Model M3528M4

Battery Voltage Monitor Module

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.

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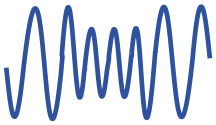
AC Drive Options

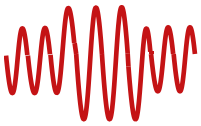
In 1975, Bonitron began working with AC inverter drive specialists at synthetic fiber plants to develop speed control systems that could be interfaced with their plant process computers. Ever since, Bonitron has developed AC drive options that solve application issues associated with modern AC variable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

World Class Products



Undervoltage Solutions

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



Overvoltage Solutions

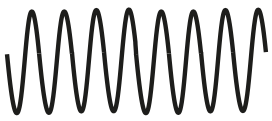
Braking Transistors
Braking Resistors
Transistor/Resistor Combo
Line Regeneration
Dynamic Braking for Servo Drives

Common Bus Solutions

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

Portable Maintenance Solutions

Capacitor Formers
Capacitor Testers



Power Quality Solutions

12 and 18 Pulse Kits

Green Solutions

Line Regeneration

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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 DC 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 M3528M4 Battery Voltage Monitor Module. It will provide the user with the necessary information to successfully install, integrate, and use the M3528M4.

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

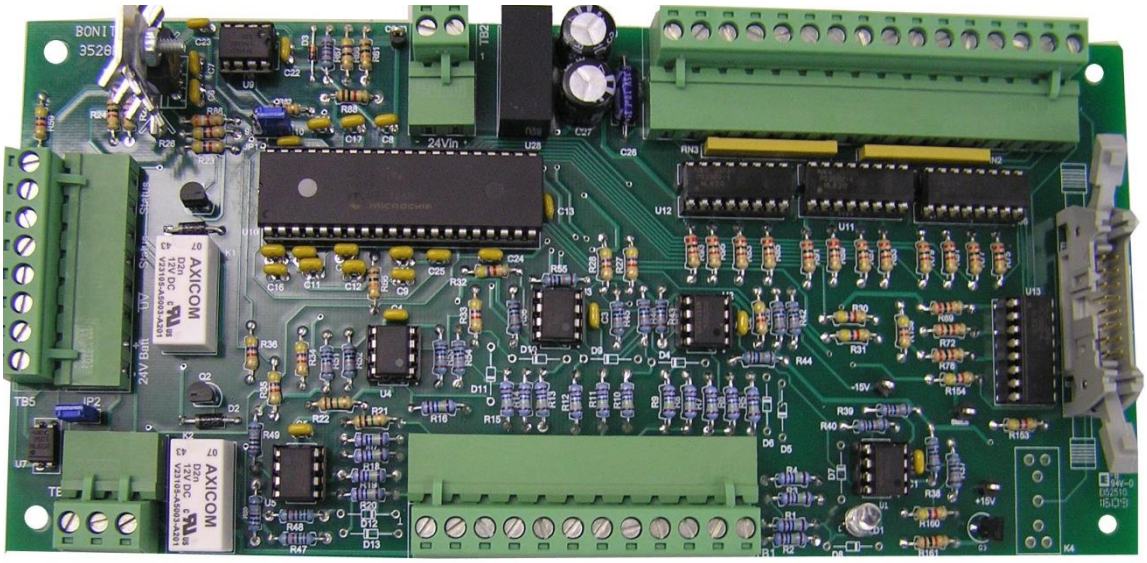
1.3. MANUAL VERSION AND CHANGE RECORD

Rev 00 is the initial release of this manual.

About Bonitron Section was updated in Rev 00a.

The manual template was updated in Rev 00b.

Figure 1-1: Model M3528M4



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2. Product Description

DC voltage monitoring is required for battery storage systems to ensure individual battery voltages are within safe tolerances. If a battery discharges too far, individual cells may change polarity, causing permanent damage to the battery and reducing its lifetime. A battery subjected to an overvoltage can produce harmful or explosive gases and lead to dangerous conditions and severe battery damage. Batteries, capacitors, and any other system can be damaged by the voltage across them rising too high. The M3528M4 voltage monitor is designed to monitor DC voltage levels and signal the user if the voltage departs a set range.

The M3528M4 monitors a series of 12V batteries and signals the user if:

- One or more of the battery's voltages fall below the undervoltage set point
- One or more of the battery's voltages exceeds the overvoltage set point
- A fuse is blown
- Over-temperatures exist

2.1. RELATED PRODUCTS

This product is designed for use with battery strings connected in series to attain a higher terminal voltage, such as the Bonitron M3528B Battery Storage Modules.

