can charge strings of batteries or Ultra Capacitors to voltages required for industrial and commercial applications. AC or DC input is available, along with separate float and equalization charge levels. The charger is current limited, and designed for use in integrated storage and backup systems, but can also be used in bench or mobile systems.

M3628 ULTRA CAPACITOR DISCHARGE CONTROLLER

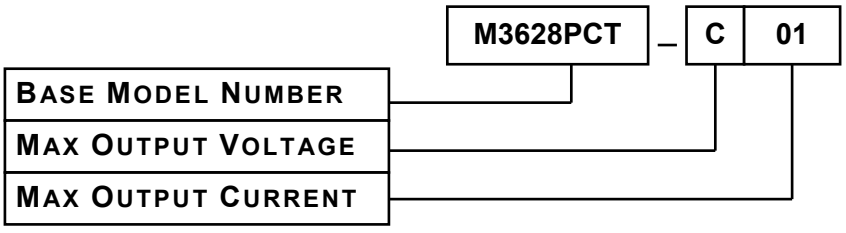
Large capacitor banks store huge amounts of energy, and can be a hazard when systems are shut down for system maintenance. The M3628 system discharges capacitor banks to safe working levels quickly, allowing work on the system to begin in seconds, rather than hours.

M3628PCF PORTABLE CAPACITOR FORMER

The M3628 Portable Capacitor Former can be used to charge or discharge capacitor banks as large as 50 kJ. The output voltage is manually variable between 0 and 800 VDC, and the system is capable of supplying 1 ADC continuously. The unit can also be used for reforming disused capacitors.

2.2. PART NUMBER BREAKDOWN

Figure 2-1: Example of Part Number Breakdown



BASE MODEL NUMBER

The Base Model Number for all Portable Capacitor Testers is M3628PCT.

MAX OUTPUT VOLTAGE RATING

The Max Output Voltage Rating indicates the maximum DC output voltage the unit can supply. The Max Output Voltage is indicated by a code letter.

Table 2-1: Max Output Voltage

RATING CODE	VOLTAGES (DC VOLTAGE OUTPUT)
U	163VDC out
L	325VDC out
E	565VDC out
H	650VDC out
C	810VDC out

MAX OUTPUT VOLTAGE RATING

The Max Output Current rating indicates the maximum DC current the unit can supply at its maximum voltage.

2.3. GENERAL SPECIFICATIONS

Table 2-2: General Specifications Table

PARAMETER	SPECIFICATION
Input Voltage	110-120VAC 1∅
Output Voltage	0-800VDC
Output Current	0-1.3ADC
Minimum Load Capacitance	2,200 µF
Maximum Load Capacitance	1 Farad
Maximum Discharging Time	20 minutes
Controls	Four display soft keys Immediate Discharge button
Display	Four line, eighty character LCD (4x20)
Unit Size (H x W x D)	22" x 18" x 10.5"
Weight	50 lbs.
Storage Temp	-20°C to + 65°C
Humidity	Below 90% non-condensing
Atmosphere	Free of corrosive gas and conductive dust

2.4. General Precautions and Safety Warnings

ELECTROCUTION HAZARD!

- **This unit produces voltages capable of causing injury or death!**
- **For use by qualified and trained personnel only!**
- **IMPROPER OPERATION OF THE PRODUCT OR IGNORING THESE WARNINGS MAY RESULT IN SERIOUS BODILY INJURY OR DEATH!**
- **Before connecting the M3628PCT to a capacitor bank, ensure that the bank is fully discharged by checking with a voltmeter.**
- **Connecting the M3628PCT's voltage output to a load with the polarity reversed can cause damage to your equipment and potentially create a fire or explosion hazard, threatening lives. Ensure that the positive and negative terminals on both the source and load are positively identified and correctly connected before operation.**
- **Never operate this product with the enclosure cover removed.**

DANGER!

