

# **Cellcorder® CRT-300 User's Guide**



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# **1 Safety Information**

You must read and understand the following safety precautions and those printed elsewhere in this manual before using the Cellcorder®.

- Except as explained in this manual, do not attempt to service Albér 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 Albér directly.
- Ensure equipment is provided adequate ventilation. Do not block equipment ventilation openings.
- Do not exceed equipment voltage or power ratings or capabilities.
- Do not let unauthorized persons operate the equipment.
- The maximum voltage the Cellcorder can read is 20V. Do not attempt to read Overall Volts (OV). The Cellcorder calculates OV based on cell voltage readings.
- Never let any Cellcorder metal surfaces come in contact with a battery post or grounded rack while testing with the unit.
- Do not attempt to read internal resistance of an open cell/module while the battery is on-line.
- Do not perform any testing with the Cellcorder when the AC Power indicator is lit or when the charger module is connected to the Cellcorder. Injury to personnel or damage to equipment could result.
- Use of this product in a manner not specified could compromise the designed-in safety of this product.
- High voltage or current may be present in the equipment. Only qualified personnel should perform the operations described in this manual.

## 2 *What's New*

The Cellcorder® CRT-300 battery cell voltage and resistance tester is the newest addition to the Albér Cellcorder line. The CRT-300 is lightweight, stylish, rugged, and durable. Special features include new, user-friendly operation, Smart Media® memory card, infrared (IR) communication, a graphical LCD display, and redesigned cables and clamps.

**Voltage and Current Protection** - An internal circuit helps protect the Cellcorder if inadvertently placed across a high voltage. Circuitry senses the input voltage across the current carrying leads and, if the input voltage exceeds 20 volts, a beep sounds and the test current relays are disabled. As a reminder, it is still potentially hazardous to exceed the rated voltage of the Cellcorder (20 volts).

**New Excel® Compatible .CSV File Format** - The CRT-300 creates a .CSV file when a .CDF Cellcorder data file is created. The .CSV file is used by Microsoft Excel to display data in spreadsheet format.

**Help Screens and Menu Selections** - The new CRT-300 has easier-to-use screens, many of which offer Help pages that provide details about options on the screen.

In addition, you now select options using the F1 to F4 function buttons instead of the keypad. To speed up the selection process, function locations have been standardized: Yes and No are at F1 and F2, and Cancel and Back appear on F4 or F3 when possible.

Main Menu > Get a coffee | Read this manual | Use the CRT-300

To make the manual easier to use, menu sequences appear about paragraphs describing specific operations. This manual contains a complete description of all Cellcorder features and specifications.

### **3    *System Requirements***

A typical Cellcorder system requires the following manuals:

Cellcorder CRT-300 User's Guide, 4200-038

Battery Analysis System User's Guide, 4200-002 (if a computer is used)

UPS (uninterruptible power supply) manufacturer's instruction manual (if a UPS is used)

USB Media Reader/Writer manufacturer's instruction manual (Belkin Components, Smart Media or other)

Hydrometer manual (if a hydrometer is used)

Data storage module (used with the hydrometer)

## **4 General Description**

The CRT-300 Cellcorder battery cell voltage and resistance tester features a Smart Media<sup>®</sup> memory card, infrared communication, graphical reflective LCD display, and newly designed cables and clamps. The Cellcorder reads single cells and multicell modules, and displays and records cell float voltage, internal cell resistance, and intercell connection resistance. A compatible hydrometer can transfer specific gravity and temperature data via the IR port.

The self-contained CRT-300 Cellcorder is comprised of a microprocessor, load resistor, display, and rechargeable battery. Voltmeter probes and a three clip resistance set are provided; optional test leads are available from Albér.

The CRT-300 functions well even in high noise environments, without the need to disconnect the battery from service. A 60 amp DC load (on 2V cells) is used to calculate internal cell resistance and intercell resistance. Circuitry rejects the 50Hz/60Hz ripple and associated harmonics often troublesome to AC-based impedance and conductance meters.