The M3528D4 Local Display is used with this monitor board to allow for a visual indication of the storage system status for mounting in a door or access cover of the storage system.

Contact your distributor for more information.

2.2. PART NUMBER BREAKDOWN

The Base Model Number, M3528, indicates that the unit is related to storage system components. 'M' specifies a monitor board, and '4' specifies this particular unit.

There are no options at this time.

2.3. GENERAL SPECIFICATIONS

Table 2-1: General Specifications Table

PARAMETER	SPECIFICATION
Power	24 VDC ± 10%, 200mA
Monitor Voltages	10 batteries (0-15VDC) each
Outputs	(10) Good Battery Open Collector (24VDC, 150mA Max) (11) LED driver outputs for remote LED display (1) Not Undervoltage - Open Collector (24VDC, 150mA Max) (1) Not Overvoltage- Open Collector (24VDC, 150mA Max) (1) Not Overtemp - Open Collector (24VDC, 150mA Max) (1) Not Blown fuse - Open Collector (24VDC, 150mA Max) (2) Status - Relay output (250VDC, 230VAC, 3A MAX.) (1) Not Under Voltage Relay output (250VDC, 230VAC, 3A MAX.)
Inputs	(1) Reset – Active Low, Open Base (24VDC)
Local Indicators	Power, Status
Storage Temp	-20 to +65ºC
Operation Temp	0 to +40ºC
Humidity	Below 90% non-condensing
Atmosphere	Free of corrosive gas and conductive dust

2.4. General Precautions and Safety Warnings

DANGER!

- **High voltages may be present!**
- **Failure to heed these warnings may result in serious bodily injury or death!**

CAUTION!

- **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 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

CAUTION!

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 M3528M4 Battery Voltage Monitor Module should be accomplished following the steps outlined below. Please direct all installation and start up inquiries regarding this product to your supplier or system integrator.

3.1. ENVIRONMENT

The installation site should be dry and clean without extreme temperatures.

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 which the product was purchased.

3.3. WIRING AND CUSTOMER CONNECTIONS

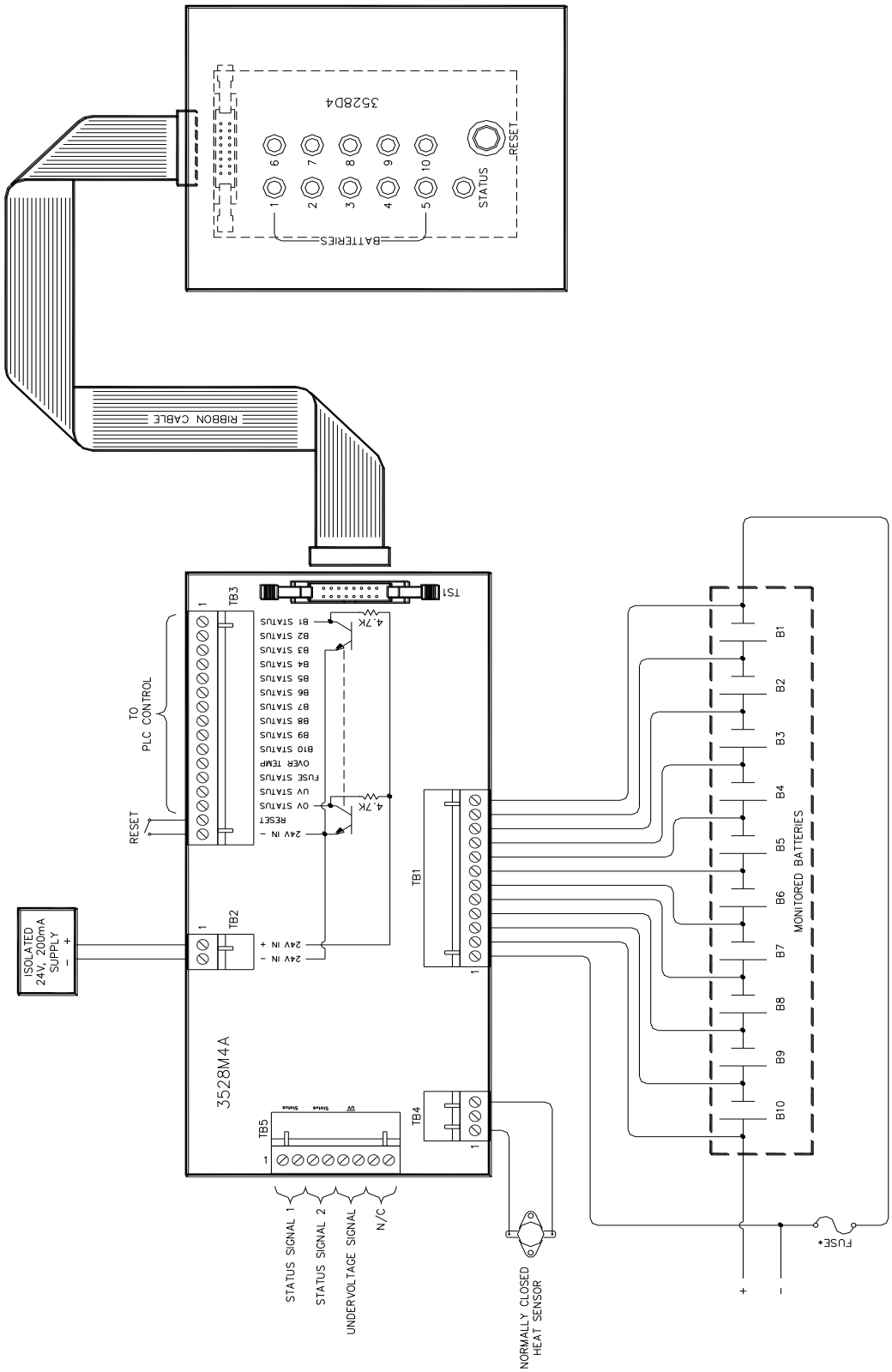
This section provides information about the field connection of the batteries and signal inputs to the M3528M4 Voltage Monitor Module.