- **Never attempt to service this product.**
- **Certain parts inside this product may get hot during operation.**
- **Before connecting this device to any other product, be sure to review all documentation of that product for pertinent safety precautions.**

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

3. INSTALLATION INSTRUCTIONS

3.1. ENVIRONMENT

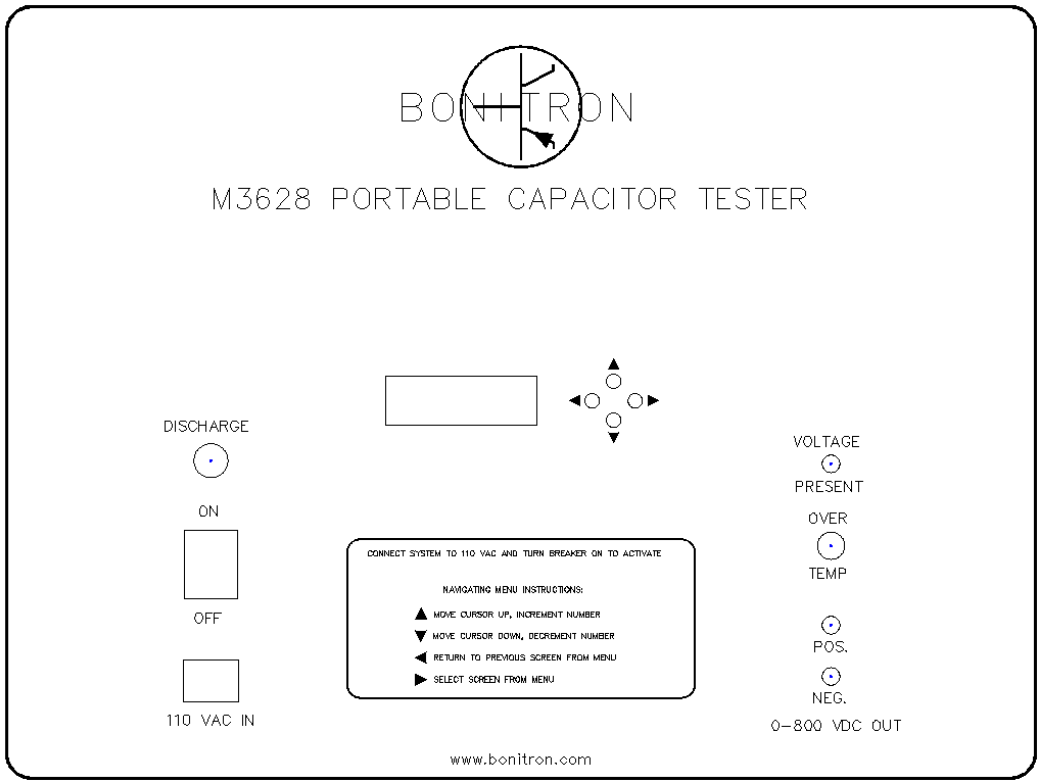
While closed, the M3628PCT is water, dust, and crush resistant. When open and in operation, the unit should be used only in dry, clean areas. Ensure that the interior of the unit casing is kept dry.

3.2. WIRING AND CUSTOMER CONNECTIONS

3.2.1. POWER WIRING

The Power Input connector accepts 50-60Hz 110VAC from the included standard C13 power cable. The DC Output connectors supply DC voltage at the user-selected level via a pair of banana connectors. Output leads can be constructed as needed.
The unit should be powered ON before connecting to a load, as the unit is in discharge mode when powered off.