The CRT-300 ships with an 8M memory card, USB memory card reader/writer, resistance and voltage test leads, carrying case, charger module, and Battery Analysis System (BAS) software. An optional thermal printer is available.

**Data Memory and Communication** - The removable memory card stores a large amount of data in both CRT-300 .CDF and Excel<sup>™</sup> .CSV file formats. The memory card or IR port transfers readings to a computer for analysis and report generation.

**System Display** - The high contrast, 128 x 64 pixel, backlit graphical display shows menus, warnings, and test results.

**Power** - The CRT-300 is powered by a lithium ion rechargeable battery. It does not operate on AC power. A fully charged unit can test for seven hours. Isolated operation helps ensure safety. A charger module is included.

**Float Voltage Readings** - The CRT-300 measures the voltage applied during full float operation. The voltage range covers all cells or modules up to 20 volts. Accuracy of readings is to four full digits.

**Internal Cell Resistance** - Using a patented process, the CRT-300 applies a momentary load and calculates internal cell resistance by determining instantaneous voltage drop and load current. Cells floating on-line or off-line can be measured. This method helps find weak, potentially failing cells when comparing internal cell resistance of all like cells in the string.

**TIP:** Refer to Application Note CC-001 for more about cell resistance. Tips throughout this book alert you to key points.

**Intercell Resistance** - The CRT-300 measures the resistance between two electrically connected cell terminals. The measurement consists of connector resistance and contact resistance at the points of connection to the cell terminals.

**Auto Ranging** - The CRT-300 automatically selects the correct voltage range, load resistor, and test time.

**Data Extraction and Analysis** - The memory card or IR interface transfer data to a computer. The BAS program analyzes data, displays results in graph or tabulated formats, and prints reports. It also exports report files in ASCII, Excel™ or comma-delimited format so other programs can generate customized reports. Refer to the *Battery Analysis System User's Guide*.

## 5 Panel Controls and Indicators

This section describes the Cellcorder controls, indicators, and connectors. Menu items on the LCD display are described in the sections of the manual where they are used.

### Top Panel Indicators

- AC Power.....Red. On when Cellcorder battery charger is connected.
- Charge.....Green. On when charger is connected and battery is charging. Off indicates fully charged battery.
- Smart Media Card....Yellow. On when Cellcorder is accessing the Smart Media memory card for read or write.
- Test .....Red. On when resistance test is in progress. Flashing indicates a problem with the resistance test.
- Beeper .....Emits audible feedback when enabled.

### Top Panel Controls

- Shift.....Press Shift, release Shift, then press *another key* to select orange text on a key. (Shift+*key name*).
- F1 to F4.....The F1, F2, F3 and F4 buttons select the functions on the LCD directly above. The buttons also have the following options.
- Print (Shift+F1) ....Sends data to the printer via IR.
  - Send (Shift+F2) ....Sends data to the computer via IR.
  - Save (Shift+F3) ....Saves data to the memory card.
  - Site (Shift+F4).....Displays the site selected.
- Power .....Press and release to power on the CRT-300. Press and hold to power off.
- Enter / Arrows.....Five functions: Enter plus Arrow keys. Press Enter after typing data, such as password. Press Up, Down, Left or Right arrows to navigate screens.
- Test .....Press to initiate cell testing.
- 0 to 9 .....The keypad offers alphanumeric data entry and the following options.
- Start (Shift+1) .....Start. Displays the Main Menu.
  - Time (Shift+2) .....Time. Sets the date format and time.
  - Mem (Shift+3) .....Memory. Clears stored data.
  - Hz (Shift+4) .....Frequency (Hz) for 50Hz/60Hz ripple frequency.

- Alarm (Shift+5) .....Alarm. Sets threshold levels.
- Disp (Shift+6) .....Display. Adjusts LCD contrast.
- Serv (Shift+7) .....Service. Accesses calibration, default, and password.
- Mute (Shift+8) .....Mute. Sets the internal beeper on or off.
- Diag (Shift+9) .....Diagnostics.
- Esc.....Escape key. Press to exit certain screens. Hold and press Power On (Esc+Power On) to start in firmware upgrade mode.