Be sure to review all pertinent system documentation as well as the power wiring information in Section 3.4.1 before proceeding.

Refer to Table 3-1 for the maximum wire size accepted by the individual field connection terminals. Wire types and sizes should be chosen in accordance with national and local electrical codes to meet the voltage and current levels present for your application.

Figure 3-1 shows a typical interconnection of the M3528M4 with a DC voltage source and I/O signals.

Figure 3-1: Typical Interconnection



Dwg: 090113 Rev: 20090417

CAUTION!

Only qualified electricians should perform and maintain the interconnection wiring of this product. All wiring should be done in accordance with National Electrical Code or equivalent regulations.

3.3.1. POWER WIRING

Internal or external 24V 200mA.

3.3.2. I/O WIRING

The I/O connectors connect the unit to the internal batteries to be monitored and to external signals used to indicate the state of the monitor voltage.

Table 3-1: Wiring Specifications TB1

TERMINAL	FUNCTION	ELECTRICAL SPECIFICATIONS	MIN WIRE AWG	MAX WIRE AWG	TORQUE
TB1-1	Fuse terminal note(1)	12VDC to TB1-2 1mA	24	12	.5 Nm
TB1-2	Battery 10 (+)	12VDC to TB1-3 1mA	24	12	.5 Nm
TB1-3	Battery 10 (-) Battery 9 (+)	12VDC to TB1-4 1mA	24	12	.5 Nm
TB1-4	Battery 9 (-) Battery 8 (+)	12VDC to TB1-5 1mA	24	12	.5 Nm
TB1-5	Battery 8 (-) Battery 7 (+)	12VDC to TB1-6 1mA	24	12	.5 Nm
TB1-6	Battery 7 (-) Battery 6 (+)	12VDC to TB1-7 1mA	24	12	.5 Nm
TB1-7	Battery 6 (-) Battery 5 (+)	12VDC to TB1-8 1mA	24	12	.5 Nm
TB1-8	Battery 5 (-) Battery 4 (+)	12VDC to TB1-9 1mA	24	12	.5 Nm
TB1-9	Battery 4 (-) Battery 3 (+)	12VDC to TB1-10 1mA	24	12	.5 Nm
TB1-10	Battery 3 (-) Battery 2 (+)	12VDC to TB1-11 1mA	24	12	.5 Nm
TB1-11	Battery 2 (-) Battery 1 (+)	12VDC to TB1-12 1mA	24	12	.5 Nm
TB1-12	Battery 1 (-)	12VDC to TB1-11 1mA	24	12	.5 Nm

Note (1): Fuse must be connected to the negative terminal of the batteries series.