Figure 3-1: M3628PCT



3.2.2. SOURCE CONSIDERATIONS

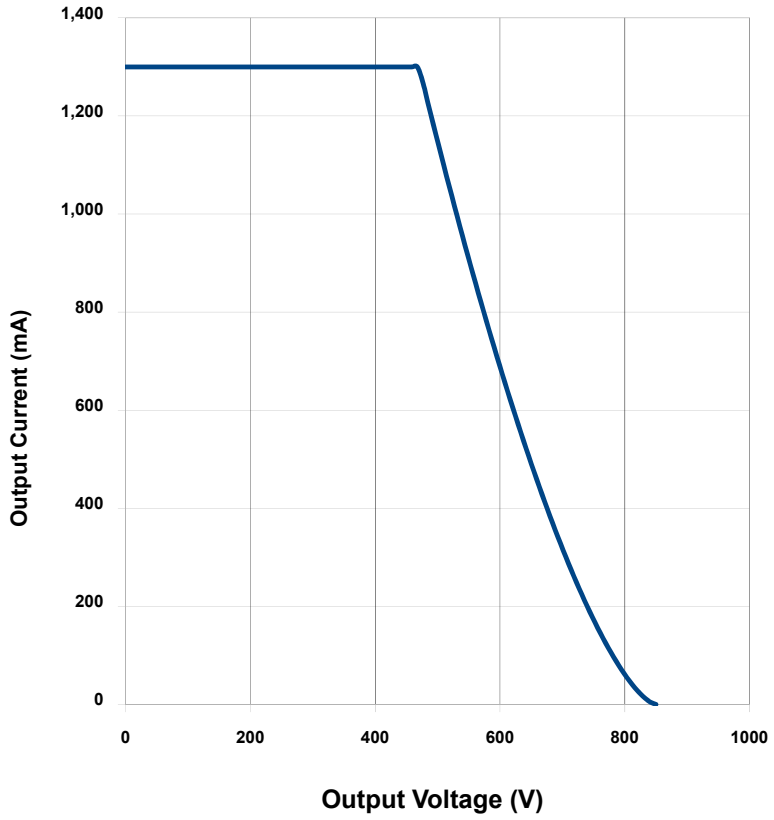
Input voltage should not exceed 120VAC or damage to the unit may result. The source must be capable of supplying at least six (6) amps to guarantee correct system operation at all output voltages.

4. OPERATION

4.1. FUNCTIONAL DESCRIPTION

The M3628PCT is a digitally controlled DC supply capable of sourcing up to 1.3A at between 0 and 800VDC. Actual available charge current depends on load voltage (see Figure 4-1). The unit is powered by standard 50-60 Hz 110-120 VAC. The output voltage is controlled by the digital display panel on the front of the unit. The unit is capable of safely charging and discharging connected capacitors. It is also capable of executing a pre-programmed forming profile, with defined step voltages and hold times. When a capacitor bank is discharged, the unit will calculate and display the capacitance of the bank. An Immediate Discharge button is present in case of accidental overvoltage and the unit automatically enters discharge mode when powered off.

Figure 4-1: Max Current past 450V ≈ 2875 - 3.6Vc mA



4.2. FEATURES

4.2.1. HARDWARE

4.2.1.1. AC POWER INPUT CONNECTOR

The M3628PCT is equipped with a standard IEC C14 connector for input power. This connector mates with a standard C13 cable, commonly used with desktop computers, to provide power to the unit.

4.2.1.2. DC OUTPUT CONNECTORS

Two banana jacks provide the user with DC output voltage between 0 and 800VDC. These connectors accept standard 4mm banana plugs.

4.2.1.3. DISPLAY

The digital display presents the user with information about the present status of the system, including the output voltage and current. The display also presents the user with options to control system operation, including charging and discharging attached capacitors.

4.2.1.4. DIRECTIONAL BUTTONS

Each of the four buttons corresponds to a direction, up, down, left or right. Right frequently moves to a screen selected on a menu, and left frequently moves back to the previous screen, while up and down move the cursor among menu items. On screens where numbers are input by the user, the left and right buttons move the cursor, while the up and down buttons change the selected digits. On some screens, certain buttons may have no function at all.

4.2.1.5. IMMEDIATE DISCHARGE BUTTON

There is an Immediate Discharge button on the face of the unit. This button will cause the system to immediately switch to discharge mode, regardless of the present system activity. In the event the unit is accidentally set to charge to a higher voltage than is safe for one load, this button should be pressed immediately.

4.2.1.6. VOLTAGE PRESENT INDICATOR

WARNING!

Do not use this light as an indication that the output is safe to work on! Always check the output with a working voltmeter before servicing equipment, as the lamp may be malfunctioning!