### **Left Panel Connectors**

- Test Leads .....Connector for test leads that connect to the cell under test. Do not connect or use when Cellcorder AC LED is lit.
- Memory Card .....Port for inserting the memory card. May insert/remove with power on or off, but the Smart Media Card yellow LED must not be lit.

### **Right Panel Connectors**

- Infrared Port .....For communicating with a computer or printer via infrared (IR) light signal.

### **Bottom Panel Controls (Battery Compartment)**

- Mechanical Reset .....Switch located under the battery pack. Press to reset the Cellcorder.

### **Bottom Panel Connectors (Accessory Compartment)**

- Telco .....A modular jack for communicating with a remote computer via telephone.
- Power .....A 5VDC input jack for connecting the Cellcorder battery charger module.

## 6 CRT-300 Basics

This section describes CRT-300 Cellcorder features, including the power up sequence, main menu, mechanical reset, and test lead connection.

### 6.1 Power On/Off

To power on the CRT-300, press the green Power key. The LCD screen displays the Albér logo, the firmware version, and the Main Menu. To power off, press and hold the Power key until Release power button appears. Powering off does not remove readings from temporary storage.

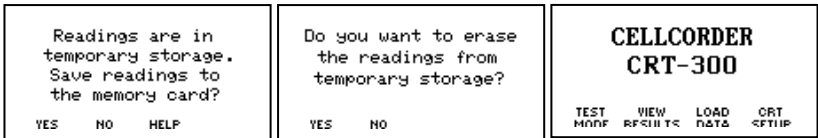


Figure 1. Data in Memory Messages and Main Menu

**At power up or power down, a message** may appear: Readings are in temporary storage. Save readings to the memory card? To save cell readings to the memory card, insert the card and press Yes. Whether you press No or Yes, data remains in Cellcorder temporary storage. If Do you want to erase the readings from temporary storage? appears, to clear data from memory, press Yes; all readings in temporary storage will be deleted.

**TIP:** To keep cell data, you must save it before clearing temporary storage.

**Shift** - Press Shift to display the **S**hift symbol on the top right of the screen. Some commands require that you press and release Shift, then press another key with orange text. For example, to display the Main Menu, press Shift+Start. The Shift symbol on the screen confirms Shift is enabled.

**Esc** - In some cases, the Escape key behaves like the Cancel or Back key.

### 6.2 Reset Switch

**WARNING:** Do not reset the CRT-300 when the AC Power indicator is lit. Before resetting, disconnect the CRT-300 test leads from any equipment.

A reset switch is located in the battery compartment under the batteries. If the CRT-300 locks up (no keys respond), disconnect the unit from all voltages, open the battery compartment, and press the reset switch using a pointed object. Do not use a pencil, as graphite may get inside the unit.

## 6.3 Main Menu

The Main Menu options are Test Mode, View Results, Load Data, and CRT Setup. Press the F1 to F4 buttons below the options to select them.

- |              |                                                                                                                                                                                               |
|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Test Mode    | Displays menus to measure voltage, determine resistance or add specific gravity (SG) and temperature readings. SG/Temp are imported from a separate instrument.                               |
| View Results | Summarizes overall voltage (OV), cell voltage, cell resistance, and intercell resistance readings as averages, min/max lists or threshold violations. Helps determine if retesting is needed. |
| Load Data    | Accesses site setup and <b>.CDF</b> cell data files.                                                                                                                                          |
| CRT Setup    | Displays menus for voltage, resistance, and SG/Temperature threshold limits, memory, LCD settings, sound, ripple frequency, and date/time.                                                    |

## 6.4 Using the Test Leads

This section summarizes good test lead connection practices to help ensure the accuracy of readings. For actual test lead connection, refer to *Measuring Voltage and Resistance*.

**WARNING:** Never let any Cellcorder metal surface touch a battery post or grounded rack.

**WARNING:** Do not attempt to read internal resistance of an open cell/module while the battery is on-line. An open cell can be determined by the unusually high voltage across it and the lower (nominal) voltage across all other cells/modules. Refer to *Application Note CC-001*.