Table 3-2: Wiring Specifications TB2

TERMINAL	FUNCTION	ELECTRICAL SPECIFICATIONS	MIN WIRE AWG	MAX WIRE AWG	TORQUE
TB2-1	+24V	24VDC 200mA	24	12	.5 Nm
TB2-2	0V	24VDC 200mA	24	12	.5 Nm

Table 3-3: Wiring Specifications TB3

TERMINAL	FUNCTION	ELECTRICAL SPECIFICATIONS	MIN WIRE AWG	MAX WIRE AWG	TORQUE
TB3-1	Battery 1 status signal	Open Collector 24V 150mA (2)	24	12	.5 Nm
TB3-2	Battery 2 status signal	Open Collector 24V 150mA (2)	24	12	.5 Nm
TB3-3	Battery 3 status signal	Open Collector 24V 150mA (2)	24	12	.5 Nm
TB3-4	Battery 4 status signal	Open Collector 24V 150mA (2)	24	12	.5 Nm
TB3-5	Battery 5 status signal	Open Collector 24V 150mA (2)	24	12	.5 Nm
TB3-6	Battery 6 status signal	Open Collector 24V 150mA (2)	24	12	.5 Nm
TB3-7	Battery 7 status signal	Open Collector 24V 150mA (2)	24	12	.5 Nm
TB3-8	Battery 8 status signal	Open Collector 24V 150mA (2)	24	12	.5 Nm
TB3-9	Battery 9 status signal	Open Collector 24V 150mA (2)	24	12	.5 Nm
TB3-10	Battery 10 status signal	Open Collector 24V 150mA (2)	24	12	.5 Nm
TB3-11	Over Temperature status signal	Open Collector 24V 150mA (2)	24	12	.5 Nm
TB3-12	Fuse status signal	Open Collector 24V 150mA (2)	24	12	.5 Nm
TB3-13	Undervoltage status signal	Open Collector 24V 150mA (2)	24	12	.5 Nm
TB3-14	Overvoltage status signal	Open Collector 24V 150mA (2)	24	12	.5 Nm
TB3-15	External Reset signal	Dry Contact 24V, 10mA	24	12	.5 Nm
TB3-16	24V com	24VDC 200mA	24	12	.5 Nm

Note (2): Outputs have an internal 4.7k pull up resistor to the 24V+ power supply.

Table 3-4: Wiring Specifications TB4

TERMINAL	FUNCTION	ELECTRICAL SPECIFICATIONS	MIN WIRE AWG	MAX WIRE AWG	TORQUE
TB4-1	Thermostat Input -1	Dry contact 24VDC 20mA	24	12	.5 Nm
TB4-2	NC		24	12	.5 Nm
TB4-3	Thermostat Input -2	Dry contact 24VDC 20mA	24	12	.5 Nm
TB5-1	Status Output 1	Relay Output 250VDC, 230VAC, 3A MAX.	24	12	.5 Nm
TB5-2	Status Output 1	Relay Output 250VDC, 230VAC, 3A MAX.	24	12	.5 Nm
TB5-3	Status Output 2	Relay Output 250VDC, 230VAC, 3A MAX.	24	12	.5 Nm
TB5-4	Status Output 2	Relay Output 250VDC, 230VAC, 3A MAX.	24	12	.5 Nm
TB5-5	Undervoltage Output	Relay Output 250VDC, 230VAC, 3A MAX.	24	12	.5 Nm
TB5-6	Undervoltage Output pole	Relay Output 250VDC, 230VAC, 3A MAX.	24	12	.5 Nm
TB5-7	No Connection				
TB5-8	No Connection				

4. OPERATION

4.1. FUNCTIONAL DESCRIPTION

The M3528M4 Module monitors nine or ten (0-15VDC batteries) voltages connected to the input terminals TB2 (2 - 12). The module monitors each battery's voltage, and indicates if the voltage is outside a predefined voltage range. Individual batteries are indicated, along with the specific fault. There are remote monitoring outputs for connection to a PLC or other supervisory system, as well as relay outputs to allow for control functions of ancillary equipment. The unit has a ribbon connector that can be used to drive the Bonitron M3528D4 display panel for remote mounting of indicators.

