BPM
Battery Performance Monitor

Instruction Manual

Albércorp.

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- Except as explained in this manual, do not attempt to service Albércorp equipment yourself. Opening the equipment may expose you to dangerous voltages. Refer servicing beyond that described in this manual to authorized personnel.

- Do not allow liquids or moisture to get into the equipment. If liquid does get into the equipment, unplug it immediately and contact your nearest authorized service center or Albércorp directly.

- Ensure equipment is provided adequate ventilation. Do not block equipment ventilation openings.

- Do not exceed equipment voltage or power ratings and capabilities.

- Make sure that equipment is properly grounded.

- Do not let unauthorized persons operate the equipment.

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1. Introduction

The Battery Performance Monitor (BPM) is an intelligent, microprocessor based, multi-function monitor that continuously monitors the battery room ambient temperature and the overall voltage and current (optional) of four separate battery strings.

The BPM monitor records and stores the following parameters:

- Number of discharges.

- Duration of each discharge.

- Date and time of each discharge.

- Lowest voltage and highest current reached during each discharge.

- The overall voltage and current at thirty seconds into each discharge.

- Alarms triggered by out-of-tolerance conditions.

The BPM is housed in an 8.5" x 4.5" x 10" enclosure that is mounted near the batteries being monitored. A 4-lines by 20-character LCD display and a 16-key keypad are provided for user interface.

2. Installation

Mount the BPM and connect the wiring as described in this section.

2.1. Mounting the BPM

Select a mounting location near the batteries being monitored and a 115 VAC power source (or 230 VAC source if required), and that allows easy access to the BPM front panel. Using the enclosed hardware, fasten the unit to the desired surface. Make sure there is adequate conduit access into the unit for the sense lead, power, and alarm contact harnesses.

WARNING: The BPM has no AC power switch. When wiring AC power to the BPM, do not apply 115 VAC power until after you complete all connections and close the unit cover. Follow local standards and electrical codes when wiring the BPM system.

2.2. Connecting the BPM

Open the BPM front panel to expose the terminal strips where the sense lead, power, and alarm contact harnesses connect. The terminal strips are labeled to identify each input/output.

Connect the voltage and current sense leads to the appropriate terminals, then route these wires to the batteries being monitored. Using the high voltage fuses and fuse holders provided, terminate the sense leads at the battery terminals.

Connect the alarm contacts to the appropriate terminals, then route these wires to the facility monitor that reports all alarms. The contact closures are rated 1 Amp at either 28 VDC or 115 VAC.

Connect jumper JP6 to enable the internal circuit board. The jumper is on the PC board near the large heat sink. NOTE: The display will not power up until the jumper is installed.

Connect the violet and gray leads to the battery inside the BPM. Connect the violet lead to the plus (+) terminal and the gray lead to the minus (-) terminal.

Connect the 115 VAC power leads to the terminal strip and connect the other end to a fused 115 VAC source. Power required is less than 50 watts. Do not apply AC power to the unit at this time.

This completes the wiring of the BPM. The BPM DIP switch is factory set for four battery strings. If you are monitoring four strings, close the cabinet. If not, refer to *Configuring the DIP Switch*.

2.3. Configuring the DIP Switch

DIP switch SW-1 on the PC board sets the BPM for the number of battery strings being monitored. The four switches on SW-1 are factory set to the Open position to monitor four battery strings. To monitor fewer than four strings, power down the BPM and set the switches on SW-1 as shown. (Open = Off; Closed=On.) NOTE: The hex code column is explained in *System Parameters Menu*.

No. of Strings	SW1-1	SW1-2	SW1-3	SW1-4	Hex Code
4	open	open	open	open	Fh
3	open	open	open	closed	7h
2	open	open	closed	closed	3h
1	open	closed	closed	closed	1h

Figure 1. Configuration Switch Settings

For settings to take effect, switch the BPM power off then on. Refer to *Power Up / Power Down*.

3. BPM Stand-Alone Operation

The BPM uses menus that allow access to all the functions. You may operate the BPM from the front panel keypad or with the BPM software program. This section describes how to operate the BPM using the front panel keypad. Drawing BPM-305-D1126 is a flow chart of the BPM functions. Refer to the diagram as necessary.

3.1. Navigating Menus

To move from one menu to another, press the key indicated. To return to the previous menu, press the ESC key.

To step from one battery string to another, press the F1 key.

Key combinations: When instructed to press two keys on the BPM keypad, such as F2 + 2, press and hold the first key and press the second key.

In this manual, a line like this: Main Menu ⇒ 2.Menu Item ⇒ 1.Menu Item appears at the start of many sections to help you navigate to the LCD screen being discussed.

3.2. Password

You must enter a password to access certain functions. The default password is 7777. When an item requires the password, press the appropriate keypad numbers, then press Enter.
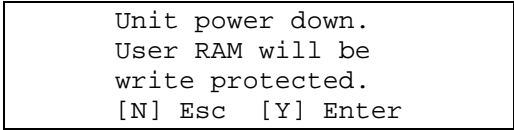
3.3. Power Up / Power Down

To power up the BPM, you must first connect a jumper inside the unit.

WARNING: Make certain the AC power is disconnected before opening the unit.

With the AC power disconnected, open the unit and place a jumper across the pins at JP6. (JP6 is located next to the heat sink on the PC board.) This connects the internal battery to the circuitry. To power up the BPM, apply AC power to the unit. The BPM has no AC power switch.

Power down the BPM in the following sequence to prevent corruption of calibration settings and alarm data. To display the Power Down LCD screen, from the Main Menu, press F2 + Esc.

```
        Unit power down.
        User RAM will be
        write protected.
        [N] Esc  [Y] Enter
```

Figure 2. Power Down Screen (LCD)

To power down, press Enter on the keypad. At the message "Unit powered down. Remove AC power," it is safe to remove the AC power source. To not power down, press Esc to return to the Main Menu.

After the BPM is disconnected from AC power, open the unit and disconnect jumper JP6 to conserve the BPM internal battery. Make certain the AC power is disconnected before opening the unit.

3.4. Main Menu

At power up, the system status and version number are displayed, then the Main Menu appears. Items on the menu are described elsewhere in this manual. From most LCD screens, you may press Esc to return to the previous screen or the Main Menu.

```
         Main Menu
    1-Battery Monitor
    2-Battery Data
    3-Utilities
```
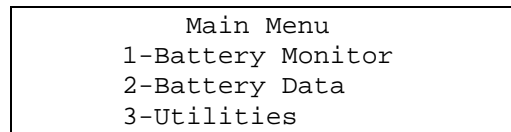
Figure 3. Main Menu (LCD)

NOTE: All BPM front panel keypad settings, with the exception of MODBUS setting, may also be configured using the BPM software described in this manual.

3.5. Setting Up the BPM

Main Menu ⇒ 3.Utilities ⇒ Type Password ⇒ Enter

To configure the BPM for the attached hardware and to set alarm levels for all parameters, do the following.

1. To display the Utilities Menu, from the Main Menu, press 3 - Utilities. Enter the user password, then press Enter. (Default password is 7777.)

```
        Utilities Menu
    1-Alarms    4-Memory
    2-DateTime  5-Config
    3-Calib     6-Diags
```
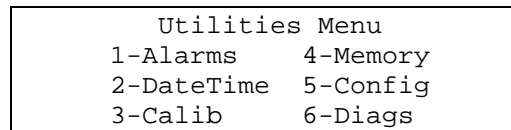
Figure 4. Utilities Menu (LCD)

2. Press 5 - Config, then 1 - Current Sensors. Enter the amps/millivolt value of the optional shunt or current transducer that may be installed. (Press F1 to select the next battery string.) (Refer to *Configuration* under *Utilities* for more details.)

3. From the Configuration Menu, press 2 - Date/Temp Format and select the format for date and temperature. (Refer to *Configuration* under *Utilities*.)

4. From the Utilities Menu, press 1 - Alarms, then enter the high and low alarm levels for all the monitored parameters. (Refer to *Alarms* under *Utilities*.)

5. From the Utilities Menu, press 2 - Date Time and set the correct values. (Refer to *Date and Time* under *Utilities*.)

- From the Utilities Menu, you may press the key sequence F1 + 4 to display the Active Thresholds LCD screen.

3.6. Normal Operating Mode

After the BPM is set up and connected to the batteries, the Battery Monitor LCD screen is usually selected to view the present values of the monitored parameters.