ELECTROCUTION HAZARD! *This unit produces dangerous levels of voltage that can cause injury or death. Always follow safety protocols when working with high voltages!*

A red light indicates that there is voltage on the DC output of the unit. Do not touch the output connectors or the attached equipment while this light is on, as electric shock will result.

4.2.1.7. OVER TEMPERATURE INDICATOR

A yellow light indicates that the internal case temperature has risen too high for safe operation. Leave the system connected to power and the load, and wait for the light to clear. This may take up to half an hour. For very large capacitors, this light may turn on during charging. Let the unit cool and charging will resume.

4.2.1.8. POWER SWITCH / CIRCUIT BREAKER

The Power Switch also acts as a circuit breaker to protect from overload conditions. If the breaker is tripped, you can reset it by simply turning the switch back on.

4.2.2. SCREENS & MENU NAVIGATION

Many screens are menus allowing access to other screens, or lists presenting a number of options. The presently selected item on the menu is indicated by a '>' cursor. This selection indicator is moved using the *up* and *down* buttons. If a line on the menu represents another screen, that screen is accessed with the *right* button. The *left* button will return the display to the parent screen. See Figure 4-3.

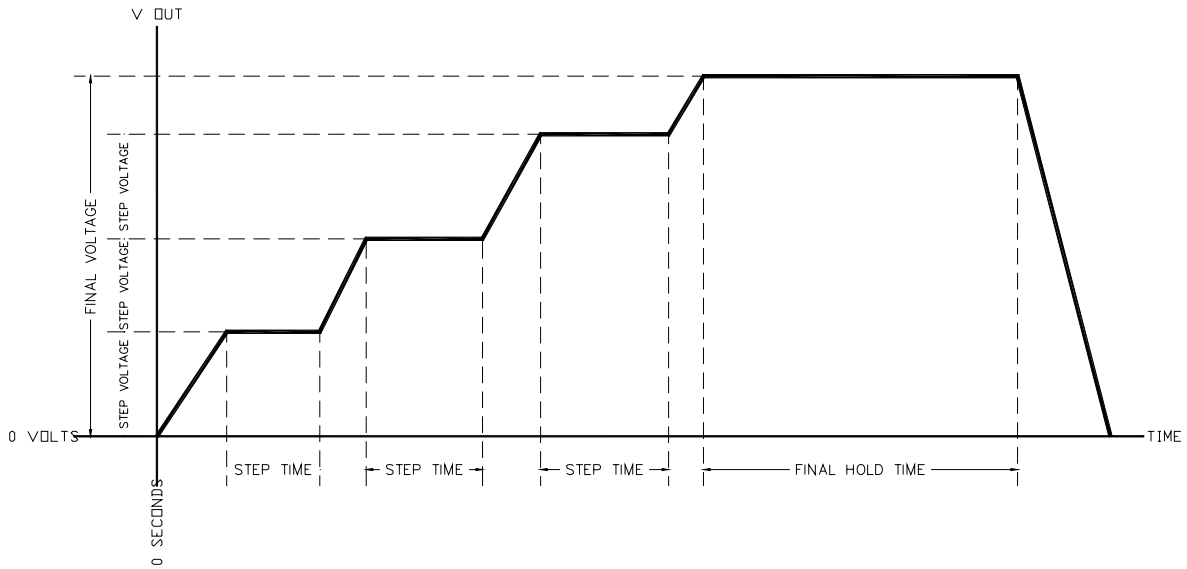
4.2.2.1. MAIN MENU

The Charge menu, Discharge Confirmation screen, and previous measurement Results may be accessed from the Main Menu.