When measuring internal cell resistance, place the sense leads directly on the positive and negative terminal posts, so the measurement does not include any part of the external circuit.

**TIP:** Consistency in the way readings are taken is necessary when comparing readings over time.

When measuring intercell connector resistance, place the sense leads on the terminal posts. Intercell measurement checks the quality of the connection between the intercell bar and the terminal post.

On some batteries (typically VRLA), the posts are inaccessible because they are covered by the intercell connector. For valve regulated batteries, where only the intercell and the mounting bolt are accessible, connect the current lead to the bolt head and the voltage sensing lead to the intercell. Measuring from bolt head to bolt head is not a true measure of the connection between the post and intercell bar; in most cases, the reading will be high because of the high resistance of the bolt itself. (Refer to *Application Note CC-002*.)

Most battery terminal posts have a layer of lead dioxide, lead sulfate, copper oxide or dirt mixed with No-Ox grease. All are high in resistance, so make sure the test leads have good connection to the metal surfaces.

## 6.5 Before Taking Measurements

Before taking cell measurements, charge the Cellcorder and confirm calibration by reading a known voltage using a known shunt as an intercell connector. Refer to *Using the Test Leads* to review good test lead connection and to *Application Note CC-002*, which discusses internal resistance measurement.

Before testing cell voltage or resistance, you should select a site, though this is not mandatory. To create or select a site, refer to *Setting Up a Site Before Test* and *Selecting a Site for Test*.

**WARNING:** Do not test any cells when the Cellcorder AC Power indicator is lit. Injury to personnel or damage to equipment could result.

## 6.6 Charging the Cellcorder

Prior to testing, charge the CRT-300 using the charger module until the green Battery LED goes out. This LED indicates battery level only with the charger connected. Charging may take several hours. If the battery wears down during testing, do not use the charger for power when testing cells.

**TIP:** A discharged battery does not affect data readings in temporary storage.

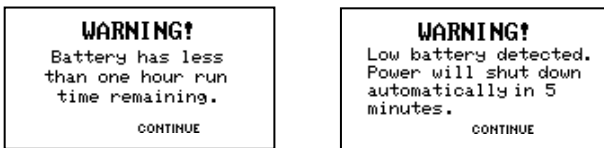
|                                                                                                                                                      |
|------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>WARNING:</b> Do not test any cells when the Cellcorder AC Power indicator is lit. Injury to personnel or damage to equipment could result.</p> |
|------------------------------------------------------------------------------------------------------------------------------------------------------|

Before charging, first disconnect any test leads from the CRT-300, then open the accessory compartment cover by loosening the two slotted screws. Connect the charger to the power connector inside the compartment, then plug the charger into 115VAC. The Power AC and Battery LEDs light.

When the battery is fully charged, unplug the charger from 115VAC then from the CRT-300. Replace the accessory compartment cover. Before beginning testing, cycle CRT-300 power off then on.

The life of the lithium ion battery depends on how well it is charged. Do not store the CRT-300 in a discharged condition.

When the battery is low, warnings indicate remaining test time. At full discharge, the unit turns off. You can access data in temporary storage after recharging. If you use a unit needing recharge, it will shut down without warning. If you continue to use the unit in this state, data could be lost. To prolong battery life, the CRT-300 shuts down if inactive for ten minutes.



**Figure 2. Typical Battery Power Warnings**

## **6.7 Using the Memory Card Drive**

The CRT-300 stores data on an 8 megabyte memory card. Cards up to 128M are available. Use the card to transfer cell data to a computer for analysis, transfer firmware upgrades from computer to Cellcorder, back up and restore calibration constants, and store site setup. Use Windows Explorer™ to access the card drive and data.

Connect the memory card reader/writer drive to a USB port on the computer and follow manufacturer's instructions to install the driver software. Do not use the Microsoft Windows driver. If a USB connection is not available, contact Albér for alternate drives.