3.6.1. Battery Monitor Screen

Main Menu ⇒ 1.Battery Monitor

This LCD screen lets you view present conditions, such as battery voltage, ambient temperature, and current. From the Main Menu, press 1 - Battery Monitor. The screen displays the voltage, temperature, and float current of the selected battery. To select the next battery string, press F1.

3.6.2. System Parameters Menu

Main Menu ⇒ 1.Battery Monitor ⇒ F2+1

To view the date, time, and alarm level settings for a battery string, open the System Parameters Menu. To access this menu, from the Battery Monitor screen, press F2 + 1.

```
     System Parameters
  1-Date/Time   2-Alarms
  3-Hardware    4-SW1
  5-UMEMChkSum
```

Figure 5. System Parameters Menu (LCD)

Date/Time - Displays the date and time set under the Utilities menu.

Alarms - Displays the high/low alarm set points entered under the Utilities menu. To select the next battery string, press F1.

Hardware - Displays the amp/millivolt settings for the load current sensors (current transducers or shunts) set under the Configuration menu.

SW1 - Displays the hex value of the switch SW-1 setting, which determines the number of battery strings being monitored. This hex value is listed in the table in *Configuring the DIP Switch*.

UMEMChkSum - Displays the user memory checksum.

5

3.7. Battery Data

From this menu, you may view all cycle, alarm, and discharge data stored for each battery monitored. To display the Battery Data Menu, from the Main Menu, press 2 - Battery Data. To change the battery number, press F1. The items on this menu are described in the following sections.

```
          Battery 1 Data
             1-Cycle Data
             2-Alarm Data
```

Figure 6. Battery Data Menu (LCD)

3.7.1.   Cycle Data

From the Battery Data Menu, press 1 - Cycle Data to view stored data for the total number of discharge cycles on a battery, the battery voltage 30 seconds into the discharge cycle, the lowest voltage reached during the discharge, and a historical listing of the discharge times and durations.

```
        Battery 1 Cycle Data
           1-No.Cycles/View
           2-Voltage vs Time
           3-Cycle History
```

Figure 7. Cycle Data Menu (LCD)

Number of Cycles/View - Enter the number of the record to be viewed.

Voltage vs. Time - Show the voltage during discharge of each cycle.

```
        Voltage vs Time Batt-1
           1-Lowest Voltage
           2-Volts@30s
```

Figure 8. Voltage vs Time Menu (LCD)

From the Voltage vs. Time Menu, press 1 to display the lowest voltage LCD screen. Press 2 to display the voltage at 30 seconds LCD screen.

Cycle History - Show the date and duration of each cycle.

- From the Cycle History LCD screen, you may press Enter to display the VLo, V30s, and duration LCD screen.
- From the above VLo, V30s, duration screen, you may press Enter to display the ILMax and IL30s LCD screen.

3.7.2. Alarm Data

Main Menu ⇒ 2.Battery Data ⇒ 2.Alarm Data

From the Battery Data Menu, press 2 - Alarm Data to view stored data for the overall voltage, current, and temperature.

```
Battery 1 Alarm Data
   1-No.Alarms/View
   2-Alarm History
   3-TEMP Alarms
```

Figure 9. Alarm Data Menu (LCD)

Number of Alarms/View - Display the number of alarms and the view record number.

- From the Battery Alarms LCD screen, you may press Enter to display the Alarm Record LCD screen.

Alarm History - Display a chronological listing of each alarm.

Temp Alarms - Display the Temp Alarm Data Menu. This menu permits viewing of each temperature alarm.

```
   Temp Alarm Data
   1-No.Alarms/View
   2-Alarm History
```

Figure 10. Temp Alarm Data Menu (LCD)

Number of Alarms and View - From the Temp Alarm Data Menu, press 1 to display the Temperature Alarms view record number LCD screen.

- From the Temperature Alarms view record number LCD screen, you may press Enter to display the temperature alarm record LCD screen.

Alarm History - From the Temp Alarm Data Menu, press 2 to display the temperature alarm date and time LCD screen.

- From the temperature alarm date and time LCD screen, you may press Enter to display the temperature alarm record LCD screen.

3.8. Utilities Menu

Main Menu ⇒ 3.Utilities ⇒ Type Password ⇒ Enter

Use the Utilities Menu to set up, calibrate, and configure the BPM. To display the menu, from the Main Menu, press 3 - Utilities. Enter the password and press Enter. The default password is 7777. The Utilities Menu appears. Items on this menu are described in the following sections.

```
      Utilities Menu
   1-Alarms     4-Memory
   2-DateTime  5-Config
   3-Calib      6-Diags
```

Figure 11. Utilities Menu (LCD)

3.8.1.   Alarms

Main Menu ⇒ 3.Utilities ⇒ Type Password ⇒ Enter ⇒ 1.Alarms

The BPM monitors voltage and current, and records any values that are out of range. Use the Alarms Menu to set the high and low alarm levels for each of the monitored parameters of each battery string. From the Utilities Menu, press 1 - Alarms.

```
    Alarms   Battery-1
   1-Hi Volt  4-Lo Volt
   2-Hi Temp  5-Lo Temp
   3-Hi IF    6-Lo IF
```

Figure 12. Alarms Menu (LCD)

From the Alarms menu, select and set operational voltage, float current, and temperature alarm levels.

Clear Alarm Settings To clear all alarm settings for a battery, from the Alarms Menu, press F2 + Esc, then press Enter.

3.8.2.   Date and Time

Main Menu ⇒ 3.Utilities ⇒ Type Password ⇒ Enter ⇒ 2.DateTime

To set the date and time, from the Utilities Menu, press 2 - DateTime. Press Enter to step through the date and time fields. When the date and time are correct, press Esc to return to the Utilities Menu.

3.8.3.   Calibration

Main Menu ⇒ 3.Utilities ⇒ Type Password ⇒ Enter ⇒ 3.Calib

To calibrate the BPM, from the Utilities Menu, press 3 - Calibrate. To calibrate the voltage, current, and temperature parameters, refer to *BPM Calibration*.

3.8.4. Memory Menu

Main Menu ⇒ 3.Utilities ⇒ Type Password ⇒ Enter ⇒ 4.Memory

To open the Memory Menu, from the Utilities Menu, press 4 - Memory.

```
User Memory Batt-1
1-Clear Cycle Data
2-Clear Alarm Data
3-Clear All Data
```

Figure 13. Memory Menu (LCD)

Press 1, 2 or 3 to select options to clear the indicated data for a battery from the BPM memory. To select the next battery string, press F1. To clear all cycle and alarm data for all battery strings, press F2 + Esc.

3.8.5. Configuration Menu

Main Menu ⇒ 3.Utilities ⇒ Type Password ⇒ Enter ⇒ 5.Config

Use the Configuration Menu to set current transducer scaling, the date and temperature format, and the MODBUS address. From the Utilities Menu, press 5 - Config. The Configuration Menu appears.

```
Configuration Menu
1-Current Sensors
2-Date/Temp Format
3-MODBUS Address
```

Figure 14. Configuration Menu (LCD)

Current Sensors - To enter the amps/millivolt value of the optional shunt or current transducer that may be installed, press 1 - Current Sensors. Press Enter to step between the fields and enter the values. (Press F1 to select the next battery string.)

Date/Temp Format - Press 2 - Date/Temp Format and press 1 or 2 to select U.S. or European format for date and temperature (Fahrenheit or Celsius).

MODBUS Address - The MODBUS address must be changed in both the hardware and software. Do not change without first referring to *Setting the MODBUS Address* for a complete description of this parameter.

- From the Configuration Menu, you may press the key sequence F1 + Esc to display the Cycle Category Code LCD screen.

3.8.6. Diagnostics Menu

Main Menu ⇒ 3.Utilities ⇒ Type Password ⇒ Enter ⇒ 6.Diags

The BPM has built-in diagnostics that check the operation of the unit. To open the Diagnostics Menu, from the Utilities Menu, press 6 - Diags.

```
        Diagnostics Menu
     1-Keybrd     3-RS-232
     2-Display    4-Alarm
```

Figure 15. Diagnostics Menu (LCD)

Keybrd - The BPM keyboard diagnostic displays the name of each key as it is pressed. The function of every key can be checked. NOTE: To return to the Diagnostics Menu, press F1 + Esc.