4.2. FEATURES

4.2.1. OPERATION

4.2.1.1. UNDERVOLTAGE

When one or more of the batteries voltages fall below the undervoltage set point for 12 seconds, undervoltage output relay opens and the status LED blinks (see Blink Pattern Table 4-1), the undervoltage signal goes low and one or more of the display LEDs turn on indicating which battery falls under the undervoltage setpoint. The fault will latch until the batteries voltages rise above the undervoltage set point and the user pushes the reset button on the front panel. Then the undervoltage output relay closes and the status LED turns on. An undervoltage is indicated by an individual battery terminal voltage of 9V.

4.2.1.2. OVERVOLTAGE

When one or more of the batteries voltages rise above the overvoltage setpoint, the status output relays open, the Status LED blinks (see Blink Pattern Table 4-1), the Overvoltage signal goes low, and one or more of the display LEDs turn on indicating which battery has risen above the overvoltage setpoint. The Fault will latch until the batteries voltages fall under the undervoltage set point and the user pushes the reset button on the front panel. Then the status output relay closes and the status LED turns on. An Overvoltage is indicated by an individual battery terminal voltage of 15.2V ±0.1V.

4.2.1.3. OVERVOLTAGE AND UNDERVOLTAGE

When one of the battery string voltages rises above the 15.2V ±0.1V and another battery voltage falls below 9V, status relays and the undervoltage relay open. The Status LED blinks as an Overvoltage Fault (see Table 4-1).

4.2.1.4. BLOWN FUSE DETECTION

When the fuse is blown the Status LED blinks (see Blink Pattern Table 4-1), the blown fuse signal will go low and the status output relays open. The status LED will keep blinking until the user changes the fuse and pushes the reset button on the front panel.

4.2.1.5. OVER TEMPERATURE

When temperature sensor reaches a setpoint the status LED blinks (see Blink Pattern Table 4-1), the Over Temperature signal will go low and the Status

Output relays open. The Fault will latch until the unit cools down and the user pushes the reset button on the front panel.

4.2.2. CONNECTORS

4.2.2.1. TB1 -1 (FUSE)

This terminal connects the input side of the fuse for monitoring. A voltage higher than 10VDC on this pin between TB1-1 and TB1-12 will indicate a good fuse.

4.2.2.2. TB1 - 2 THRU 12 (BATTERY MONITOR)

These terminals measure the voltage across each individual cell. The nominal voltage is 12VDC. If the voltage between adjacent pins is not between 9 volts and 15.1 volts, a fault will be indicated.

4.2.2.3. TB2 - 1&2 (POWER CONNECTOR)

This is the control power input for the board. This can be from a separate 24VDC power supply; or the first two batteries of the string can be used as a local supply by connecting to Terminals TB5-7 & 8. Be aware that this can cause unbalanced battery voltages if the batteries are not being constantly charged.

4.2.2.4. TB3 - 1 THRU 10 - BATTERY CELL GOOD

Each of these outputs indicates that each individual battery's voltage is within range. When the voltage falls outside the range, the input will go low.

4.2.2.5. TB3 - 11 NOT OVER TEMPERATURE

This output indicates that there is not an overtemperature alarm. It is controlled by the temperature input at TB4-1 & 3.

4.2.2.6. TB3 - 12 NOT BLOWN FUSE

This output indicates that there is no blown fuse.

4.2.2.7. TB3 - 13 NOT UNDERVOLTAGE

This output is normally high, and indicates that there is no undervoltage fault on any battery.

4.2.2.8. TB3 - 14 NOT OVERVOLTAGE

This output is normally high, and indicates that there is no overvoltage fault on any battery.

4.2.2.9. TB3 - 15 (RESET SIGNAL)

Closing a contact between TB3-15 and TB3-16 will reset any faults. The input is open base pulled up internally to 24VDC.

4.2.2.10. TB3 - 16 (24V COM)

Signal common for all outputs on TB3.

4.2.2.11. TB4 - 1&3 (THERMOSTAT INPUT)

Accepts normally closed thermostat terminals.

4.2.2.12. TB5 - 1&2 (STATUS SIGNAL OUTPUT)

The isolated overvoltage signal output connector is connected to a normally open held closed relay.

This relay opens when any battery has an Overvoltage, a Blown Fuse, or Overtemperature. The relay is rated for 250 VDC, 230VAC, 3A maximum.

4.2.2.13. TB5 - 3&4 (STATUS SIGNAL OUTPUT)

Same as TB5-1&2.