4.2.2.1.1. CHARGING PROFILE

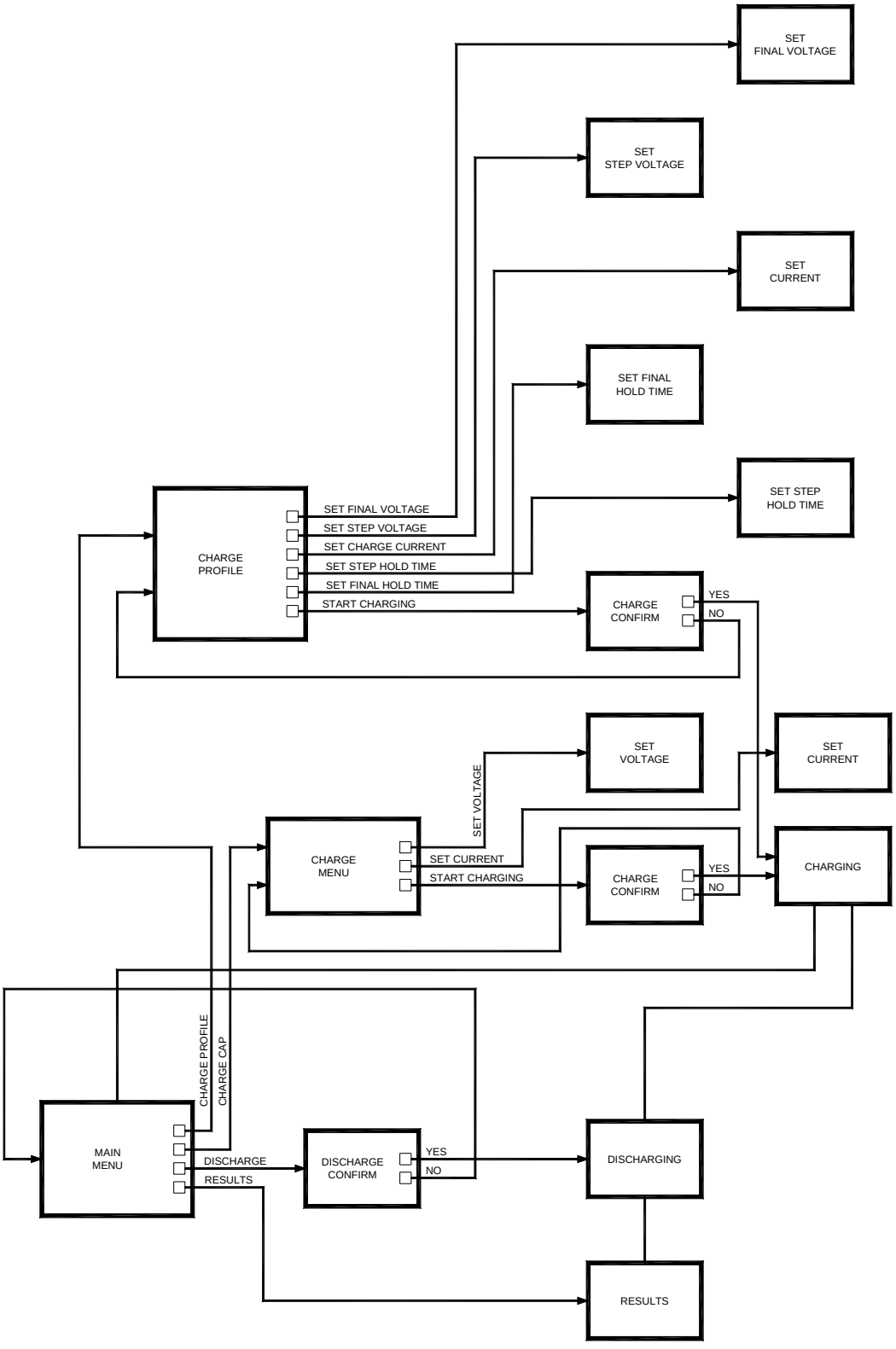
From the Charge Menu, the user may input the variables necessary to execute an automatic reforming profile. A reforming profile charges the capacitor in steps, each step a specified voltage apart. When each step voltage is reached, the load is held at that voltage for a specified number of seconds before charging to the next step voltage. When the final voltage is reached, the load is held at that voltage for a specified number of seconds before discharging. Voltage setpoints may vary by up to ±5V. See Figure 4-2.