Display - The LCD screen displays characters and patterns. Upon completion, the unit returns to the Diagnostics Menu.

RS-232 - When this diagnostic is selected, the display prompts you to install a loop back connector or cable. This connector is not supplied with the BPM; however, one can be simulated by connecting pin 2 to pin 3 on the RS-232 connector. After connecting the loop back, press Enter to transmit and receive known data. If the data is corrupt, the error count field increments. Press Esc for about one second to return to the Diagnostics Menu.

Alarm - Use the sub-menu to test the BPM alarm contacts, alarm beeper, and the front panel Alarm LED. Press Esc to return to the Diagnostics Menu.

3.8.7. Reset System Parameters

Main Menu ⇒ 3.Utilities ⇒ Type Password ⇒ Enter ⇒ F2+Esc

WARNING: Resetting system parameters erases all data in memory and all calibration settings. You will lose all data and settings.

To initialize memory and reset the BPM parameters to system defaults, from the Utilities Menu, press F2 + Esc.

3.9. Alarm LED Reset

Main Menu ⇒ 1.Battery Monitor ⇒ F2+Enter

If the Alarm LED on the BPM is lit, you may reset it from the keypad. From the Main Menu, press 1 - Battery Monitor. On the keypad, press F2 + Enter. This shuts off the LED, any audible alarms, and the external alarm latching relays.

3.10. Setting the MODBUS Address

You may connect the BPM to any device that can communicate using MODBUS protocol. When using multiple BPMs with MODBUS protocol on a single serial line or COM port, assign a unique ID address to each BPM. Valid unit ID addresses range from 1 to 247.

The BPM hardware defaults to MODBUS address 1 unless you change it using the BPM front panel keypad. Changing the address in the software does not change the address in the hardware. Unless a MODBUS controller is controlling the BPM, the address in both the hardware and software should remain set to 1 and not be changed.

CAUTION: The MODBUS address set using the BPM keypad must match the address set in the program, or the software will not communicate with the BPM.

3.10.1. MODBUS Setting (Hardware)

Main Menu ⇒ 3.Utilities ⇒ Type Password ⇒ Enter ⇒ 5.Config ⇒ 3.MODBUS Address

To change the MODBUS address on the BPM, from the Utilities Menu press 5 - Config, then press 3 - MODBUS Address. Enter the new address from the keypad, then press Enter. After the display indicates Entry Accepted, press Enter to return to the Configuration Menu. The default address is 1. (The BPM display shows 001.)

3.10.2. MODBUS Setting (Software)

Use the BPM program to select the MODBUS address in the software when a new site is set up, and to change the address after the site is created. The default address is 1.

For a new site, from the Main Menu click Site|New. At the MODBUS Address box, type a valid address number.

To change the address of an existing site, first open the site. From the Main Menu, click Site|Info to open the Information dialog box. At the MODBUS Address box, type a valid address number.

3.10.3. MODBUS Assistance

Consult the following sources for assistance with the MODBUS protocol:

The Technical Library/MODBUS Register Maps section on the Albércorp Web site at: www.alber.com

Modicon MODBUS Protocol Reference Guide.
Modicon, Inc., Industrial Automation Systems, 1 High Street, North Andover, MA 01845
www.modicon.com

Wintech Software, P.O. Box 907, Lewisburg, WV 24901
www.win-tech.com
The test software is Modscan.

4. BPM Calibration

Main Menu ⇒ 3.Utilities ⇒ Type Password ⇒ Enter ⇒ 3.Calib

To check or adjust system calibration, from the Main Menu, press 3 - Utilities. Enter the password and press Enter. The default password is 7777. From the Utilities Menu, press 3 - Calib.

```
     Calibration Batt - 1
   1-Volts  3-IF Current
   2-Temp   4-IL Current
      F1 Next Battery
```

Figure 16. Calibration Menu (LCD)

The Calibration Menu displays parameters that can be calibrated. These items are described in the following sections. To step to the next battery, press F1.

WARNING: Dangerous voltages may be present inside the BPM. Only qualified personnel should calibrate and service this unit.

4.1. Voltage Calibration

Main Menu ⇒ 3.Utilities ⇒ Type Password ⇒ Enter ⇒ 3.Calib ⇒ 1.Volts

To calibrate the BPM overall voltage channel, from the Calibration Menu press 1 - Volts and do the following:

1. Connect an adjustable voltage source to the overall voltage (OV) input terminals.

2. Using a calibrated digital voltmeter (DVM) for measurement, adjust the input voltage to a value approximately 10% higher than the normal overall battery float voltage.

3. Compare the BPM display reading to the DVM. If the BPM reading is not within 0.1% ±0.5 volts of the input, press the Up/Down arrow keys to adjust the BPM reading.

4. Adjust the input voltage to a value approximately 10% lower than the normal end voltage of the string.

5. Compare the BPM display reading to the DVM. If the BPM reading is not within 0.1% ±0.5 volts of the input, you should return the BPM for repair.

4.2. Current (I_L) Calibration

Main Menu $\Rightarrow$ 3.Utilities $\Rightarrow$ Type Password $\Rightarrow$ Enter $\Rightarrow$ 3.Calib $\Rightarrow$ 4.IL Current

Current calibration is based on sensing the battery current using a standard 50 or 100 millivolt shunt. Make sure you select the proper shunt value from the Utilities|Configuration Menu. To calibrate the current, from the Calibration Menu, press 4 - IL Current and do the following:

1. Read the value stamped on the external shunt (for example 500 amps / 100 mV).

2. Disconnect the external shunt or current transducer and inject a millivolt signal equal to the full-scale value of the shunt; for example, for a 100 mV shunt, inject a 100 mV signal.

3. If the current value displayed by the BPM does not agree with the actual shunt value to within 0.1% ±1 Amp, adjust the BPM reading using the Up/Down arrow keys.

4. Adjust the input signal to 50% of the shunt value and verify the BPM reading. If the BPM is not within 1% ±1 Amp of the input, you should return the BPM for repair.

5. Adjust the input signal to 25% of the shunt value and verify the BPM reading. If the BPM is not within 1% ±1 Amp of the input, you should return the BPM for repair.

4.3. Current (I_F) Calibration

Main Menu $\Rightarrow$ 3.Utilities $\Rightarrow$ Type Password $\Rightarrow$ Enter $\Rightarrow$ 3.Calib $\Rightarrow$ 3.IF Current

Current calibration is based on sensing the battery current using a standard 50 or 100 millivolt shunt. Make sure you select the proper shunt value from the Utilities|Configuration Menu. To calibrate the current, from the Calibration Menu, press 3 - IF Current and do the following:

1. Read the value stamped on the external shunt (for example 500 amps / 100 mV).

2. Disconnect the external shunt or current transducer and inject a millivolt signal equal to the full-scale value of the shunt; for example, for a 100 mV shunt, inject a 100 mV signal.

3. If the current value displayed by the BPM does not agree with the actual shunt value to within 0.1% ±1 Amp, adjust the BPM reading using the Up/Down arrow keys.

4. Adjust the input signal to 50% of the shunt value and verify the BPM reading. If the BPM is not within 1% ±1 Amp of the input, you should return the BPM for repair.

5. Adjust the input signal to 25% of the shunt value and verify the BPM reading. If the BPM is not within 1% ±1 Amp of the input, you should return the BPM for repair.

4.4. Temperature Calibration

Main Menu ⇒ 3.Utilities ⇒ Type Password ⇒ Enter ⇒ 3.Calib ⇒ 2.Temp

To calibrate the BPM temperature, from the Calibration Menu press 2 - Temp and do the following:

1. Place a calibrated thermometer near the bottom of the BPM enclosure and measure the temperature.
2. Adjust the BPM temperature reading to the same value using the Up/Down arrow keys.
3. Check the BPM reading against the calibrated thermometer periodically. The temperature should track within one degree.

4.5. Reset Calibration Constants

Main Menu ⇒ 3.Utilities ⇒ Type Password ⇒ Enter ⇒ 3.Calib ⇒ F2+Esc

CAUTION: This option resets calibration constants to factory default values.

If it is necessary to reset the channel calibration constants, from the Calibration Menu press F2 + Esc. In the channel calibration sub-menu, to reset the constants to the factory defaults, press Enter. To exit the menu without resetting the constants, press Esc.