4.2.2.14. TB5 - 5&6 (UNDERVOLTAGE SIGNAL OUTPUT)

The isolated undervoltage signal output connector is connected to a normally open held closed relay.
This relay opens when any battery has an Undervoltage fault.
The relay is rated for 250VDC, 230VAC, 3A maximum.

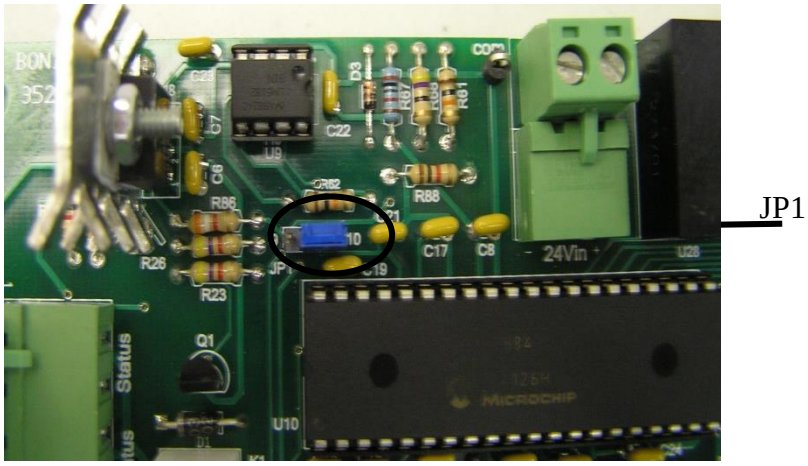
4.2.2.15. TB5 - &8 (NOT USED)

4.2.3. JUMPERS

4.2.3.1. JP1

This jumper is indicates the number of batteries in the string.
For a 9 cell string, the position should be to the left or "9" position.
For a 10 cell string, the position should be to the right or "10" position.

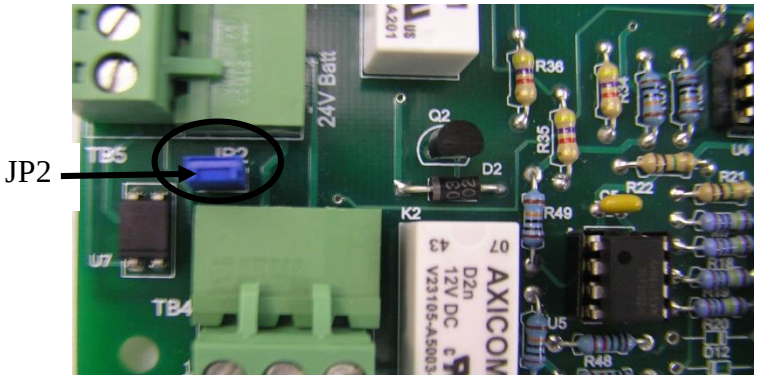
Figure 4-1: JP1



4.2.3.2. JP2

If the Over Temperature option is not used, the user needs to install JP2.

Figure 4-2: JP2



4.2.4. RIBBON CONNECTOR

The unit has a ribbon connector that can be used with the Bonitron M3528D4 display panel. The indicators on the front panel that will show basic status information for the supply.

4.2.4.1. BATTERY STATUS

The Battery Status LEDs are 10 LEDs indicate which battery reaches an Overvoltage or Undervoltage limit.

4.2.4.2. STATUS INDICATOR

The Status Indicator illuminates when there is a fault active in the unit. The blink sequence will indicate the specific fault.

Table 4-1: Blink Patterns

BLINK PATTERN	STATUS
On	No Fault
On – Off	Blown fuse
On – On – Off	Over Temperature
On – On – On – Off	Over Temperature
On – On – On – On - Off	Undervoltage

5. TROUBLESHOOTING

If a problem occurs on start-up or during normal operation, refer to the solutions 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.

5.1. STATUS RELAYS WON'T CLOSE

Make sure there is 24VDC between terminals TB4-1 & 2. Check to see if the other outputs are on, and if so, continue troubleshooting below.

5.2. STATUS LED REMAINS BLINKING AFTER CHANGING THE BLOWN FUSE

Try to reset the fault with the reset input on terminals TB3-15 & 16. If the fault will not reset, check the voltage between terminals TB1-1 and TB1-12. It should be between 0V and 10V. If this does not solve the issue, contact Bonitron for assistance.