Figure 4-2: M3628PCT Charging Profile



Dwg #: 090115 Rev: 20090421

Figure 4-3: M3628PCT Interface Screen Tree



4.2.2.1.1.1. SET FINAL VOLTAGE

From this screen the user may set the final voltage they wish to charge the load to. The right and left buttons control which digit is presently being edited, and the up and down buttons increment or decrement that digit. Pressing left on the leftmost digit will exit this screen and save the voltage.

4.2.2.1.1.2. SET STEP VOLTAGE

From this screen the user may set the voltage step by which the load will approach the final voltage. The right and left buttons control which digit is presently being edited, and the up and down buttons increment or decrement that digit. Pressing left on the leftmost digit will exit this screen and save the voltage.

4.2.2.1.1.3. SET CURRENT

From this screen the user may set the maximum current with which they wish to charge the load. The *right* and *left* buttons control which digit is presently being edited, and the *up* and *down* buttons increment or decrement that digit. Pressing left on the leftmost digit will exit this screen and save the voltage.

4.2.2.1.1.4. SET STEP HOLD TIME

From this screen the user may set the number of seconds each step voltage will be held. The right and left buttons control which digit is presently being edited, and the up and down buttons increment or decrement that digit. Pressing left on the leftmost digit will exit this screen and save the voltage.

4.2.2.1.1.5. SET FINAL HOLD TIME

From this screen the user may set the number of seconds the final voltage will be held. The right and left buttons control which digit is presently being edited, and the up and down buttons increment or decrement that digit. Pressing left on the leftmost digit will exit this screen and save the voltage.

4.2.2.1.1.6. CHARGE CONFIRM

At this screen the user is asked to confirm the charge voltage and current, and begin charging the output.

4.2.2.1.1.6.1. CHARGING

This screen displays the present output voltage and current. It transitions to the "Discharging" screen (4.2.2.1.3.1.) when the output voltage reaches the set point and is held for the specified number of seconds. Charging may be aborted by pressing any of the four directional buttons.

4.2.2.1.2. CHARGE MENU

The user may set the charge voltage and current, and initiate charging from here.

4.2.2.1.2.1. SET VOLTAGE

From this screen the user may set the voltage they wish to charge the load to. The right and left buttons control which digit is presently being edited, and the up and down buttons increment or decrement that digit. Pressing left on the leftmost digit will exit this screen and save the voltage.

4.2.2.1.2.2. SET CURRENT

From this screen the user may set the maximum current with which they wish to charge the load. The *right* and *left* buttons control which digit is presently being edited, and the *up* and *down* buttons increment or decrement that digit. Pressing *left* on the leftmost digit will exit this screen and save the current.

4.2.2.1.2.3. CHARGE CONFIRM

At this screen, the user is asked to confirm the charge voltage and current, and begin charging the load.

4.2.2.1.2.3.1. CHARGING

This screen displays the present output voltage and current. It transitions to the Voltage screen (4.2.2.2) when the output voltage reaches the set point. Charging may be aborted by pressing any of the four directional buttons.

4.2.2.1.3. DISCHARGE CONFIRM

At this screen the user is asked to confirm their intent to discharge the capacitor bank. If the user confirms, the capacitor starts discharging, until the load voltage reaches 20VDC. The time the capacitor takes to discharge to half of its starting voltage is measured, and from this value the load capacitance is calculated.

4.2.2.1.3.1. DISCHARGING

This screen displays the present output voltage and discharge current. It transitions to the "Results" screen when the output voltage reaches 20VDC.

4.2.2.1.4. RESULTS

This screen presents the user with the results of the previous capacitor discharge and measurement.

4.2.2.2. VOLTAGE

If the system is idle and no button is pressed for fifteen seconds, the system will transition to this screen, displaying the present load voltage and leakage current. Pressing left or right will transition back to the main menu.

4.2.2.3. CALIBRATE

From this menu, calibration points may be viewed, added, modified, or deleted, and the maximum value expected on each input channel can be set.