5. BPM Software

The BPM software provides access to all BPM setup and alarm information, including calibration, alarm levels, and sensors. Alarm information is stored by site and battery, to allow storage of all cycle and alarm information for a given battery. To use the BPM with the software program, connect the BPM to the COM1 serial port on the computer. NOTE: The software program does not require a password for any function.

5.1. Software Installation

The BPM software is distributed on two 3.5-inch disks and runs under Windows 95, 98 and NT. Windows 3.1 is not supported. To install the program, insert Disk 1 into the computer and click Start|Run from the Windows desktop. From the Run dialog box, type a:\setup to start the installation. Follow the on-screen instructions to install the software.

To start the BPM program, double-click the BPM icon on the desktop.

5.2. BPM Main Menu Bar

After the BPM program starts, the Main Menu appears. Items on the Main Menu are described in the following sections.
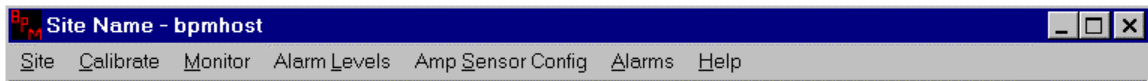
Figure 17. Main Menu Bar

5.3. Site Selection

To create a new site or open an existing site, from the Main Menu, click Site|New or Site|Open. You must open a site to establish communication with the BPM.

Figure 18. Site Menu

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5.3.1. Create a New Site

If Site|New is selected, a New Site dialog box prompts for a site name and MODBUS address. Data for the battery site is stored in an **.MDB** database file.
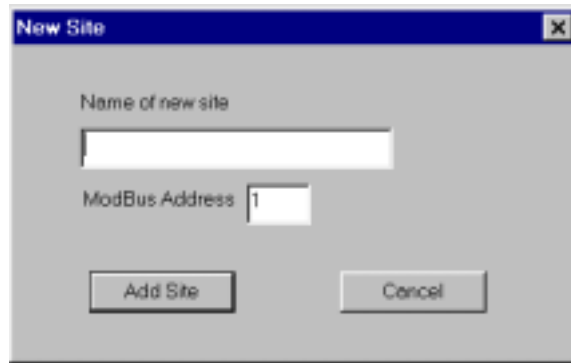
Figure 19. New Site

Name of New Site - Type the site name.

MODBUS Address - Unless using a MODBUS controller, do not change the MODBUS address. Refer to *Setting the MODBUS Address*.

5.3.2. Open an Existing Site

If Site|Open is selected, an Open BPM Site dialog box prompts for a site name.
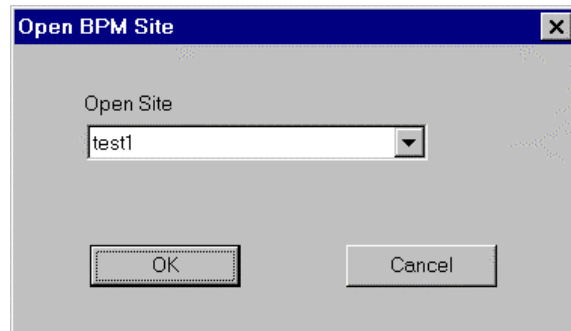
Figure 20. Existing Site

Open Site - Click the arrow next to the Open Site text box and select a site name from the drop down list.

With a site open and the BPM installed and connected to COM1, the system is ready for operation.

5.3.3. *Site Information*

The Site Information screen lets you print a header and set discharge and recovery parameters. To open the Site Information screen, from the Main Menu click Site|Info.
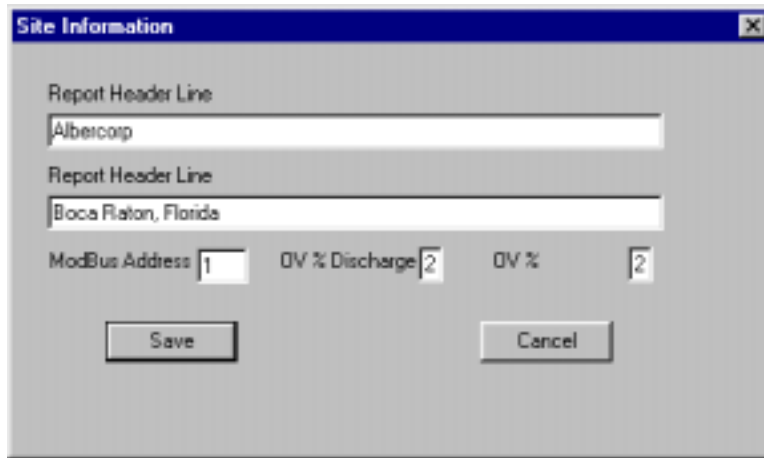
Figure 21. Site Information

Report Header Line 1 and **2** - In the Report Header text boxes, type information that will appear as a header on every page of the BPM report.

MODBUS Address - Unless using a MODBUS controller, do not change the MODBUS address. Refer to *Setting the MODBUS Address*.

OV% Discharge - This is the percent drop in voltage that the BPM needs to record a cycle. This value is typically set to 2% or 3%. (2% to 9% is the allowable range.)

OV% Recovery - This is the percent increase in voltage to end a cycle record. This value is typically set to 2% or 3%. (2% to 9% is the allowable range.)

5.4. Battery Calibration

To open the Battery Calibration dialog box, from the Main Menu, click Calibrate.
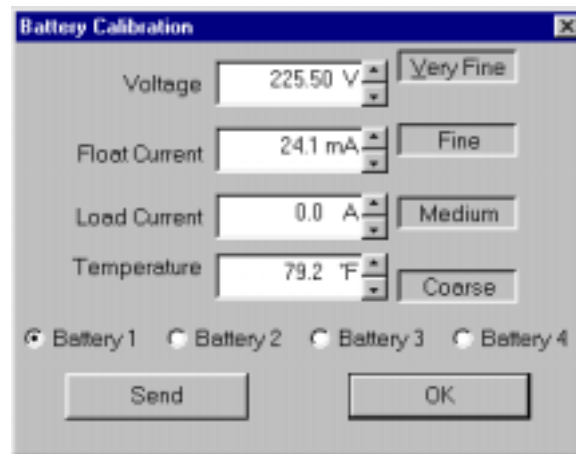
Figure 22. Battery Calibration

Battery 1 to **4** - Click one of the option buttons labeled Battery 1, 2, 3 or 4.

Voltage, **Float Current**, **Load Current**, and **Temperature** - Click the Up/Down arrows next to each box to adjust the value to the known actual readings. (Temperature is the value indicated by the calibrated thermometer.)

Very Fine, **Fine**, **Medium**, and **Coarse** - Select a button to adjust the increment.

Send and **OK** - After adjusting all battery parameters, to update the BPM, click Send or OK.

NOTE: Click OK to update the BPM and close the dialog box, or click Send to update and leave the dialog box open. To exit without uploading any changes, click the X on the top right of the dialog box.

5.5. Battery Monitor

To open the Battery Monitor dialog box, from the Main Menu, click Monitor.
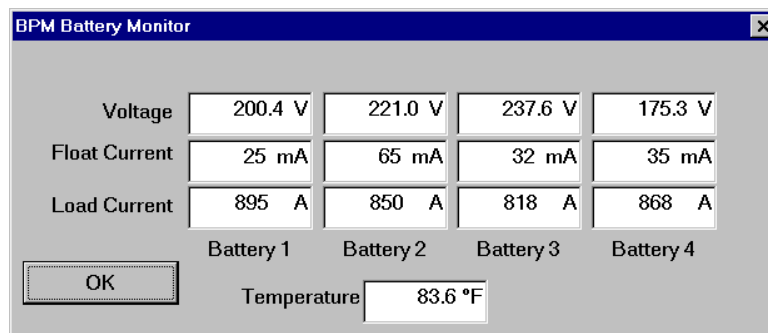
Figure 23. Battery Monitor

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The Monitor dialog box displays all present voltages, currents, and temperatures. On the Voltage line, a double-arrow (>>) before a value indicates the battery is discharging. An asterisk (*) before a value means it is out of range. (Refer to *Alarm Levels*.)