Insert the memory card into the computer or CRT-300 drive to read or write data. You may insert or remove the card from the CRT-300 with power on or off, but the CRT-300 yellow Smart Media Card LED must not be lit.

**CAUTION:** Do not insert or remove the memory card when the Cellcorder Smart Media Card LED is lit.

**WINDOWS 2000 CAUTION:** When using Windows 2000, memory card removal from some manufacturer's drives may require your doing the following:

1. Double-click the My Computer icon on the Windows desktop.
2. Right click the reader/writer drive icon and select Eject from the pop-up menu.
3. After the message It is now safe to remove the media from the drive appears, remove the memory card.

Failure to follow this procedure could result in lost data. See your drive manual to determine if this or other procedures apply.

## 7 CRT-300 Setup Options

Main Menu > CRT Setup

CRT Setup displays options for battery model selection, thresholds, memory, LCD display, sound, frequency, and date/time. This section describes the options.



Figure 3. Setup Menus

**TIP:** To scroll screens or lists, use the Up/Down Arrows. To go back a screen, exit a function, or return to the Main Menu, press Back, Cancel or Esc.

### 7.1 Battery Select

Main Menu > CRT Setup|Bat

Use Battery Select to access a database of battery models that automatically sets certain threshold parameters. Choose a manufacturer, press Accept, then choose a battery model and press Accept.

### 7.2 Thresholds

Main Menu > CRT Setup|Thresh

Voltage and resistance thresholds can be set or changed outside of site setup. (Refer to *Setting Up a Site Before Test*.) The Cellcorder indicates an out-of-tolerance reading by beeping twice and displaying the reading in reverse video.

**TIP:** Shift+[another key] opens the function in orange text on the key.

**Site Not Selected** - If a site is not selected, you can set up thresholds using CRT Setup. The settings remain in Cellcorder temporary storage until changed, cleared to default (zero) values or a site is selected.

**Site is Selected** - If a site is selected, you can change the thresholds using CRT Setup, but the changes affect only the Cellcorder and not the site file. The settings remain in temporary storage until changed, cleared to default or another site is selected.

**Default Thresholds** - If a site is selected, you can quit the site settings and return to default thresholds for voltage, resistance, temperature, and SG without affecting the site file.

**To clear site setup and thresholds** - To have no site associated with a file that has been linked, and to clear threshold settings, use the Clear button on the Active Site screen. For a complete description, refer to *Unlinking a File and Clearing Thresholds*.

Main Menu > CRT Setup|Thresh

**To set up Cellcorder (not site file) thresholds** - Select Thresholds, then choose Voltage, Cell Resistance, Intercell Resistance, Specific Gravity or Temperature. A series of screens appears for parameters that may be set. Press the Arrows to change values. Press Accept to accept the value displayed.

**Fahrenheit or Celsius** - On the Temperature screen, select Celsius or Fahrenheit using the C/F button before setting the high/low temperatures.

**Disabling a Threshold** - Setting any threshold value to zero (or 32°F / 0°C for temperature) disables the threshold.

Use the Up-Down-Left-Right Arrows to enter threshold values. You cannot use the keypad to type numeric values. The following table shows the ranges for each programmable entry.

**TIP:** Shift+Alrm also accesses Threshold.

|                                        |              |                    |
|----------------------------------------|--------------|--------------------|
| <b>Voltage Threshold</b>               |              |                    |
| High.....                              | 00.000V      | to 19.999V         |
| Low .....                              | 00.000V      | to 19.999V         |
| <b>Cell Resistance Threshold</b>       |              |                    |
| High.....                              | 00000μΩ      | to 64999μΩ         |
| Low .....                              | 00000μΩ      | to 64999μΩ         |
| <b>Intercell Resistance Threshold</b>  |              |                    |
| (Ric 1 of 4) High .....                | 00000μΩ      | to 24999μΩ         |
| (Ric 2 of 4) High .....                | 00000μΩ      | to 24999μΩ         |
| (Ric 3 of 4) High .....                | 00000μΩ      | to 24999μΩ         |
| (Ric 4 of 4) High .....                | 00000μΩ      | to 24999μΩ         |
| <b>Specific Gravity (SG) Threshold</b> |              |                    |
| High.....                              | 0.000        | to 9.999           |
| Low .....                              | 0.000        | to 9.999           |
| <b>Temperature Threshold</b>           |              |                    |
| High.....                              | 32.0°F (0°C) | to 99.9°F (37.7°C) |
| Low .....                              | 32.0°F (0°C) | to 99.9°F (37.7°C) |