To access the calibration menu from the configuration menu, press *up* and *down* simultaneously, and while holding them, press *right*.

WARNING!

This menu should not be accessed except by a Bonitron-trained service technician! Altering calibration data may render your display system inoperable without service!

4.2.2.3.1. ADD CALIBRATION POINT

From this screen the user may add a calibration point to any analog input channel. First, the user must select an input channel to add the point to, using the up and down buttons to scroll through the list and the right button to make a selection. Then the user must input the value that should be displayed given the present input to the system. The values are set one digit at a time, using the left and right buttons to select a digit, and the up and down buttons to change the value of the currently selected digit. Exit the screen by pressing left when the cursor is pointing at the leftmost digit. Changes are automatically saved, indicated by the confirmation screen which briefly appears.

4.2.2.3.2. MODIFY CALIBRATION POINT

From this screen the user may list all existing calibration points, and modify any of them desired. First, the user must select an input channel, using the *up* and *down* buttons to scroll through the list and the *right* button to make a selection. Existing points will be listed, in terms of internal values in "engineering units" (numbers between 0 and 4095 correlating to the full input range) and output values. The user may scroll up and down through this list to view all points. Selecting a point transitions to a screen where the user may modify that calibration point one digit at a time, using the *left* and *right* buttons to select a digit, and the *up* and *down* buttons to change the value of the currently selected digit. The user may exit the screen by pressing left when the cursor is pointing at the leftmost digit. Changes are automatically saved.

4.2.2.3.3. ERASE CALIBRATION POINT

From this screen the user may list all existing calibration points, and erase any of them desired. First, the user must select an input channel, using the *up* and *down* buttons to scroll through the list and the *right* button to make a selection. If any calibration points have been added to that channel, those points will be listed, in terms of internal and output values. The user may scroll up and down through this list to view all points. Selecting a point takes the user to a confirmation screen. If the user confirms this decision, the point is removed from memory.

4.2.2.3.4. CLEAR ALL CALIBRATION DATA

From this screen the user may clear all calibration data from all channels. Every calibration point stored will be deleted if this option is selected and confirmed.

4.2.2.3.5. SET MAXIMUM ANALOG VALUE

From this screen the user may set the maximum expected input value in volts or amps for each input channel. This is used in calculating the range of values displayed by the bar graphs.

5. TROUBLESHOOTING

If a problem occurs on start-up or during normal operation, refer to the problems described below. If a problem persists after following the steps below, contact the product supplier or your system integrator for assistance.

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.

Table 5-1: Troubleshooting

Display never comes on	• Ensure that the input power cable is connected firmly to the unit and to a functioning 110VAC power source. • If both connections and the power supply are good, make sure the input circuit breaker has not tripped.
Output voltage never rises above zero while charging	• Check the connections between the unit and the load, making sure that the connection is solid and that the polarity is correct. • Check the output voltage with a separate voltage meter; if voltage is present, the internal circuitry may need service. Consult Bonitron for service options.
Display shows no output current while charging	• Check the output connections to make sure there is good contact. • Make sure there is voltage at the output terminals.
Load capacitor takes a long time to charge/discharge	• Check the connections between the unit and the load, making sure that the connection is solid and that the polarity is correct. • Large loads may take a long time to charge or discharge (such as a load in excess of 1 Farad). • Excessively leaky loads may not be able to reach the full 800V range. • Make sure the charging current is not set to a very low value. **SEE WARNING BELOW!**
Red voltage present light is ON	• The voltage present light indicates that there is voltage between the output terminals of the unit. If the display indicates that no voltage is present, contact Bonitron.
Red voltage present light never turns on regardless of output voltage	• Check the output voltage with a separate voltmeter. If the voltage is above 50VDC, your unit may require service. Contact Bonitron.

WARNING!

Always monitor the output voltage while operating the unit. Ensure that the attached loads do not exceed their rated voltage, as catastrophic damage, injury, or death may occur.