5.6. Alarm Levels

To open the Alarm Levels dialog box, from the Main Menu, click Alarm Levels.
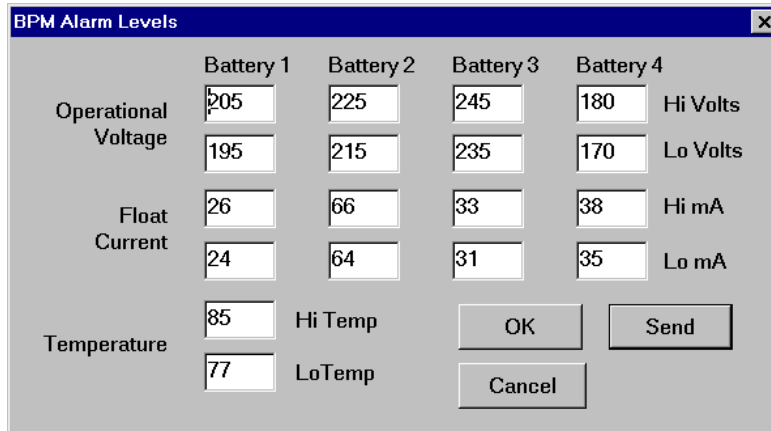
Figure 24. Alarm Levels

Operational Voltage, **Float Current**, and **Temperature** - The BPM monitors voltage and current, and records values that are out of range. Set the high and low alarm level in each box to the desired value. You may use the Tab key to step through the boxes. To update the BPM, click Send or OK.

NOTE: Click OK to update the BPM and close the dialog box. Click Send to update and leave the box open. To exit without changing, click the X on the top right.

5.7. Amp Sensor Configuration

To open the Amp Sensor Configuration dialog box, from the Main Menu, click Amp Sensor Config.
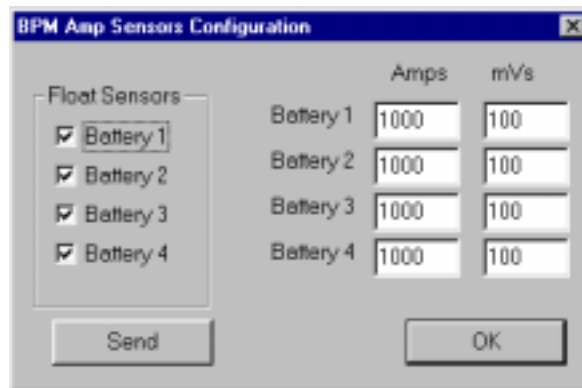
Figure 25. Amp Sensors Configuration

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Float Sensors - To enable a float sensor, check the box next to Battery 1, 2, 3 or 4.

Battery 1 to **4**, **Amps**, and **mVs** - For load current sensors, type a current value (in Amps) and a voltage value (in mV). To disable load current for a battery, type 0 Amps.

Send and **OK** -To update the BPM, click Send or OK.

NOTE: Click OK to update the BPM and close the dialog box. Click Send to update and leave the box open. To exit without changing, click the X on the top right.

5.8. Alarm Data

To open the Alarms menu, from the Main Menu, click Alarms.

The BPM stores cycle and alarm data in an **.MDB** database format. You may use Microsoft Access or other compatible database tools to access the data. If default settings are used, the BPM stores the data in c:\Program Files\ Alber\Battery Performance Monitor\bpm.mdb. All sites and battery information are stored in this one file. You should back up this file regularly.

Figure 26. BPM Connected/ Not Connected Menus

Upload - To upload alarm data from the BPM memory, first open or create a new site. With a site open, from the Main Menu, click Alarms, then click Upload. NOTE: After a few seconds, if the menu item Upload is gray, the software is not communicating with the BPM.
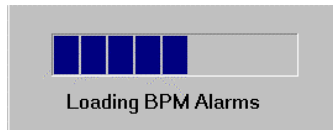
Figure 27. Upload Progress Bar

After Upload is clicked, a progress bar displays upload status. If no bar appears, there is no data stored in the BPM. After data is uploaded and displayed, it is saved and the BPM memory is cleared. The software clears the BPM hardware of all alarms and stores them in the database.

Load from Database - To load all database records for the open site, from the Main Menu, click Alarms, then click Load from Database.

Battery 4							
Cycle #	Date/Time	Start Vs	Vs@30secs	Lowest Vs	Maxium Load	Load @30secs	Duration
1	10/08/98 01:08:31pm	178.0 Vs	178.1 Vs	0.0 Vs	866A	865A	01:40:28
2	10/08/98 02:54:07pm	177.4 Vs	0.0 Vs	0.0 Vs	866A	0A	00:00:12

Battery 1						
Alarm #	Date/Time	Alarm Type	Alarm Level Start	User Level Low	User Level High	Duration
1	09/08/98 07:57:24pm	IF	43.7 mA	24 mA	20 mA	00:00:00

Figure 28. File Database

Print - The screen displays all records for the site open. To print the records, from the Main Menu, select Print.

6. Maintenance

The BPM is designed for years of trouble-free operation. Although very little maintenance is required, check the unit periodically for obvious physical damage and loose connections, and check calibration at least annually. If the unit is installed in a dirty environment, occasionally clean the display with a soft cloth, moistened with a mild cleaning solution.

7. Specifications

Reading	Range	Measurement Accuracy
Overall Voltage	0 to 600 VDC	0.1% of Reading ±0.5V
Temperature[1]	0°F to 150°F	±1°
High Current Channel[1]	0 to 4000 Amps	0.1% of reading ±1 Amp
Low Current Channel[1]	0 to 400 mA	1% of reading ±2 mA

Data Entry and Interface

Display	4 lines x 20 character LCD backlighted
Keyboard	16 key keypad
PC Interface[2]	Via an RS232C port. Albércorp software allows for uploading of all data. Data can then be displayed, analyzed, and printed.

Outputs

One maintenance alarm Form C contact rated 1 Amp at 120 VAC
One critical alarm Form C contact rated 1 Amp at 120 VAC

Power Source

Primary Input Power	115/230 VAC, 50/60 Hz
Backup Battery	Rechargeable battery: 2 full hours operation
Memory	10 year lithium type

Data Storage

Alarm Records	More than 100 individual alarms
Cycle records	More than 200 cycles

Physical Data

8.5" high, 4.5" deep, 10" wide.

Notes:
1. Optional feature requiring additional hardware
2. Optional feature requiring additional software package

Specifications are subject to change without notice.

Index

BATTERY PERFORMANCE MONITOR
MENU FLOW DIAGRAM

APPENDIX A

POWER-UP PROCEDURE

Connect Unit's Back—up Battery

Connect AC Power

POWER-DOWN PROCEDURE

Remove AC Power

✳ [F2+Esc] From Main Menu

NOTE: 28

Disconnect Unit's Back—up Battery

Unit Power—Down USER—RAM will be write protected [N]Esc [Y]Enter

NOTES: 1,28

✳ Software shut—down procedure must be followed to properly protect (non—volatile) data storage.

[F2+Esc]

Main Menu
1—Battery Monitor
2—Battery Data
3—Utilities

[1]

[2]

[3]

PASSWORD PROTECTION

Utilities Enter Password _ _ _ _ [Esc]Exit [Enter]pw

NOTES: 1, 5

UTILITIES
See Pages 5, 6, 7 & 8

USER DATA
See Pages 2 & 3

BATTERY MONITOR
See Page 4

SYSTEM NOTES
See Page 9

MAIN MENU

USER DATA

```
       [1]      Battery-1 Data      [F2+2]
                1-CYCLE Data
       [2]      2-ALARM Data
              NOTES: 1, 2
                            ── Page 3
```

CYCLE DATA

```
       [1]      Battery-1 Cycle Data      [2]
                1-No. Cycles/View
       [3]      2-Voltage vs Time
                3-Cycle History
                   NOTES: 1, 2
```

```
              Battery-1 Cycles

                #Records  = 003
              View Record = 001
                 NOTES: 1, 29
```

```
Cycle   Date      Time          [Esc]    Cycle = 001      B1
→001 00/00/00 00:00a    ◄────            VLo V30s = 298, 336
 002 00/00/00 00:00p          [Enter]    Duration = 00:00:45
 003 00/00/00 00:00a    ────►            00/00/00   00:00:00am
NOTES: 1, 18, 19, 26                        NOTES: 1, 26
```

```
                     [Esc]    Cycle = 001      B1
                                IL Max  = 0000A
                                IL 30s  = 0000A
                              00/00/00   00:00:00am
                               NOTES: 1, 26, 32
```