5.3. BATTERY OVERVOLTAGE

Try to reset the fault with the reset input on terminals TB3-15 & 16. If the fault will not reset, check the voltage between each battery terminals from TB1-1 to TB1-11. None of the voltages should be more than 15.2V ±0.1V.

5.4. BATTERY UNDERVOLTAGE

Try to reset the fault with the reset input on terminals TB3-15 & 16. If the fault will not reset, check the voltage between each battery terminals from TB1-1 to TB1-11. None of the voltages should be less 9 V.

5.5. OVER TEMPERATURE

Try to reset the fault with the reset input on terminals TB3-15 & 16. If the fault will not reset, check the voltage between terminals TB4-1 to TB4-3. It should be 0V.

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6. ENGINEERING DATA

6.1. RATINGS

Power Supply tolerance: 24VDC±10%.

6.2. DIMENSIONS AND MECHANICAL DRAWINGS

Figure 6-1: M3528M4 Dimensional Outline Drawing

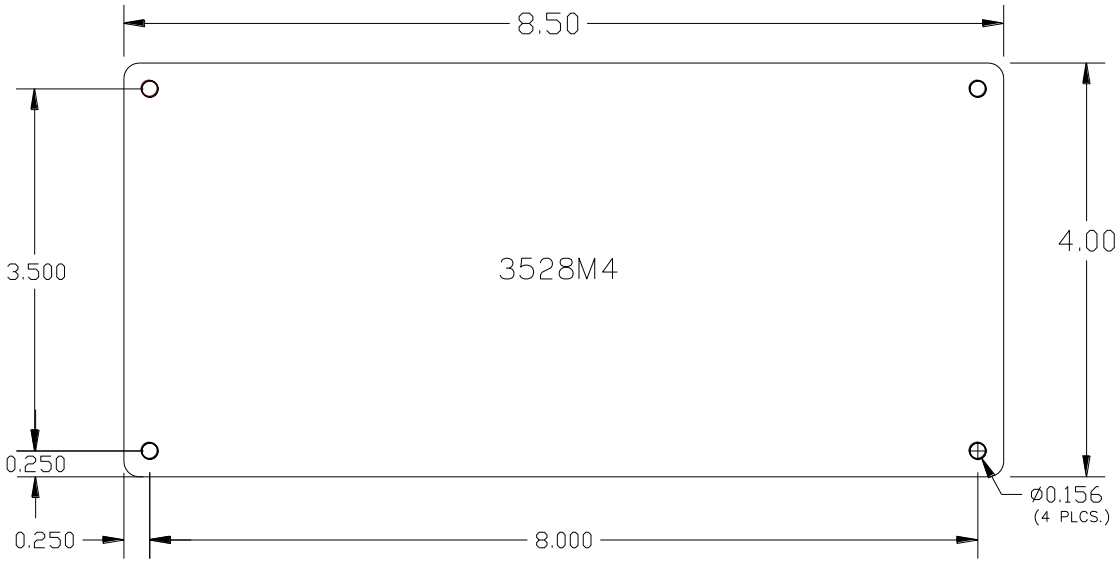
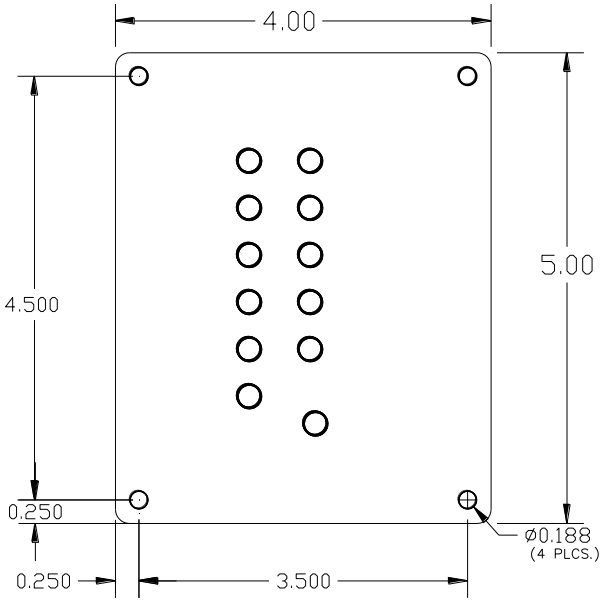


Figure 6-2: M3528D4 Battery Monitoring Panel Mounting Information



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