6. ENGINEERING DATA

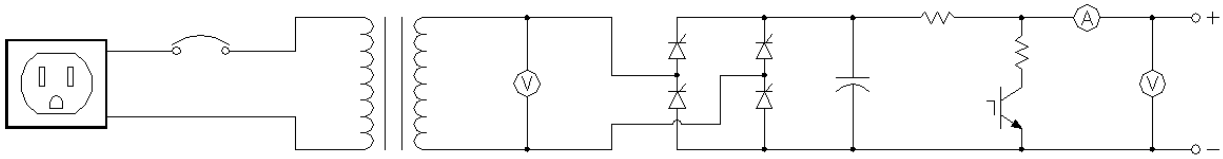
6.1. RATINGS CHART

Table 6-1: Ratings Chart

Input Voltage	110 - 120VAC
Output Voltage	0 - 800VDC
Output Current	0 - 1300mA
Output Resistor	120 Ohm
Discharge Resistor	240 Ohm
Isolation Transformer	1 kVA

6.2. DIMENSIONAL DRAWING

6.3. BLOCK DIAGRAM



7.

APPENDIX

7.1. APPLICATION NOTES

7.1.1. TYPICAL CAPACITOR BANK FORMING / TESTING PROCEDURE

Electrolytic capacitors undergo physical changes when stored for long periods. Depending on the ambient conditions of the storage, this can be from six months to two years. If the capacitors are rapidly taken to their rated voltage, excessive leakage current may cause them to overheat and fail.

Electrolytic capacitors also undergo physical and chemical changes after long periods of use. If wear continues, these capacitors can fail, potentially causing catastrophic damage. Capacitor lifetime is heavily dependent on use and ambient conditions, and thus impossible to predict. Periodically measuring the capacitance of a bank can help quantify the wear on and remaining lifetime of the capacitors, helping avoid catastrophic failure without periodically replacing the entire bank.

If the capacitor bank is part of a Variable Frequency Drive, check with the drive manufacturer for specific instructions on how to reform the capacitor bank.

A short description is below.

1. Ensure the capacitor bank is fully discharged.
2. Apply power to the M3628PCT.
3. Attach the output leads to the capacitor bank directly. If you are forming the capacitors in a drive, ensure that you are directly across the DC bus, not attached through the braking circuit.
4. Select "Charging Profile" from the main menu.
5. Set the final voltage to the rated voltage of the capacitor bank.
6. Set the step voltage to approximately 10% of the rated voltage of the capacitor.
7. Set the charging current to its maximum setting, unless counter-indicated by the capacitor manufacturer.
8. Set the step hold time to at least 600 seconds.
9. Set the final hold time to at least 900 seconds, or consult the equipment manufacturer for a suitable reforming time.
10. Begin charging the capacitor, listening for abnormal sounds or other indications in the capacitors or attached equipment. Monitor the current indicator to make sure there is not excessive leakage current, and the voltage indicator to see that the voltage is rising. Continually monitor the capacitor banks or attached equipment for abnormal signs, such as noise, heating, or smell. Internal bleeder resistors on the capacitor bank may require current during the process. Consult the equipment manufacturer for more information.

IF AT ANY TIME ABNORMAL SIGNS ARE DETECTED, OR THE LOAD CAPACITORS ARE OVERVOLTAGED, PRESS AND HOLD THE IMMEDIATE DISCHARGE BUTTON TO END THE PROCEDURE.

11. After the final hold time, the unit will discharge the load and calculate its capacitance. Wait until discharging is complete before disconnecting the load. Record the calculated capacitance somewhere

safe, along with the designation of the capacitor being tested. Multiple tests may be performed if desired, to ensure repeatability.

12. If the procedure is completed successfully, the capacitor bank or equipment can be returned to storage or put into use, as appropriate.
13. If the bank is put into service, test the capacitor bank periodically, on a schedule recommended by the capacitor manufacturer. Ensure that all tests are performed in a similar ambient temperature, otherwise comparison between results may not be valid. If over time the bank capacitance falls below the manufacturer-recommended percentage of the original recorded capacitance, discard and replace the capacitor.

NOTES