VOLTAGE vs TIME DATA

```
Cycle   LowV3    Time      [1]    Volts vs Time Batt-1
→001 00/00/00 00:00a              1-Lowest Voltage
 002 00/00/00 00:00p      [2]     2-Volts @ 30s
 003 00/00/00 00:00a
NOTES: 1, 18, 19, 26                  NOTES: 1, 2
```

```
Cycle   V1_30s   Time
→001 00/00/00 00:00a
 002 00/00/00 00:00p
 003 00/00/00 00:00a
NOTES: 1, 18, 19, 26
```

MAIN MENU

USER DATA

[1]
[2]

```
Battery-1  Data

 1-CYCLE  Data
 2-ALARM  Data
```
[F2+2]

NOTES: 1, 2

BATTERY ALARM DATA

```
Battery-1  Alarm  Data
 1-No.  Alarms/View
 2-Alarm  History
 3-TEMP  Alarms
```
[1]
[2]

[3]

NOTES: 1, 2

```
Battery-1  Alarms

#Records  =  003
View  Record  =  001
```

NOTES: 1, 14

[Enter]

```
Alarm  Record-001
OV=000.0  r:000-300
00/00/00    00:00:00am
```
[Esc]
[Enter]

NOTES: 1, 26

```
Alarm    Date      Time
→001  00/00/00  00:00a
 002  00/00/00  00:00p
 003  00/00/00  00:00a
```

NOTES: 1, 2, 18, 19, 26

TEMPERATURE ALARM DATA

```
Temperature  Alarm  Data
 1-No.  Alarms/View
 2-Alarm  History
```

NOTE: 1

[1]
[2]

```
Temperature  Alarms

#Records  =  003
View  Record  =  001
```

NOTES: 1, 29

[Enter]

```
TAlrm    Date      Time
→001  00/00/00  00:00a
```
[Esc]
[Enter]

NOTES: 1, 18, 19, 26

```
TAlrm  Record-001
  TF=000    r:080-150
00/00/00    00:00:00am
```
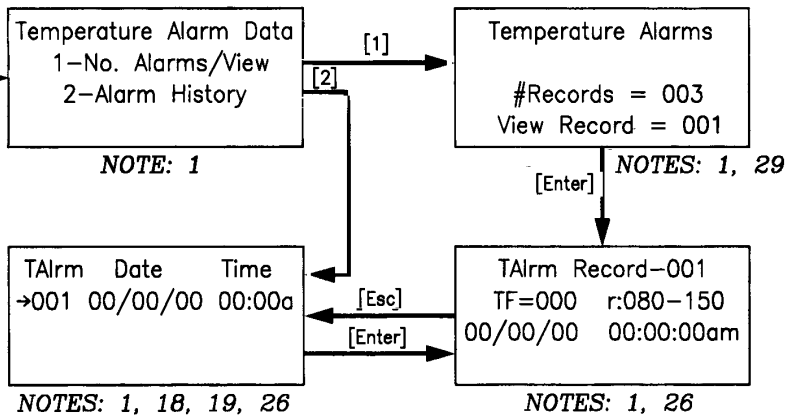
NOTES: 1, 26

MAIN MENU

BATTERY MONITOR

```
Battery – 1
Volts = ___.__
Temp = ___°F
IF = ___mA
```
[F2+2]   [F2+1]

NOTES: 1, 3, 4, 25, 30

```
Shut Off alarms,
alarm LED, &
relay.
```

SYSTEM PARAMETERS

```
System Parameters
1–Date/Time 2–Alarms
3–Hardware   4–SW1
5–UMEM_ChkSum
```
[1] [2]
[3] [4]
[5]

NOTES: 1, 2

```
Batt   IF    IL–Rating
 1   _x_ _100A/100mV
 2   _x_ _100A/100mV
 3   _x_ _100A/100mV
```
NOTES: 1, 21

```
User_Memory CheckSum
CS = efff
[Enter] to continue
```

```
Configuration Switch

SW1 = 8 hex
```
NOTES: 1, 21

```
Batt–1 User Alarms
        OV   IFmA    °F
Hi = 600   999   120
Lo = 000   000   000
```
NOTES: 1, 2, 21

```
Date/Time

00/00/00   00:00:00am
```
NOTES: 1, 21

MAIN MENU

```
CLEAR Battery-1
ALARM Settings

[N] Esc   [Y] Enter
```

```
        Utilities  Menu      [4]
[1]  1-Alarms     4-Memory    [5]
[2]  2-DateTime   5-Config    [6]
[3]  3-Calib      6-Diags
        NOTES: 6, 22
```

[F2+Esc]

ALARM PARAMETERS

```
     Alarms    Battery-1      [4]
[1]  1-HI Volts  4-LO Volts   [5]
[2]  2-HI Temp   5-LO Temp    [6]
[3]  3-HI IF     6-LO IF
        NOTES: 1, 2, 7
```

```
Batt-1  Alarm  Setting

IF  Hi  =  999  mA
      ———
NOTES: 1, 9, 14
```

```
Batt-1  Alarm  Setting

IF  Lo  =  000  mA
      ———
NOTES: 1, 9, 14
```

```
Batt-1  Alarm  Setting

Temp  Hi  =  150  °F
      ———
NOTES: 1, 9, 14
```

```
Batt-1  Alarm  Setting

Temp  Lo  =  000  °F
      ———
NOTES: 1, 9, 14
```

```
Batt-1  Alarm  Setting

OV  Hi  =  600  V
      ———
NOTE: 1, 9, 14
```

```
Batt-1  Alarm  Setting

OV  Lo  =  000  V
      ———
NOTES: 1, 9, 14
```

MAIN MENU

```
        Utilities  Menu
[1]   1—Alarms      4—Memory   [4]
[2]   2—DateTime    5—Config   [5]
[3]   3—Calib       6—Diags    [6]
```
NOTES: 6, 22

DIAGNOSTICS

```
        Diagnostics  Menu
[1]   1—Keybrd     3—RS232    [3]
[2]   2—Display    4—Alarm
```
NOTE: 1

```
     Alarm  Contact  Diag
        1—Alarm  ON
     → 2—Alarm  OFF
        [ESC]  Exit
```
NOTES: 1, 17

```
       Serial  Port  Diag
       Insert  LOOPBACK
          Connector
    [Esc]Exit  [Enter]Tst
```
NOTE: 1

```
        Serial  Port  Diag
     Tx  =  ____  Rx  =  ____
     Error  Count  =  ____
          [ESC]  Exit
```
NOTE: 16

```
XXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXX
```
NOTE: 15

DATE/TIME STAMP

```
        DATE  /  TIME
    mm/dd/yy  hh:mm:ssmm
    00/00/00    00:00:00a
```
Cursor

NOTE: 1, 13, 14

```
      KeyBoard  Diags

         Key  =  ff
      [F1+ESC]  Exit
```
NOTES: 1, 14

BATTERY PERFORMANCE MONITOR
APPENDIX A
Page 6

MAIN MENU

[F2+Esc]

```
          Utilities  Menu
[1]
          1-Alarms      4-Memory    [4]
[2]                                 [5]
          2-DateTime    5-Config    [6]
[3]
          3-Calib       6-Diags
             NOTES:  6,  22
```

CHANNEL CALIBRATION

[F2+Esc]

```
       Calibration  Batt-1
[1]                              [3]
       1-Volts     3-IF  Current
[2]                              [4]
       2-Temp      4-IL  Current
          F1-Next  Battery
       NOTES:  1,  2,  9,  10
```

```
[F2+Esc]  Calibration  Batt-1

            Temp  =

            C[n]cnts  =
```

```
          Calibration  Batt-1        [F2+Esc]

            IL  Amps  =

            C[n]cnts  =
```

NOTES: 1,9,11,12,14,27   NOTES: 1,9,12,14,27

```
[F2+Esc]  Calibration  Batt-1

            Volts  =

            C[n]cnts  =
```

```
          Calibration  Batt-1       [F2+Esc]

            IF  mAmp  =

            C[n]cnts  =
```

NOTES: 1,9,11,12,14,27   NOTES: 1,9,11,12,14,27

```
          RESET  Battery-1
          Channel  Calibration
             Constant(s)
          [N]  Esc  [Y]  Enter
```

MAIN MENU

USER MEMORY

```
      Utilities  Menu
[1]  1-Alarms    4-Memory  [4]
[2]  2-DateTime  5-Config  [5]
[3]  3-Calib     6-Diags   [6]
       NOTES: 6, 22
```

```
                        [F2+Esc]
   User Memory Batt-1    [1]
   1-Clear CYCLE Data
   2-Clear ALARM Data    [2]
   3-Clear    ALL Data   [3]
       NOTES: 1, 2
```

```
   ---- WARNING ----
   Erase ALL CYCLE &
   ALARM Batt-1 Data?
   [N] Esc    [Y] Enter
          NOTE: 1
```

```
   ---- WARNING ----
   Erase ALL ALARM
      Batt-1 Data?
   [N] Esc    [Y] Enter
          NOTE: 1
```

```
   ---- WARNING ----
   Erase ALL CYCLE
      Batt-1 Data?
   [N] Esc    [Y] Enter
          NOTE: 1
```

```
   ---- WARNING ----
   Erase ALL CYCLES &
   ALARM Battery Data?
   [N] Esc    [Y] Enter
          NOTE: 1
```

SYSTEM CONFIGURATION

```
       Configuration  Menu       [F1+Esc]
[1]    1-Current Sensors
       2-Date/Time Format
       3-ModBus Address
          NOTE: 1
```

```
   Cycle Category Code

   _ _ Category Code
       NOTES: 1, 14
```

```
Amp Sensors Batt-1

IL _____A / ___mV
IF Sensor __x__
 NOTES: 1, 2, 14, 24
```

```
 Date/Time Format
→ 1-mm/dd/yy °F
   2-dd/mm/yy °C
   NOTES: 1, 17
```

```
Enter ModBus Address

   addr = nnn
      NOTE: 1
```

NOTES:

1. Pressing [Esc] key returns user to previous screen.

2. [F1] key selects next battery if configured for multiple batteries. System can be configured for one, or three batteries. Display shows one or all batteries.

3. The field IF (Float Current) automatically changes from IF to IL (Load Current) when IF Sensor overflows A/D converter. Actual amount is dependent on IF sensor.

4. If an Alarm is present, an arrow appears to the left of the parameter in alarm. If in discharge, an arrow appears next to Battery Identifier.
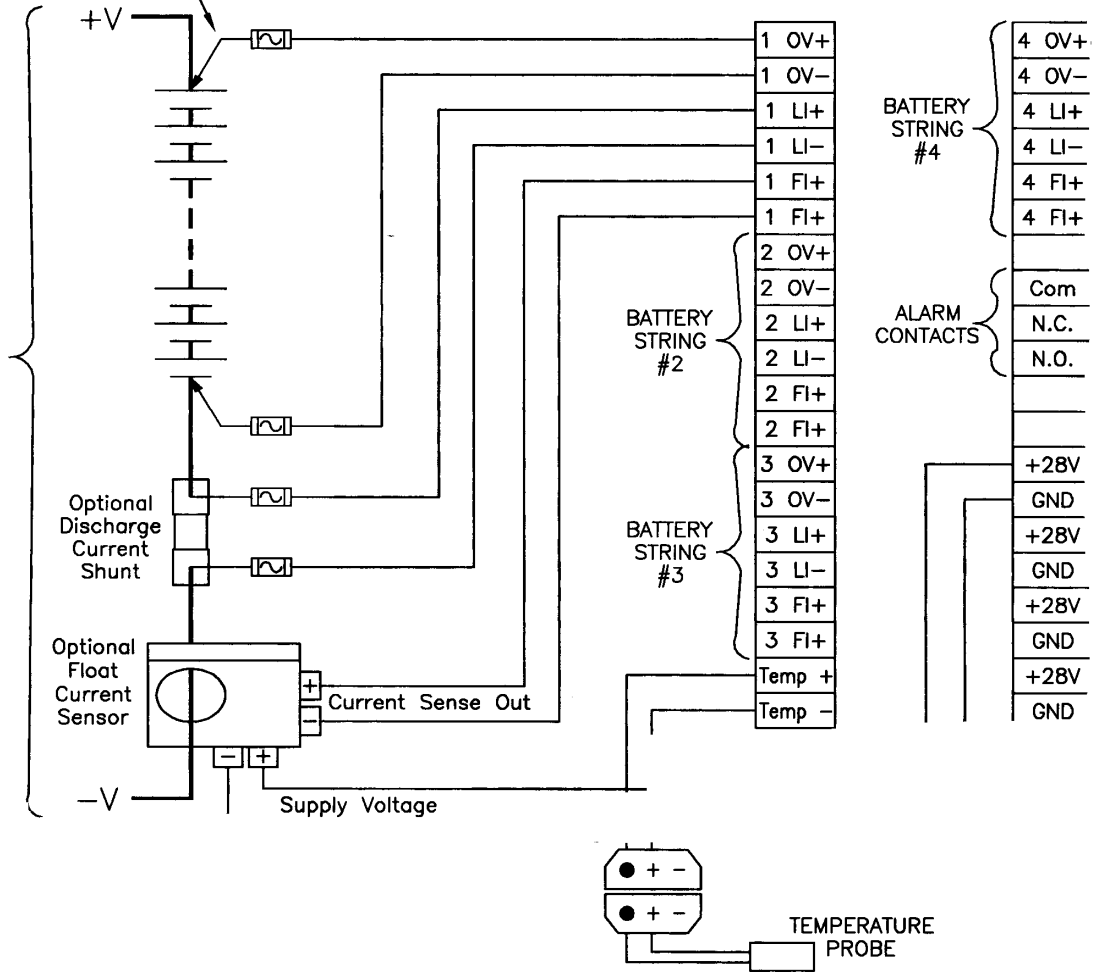
5. Default password is 7777. If password is unknown, pressing [F1+4] displays a random four digit code that the Backdoor Password can be calculated from.

6. Pressing [Esc] key shows Main Menu.

7. Pressing [F2+ESC] resets all Battery-n alarm levels to factory default values.

8. Display shows and indicates Date and Temperature Format selected under this menu.

9. Will only allow entry if configured for that battery.

10. Pressing [F2+ESC] sets all calibration constants to factory default for all batteries.

11. Pressing [F2+ESC] sets this parameter constant to factory default for the selected battery.

12. Use [↑],[↓] keys to adjust monitor value to new calibrated value. [F1] increments values quickly while [F2] provides fine increments.

13. This Menu used to enter correct Time & Date. [F1] toggles (On/Off) the active date/time stamp underneath the user programmable stamp and should only be activated when cursor is in the left most position of the user stamp.

14. As keys are pressed, they are displayed on the screen. Upon pressing [Enter], the user's numeric input is either processed and accepted or rejected which will result in a "parameter out of range" error. Pressing [Enter] toggles (On/Off) options (i.e. meridian; a.m.; p.m.; etc.).

15. After display diagnostic [2] is selected and completed, software control returns to the Diagnostic Menu.

16. Pressing [Esc] returns user to the DIAGNOSTICS MENU.

17. Options are selected by either pressing [F2] or the corresponding number key. An arrow to the left of the active selection is always shown.

18. [↑],[↓] arrow keys are used to scroll through Date/Time list. Pressing [Enter] displays data record for that event. Pointer to the left selects cycle/alarm to be viewed. Data is listed in chronological order.

19. [↑],[↓] arrow keys are used to scroll through cycles/alarms. Press [Enter] to see data record for that cycle event.

20. Pressing [F1+ESC] initializes all user memory parameters (alarm levels, temp/date format, active thresholds, channel, calibration constants, current sensors off, shunts – 100A/100mV) to factory defaults.

21. Display mode only.

22. Pressing [F1+4] brings up active threshold Menu. These critical values are used to define "discharge" in progress and "Thermal Alarm Runaway".

23. New % Value is entered via keyboard.

24. [↑],[↓], & [F2] keys are used to select field. The [Enter] key while on the IF–Sensor selection, toggles (Enable/Disable) this option (On/Off) defining the On, or active condition with an "X".

25. [F2+Esc] displays OV counts for diagnostic purposes only.

26. [F1],[↓] keys are used to select the next record available. [F2], [↑] keys are used to select the previous record.

27. [Enter] inputs user data, or toggles options (On/Off).

28. Perform this procedure for proper unit power–down and prior to removing AC power.

29. The user enters a particular record to be viewed with the numeric key pads and presses enter to view detailed data. If the entry is invalid, a message will appear "Invalid Entry."

30. [F2+2] enters the Battery Data Screen. Pressing [Esc] returns to the Main Menu.
[F2+Enter] clears alarm contacts.

31. [F2+Enter] clears alarm contacts.

32. [Enter] displays IL Max & IL at 30 seconds during the discharge cycle.

33. [F2+Esc] provides the user with a pseudo–random password seed for password reentry.
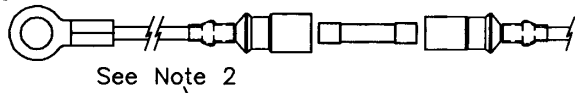
Installer must attach one end of the wire to fuse holder and other end to terminal strip. Wire gauge must be 22AWG or greater with a Voltage Rating of at least 60V D.C.

See Note 2

+V

1	OV+
1	OV−
1	LI+
1	LI−
1	FI+
1	FI+

BATTERY STRING #4

4	OV+
4	OV−
4	LI+
4	LI−
4	FI+
4	FI+

BATTERY STRING #2

2	OV+
2	OV−
2	LI+
2	LI−
2	FI+
2	FI+

ALARM CONTACTS

| Com |
| N.C. |
| N.O. |

BATTERY STRING #3

3	OV+
3	OV−
3	LI+
3	LI−
3	FI+
3	FI+

| Temp + |
| Temp − |

| +28V |
| GND |
| +28V |
| GND |
| +28V |
| GND |
| +28V |
| GND |

Optional Discharge Current Shunt

Optional Float Current Sensor

Current Sense Out

−V

Supply Voltage

TEMPERATURE PROBE

NOTES: 1. Connect each Battery String as shown to its corresponding termination points on the Terminal Strip inside the BPM enclosure.

2. Overall Voltage leads are terminated at the battery terminals using ring terminal and a series connected fuse provided by Albercorp. (See detail above.)

3. Connect Ambient Temperature Probe as shown using a (2) Conductor, 22 AWG cable not exceeding 15' in length.

4. Discharge Current Shunt and Float Current Sensor are optional.

5. Optional Discharge Current Shunt Kit consists of (1) 100mV Shunt and (2) 12.00" fused leads. Installer must mount Shunt on an insulated plate and connect leads from fuse holder to terminal strip using a (2) Conductor, shielded cable.

6. Optional Float Current Kit consists of (1) Sensor that must be physically installed by user and wired as shown. Wire gauge can 22 AWG or greater and a minimum of 300V insulation rating.

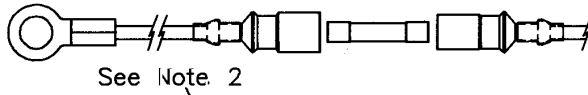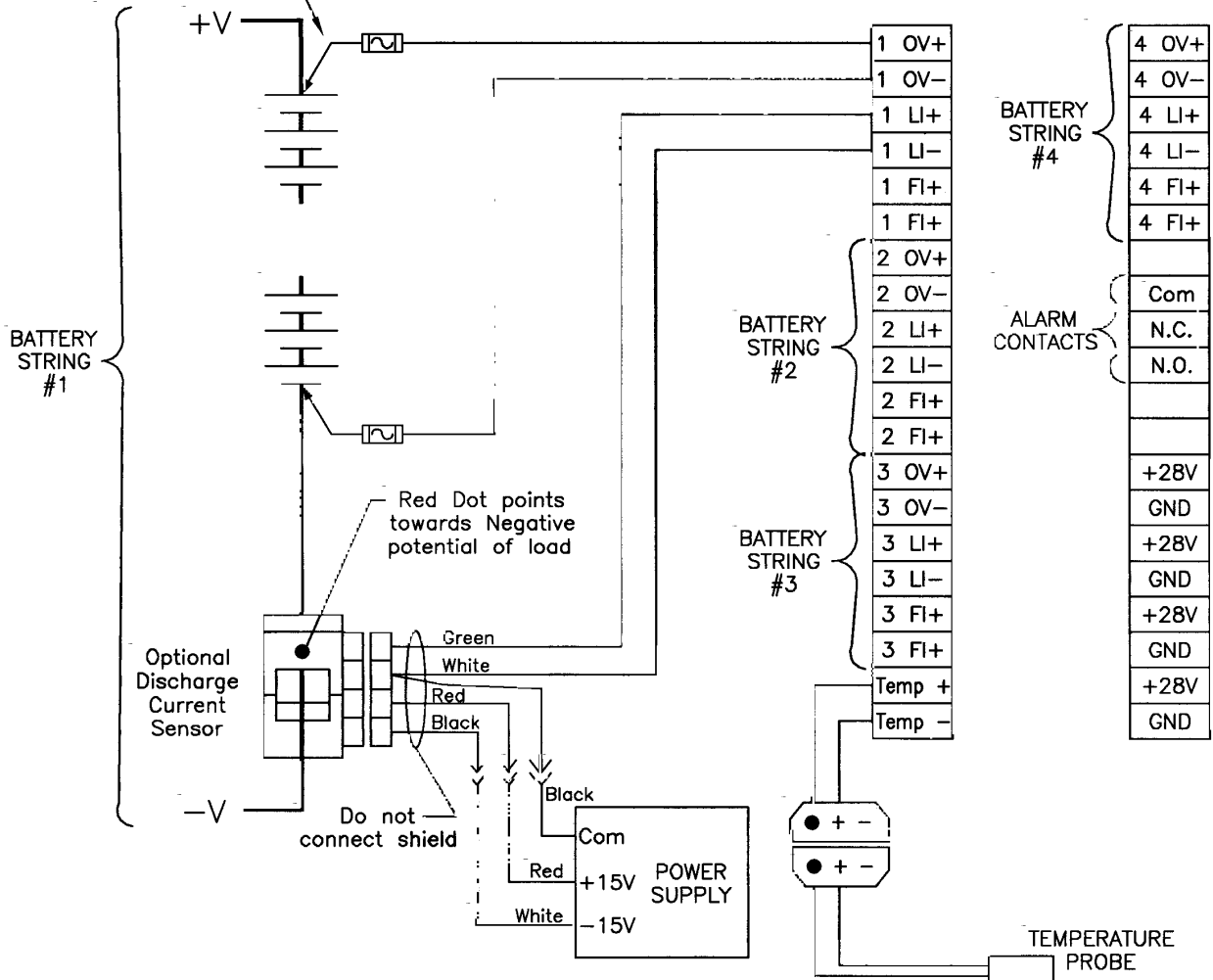BATTERY PERFORMANCE MONITOR
INSTALLATION SCHEMATIC

See Note 2

Installer must attach one end of the wire to fuse holder and other end to terminal strip. Wire gauge must be 22AWG or greater with a Voltage Rating of at least 600V D.C.

+V

BATTERY STRING #1

| 1 OV+ |
| 1 OV− |
| 1 LI+ |
| 1 LI− |
| 1 FI+ |
| 1 FI+ |

BATTERY STRING #4
| 4 OV+ |
| 4 OV− |
| 4 LI+ |
| 4 LI− |
| 4 FI+ |
| 4 FI+ |

BATTERY STRING #2
| 2 OV+ |
| 2 OV− |
| 2 LI+ |
| 2 LI− |
| 2 FI+ |
| 2 FI+ |

ALARM CONTACTS
| Com |
| N.C. |
| N.O. |

BATTERY STRING #3
| 3 OV+ |
| 3 OV− |
| 3 LI+ |
| 3 LI− |
| 3 FI+ |
| 3 FI+ |

| +28V |
| GND |
| +28V |
| GND |
| +28V |
| GND |
| +28V |
| GND |

Red Dot points towards Negative potential of load

Optional Discharge Current Sensor

Green
White
Red
Black

Temp +
Temp −

−V

Do not connect shield

Black
Com
Red +15V   POWER SUPPLY
White −15V

TEMPERATURE PROBE

NOTES: 1. Connect each Battery String as shown to its corresponding termination points on the Terminal Strip inside the BPM enclosure.

2. Overall Voltage leads are terminated at the battery terminals using ring terminal and a series connected fuse. (See detail above.)

3. Connect Ambient Temperature Probe as shown using a (2) Conductor, 22 AWG cable not exceeding 15' in length.

4. Discharge Current Sensor is optional.

5. Optional Discharge Current Kit consists of (1) Sensor and (1) ±15V Power Supply installed by user and wired as shown. NOTE: Observe color coding as shown.

BATTERY PERFORMANCE MONITOR
INSTALLATION SCHEMATIC
Discharge Sensor Revision