**Figure 4. Threshold Limits**

### 7.3 Clear Memory

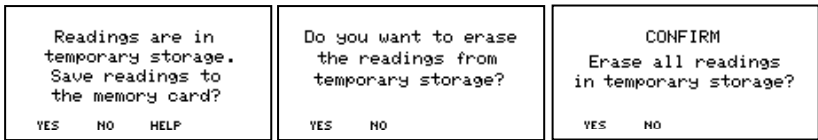
**CAUTION:** After clearing CRT-300 temporary storage, you cannot recover the data.

Main Menu > CRT Setup|Mem

Shift+Mem

Power Up or Power Down

If you want to take readings on another battery, save the previous readings to the memory card before clearing them from temporary storage. Use CRT Setup|Mem or Shift+Mem to save to the memory card and/or clear temporary storage. At power up and power down, if data is in temporary storage, messages to save and clear also appear.



**Figure 5. Data in Memory Messages**

Usually, you will not clear data until after you save it. Cleared data is lost but can be retrieved from the memory card. If you back up memory card data to a computer, you can use the BAS program to analyze cell readings.

At the message, Readings are in temporary storage. Save readings to the memory card?, to save the data, press Yes and refer to *Saving to the Memory Card*.

At Do you want to erase the readings from temporary storage?, if you are certain you want to delete (erase) the readings, press Yes. To not delete, press No.

**7.4    Display**

Main Menu > CRT Setup|▼|Disp

Use Display to adjust the Cellcorder LCD display. Use the Up/Down Arrows to adjust contrast, then press Accept.

**TIP:** Shift+Disp also accesses Display.

**7.5    Sound**

Main Menu > CRT Setup|▼|Sound

Use Sound to turn the Cellcorder beeper off or on. Use the Up/Down Arrows to select off or on, then press Accept.

**TIP:** Shift+Mute also accesses Sound.

**7.6    Frequency**

Main Menu > CRT Setup|▼|Freq

Use Frequency to have the Cellcorder A/D circuitry filter out the AC line frequency noise. Use the Up/Down Arrows to select 50Hz or 60Hz, then press Accept.

**TIP:** Shift+Hz also accesses Frequency.

## 7.7 *Date/Time*

Main Menu > CRT Setup|▼|▼|Date then Date or Format

Use Date to set the date, time, and date format. Use the Arrow keys to set the date and time, then press Accept. To select date format (MM:DD:YY or other), press the corresponding function key.

**TIP:** Shift+Time also accesses Date and Time.

## 8    *Setting Up and Editing a Site*

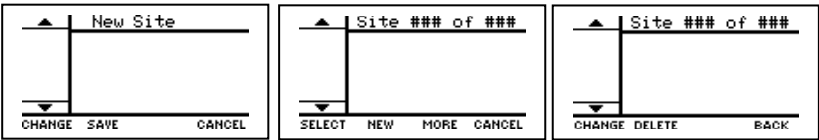
Site setup defines site names, thresholds, and other parameters. During testing, the Cellcorder uses site settings for voltage and resistance thresholds. A site setup is not required for testing, but is useful for managing many sites. Sites lets you record details for locations and use the same information for future testing. This section describes site screens and setting up, linking, editing, and deleting sites. To set up thresholds with no site selected, refer to *Setting Up the Cellcorder*.

**TIP:** To display the Main Menu from any screen, use Shift+1. (Press and release Shift, then press Start.)

### 8.1    *Navigating the Site Menu*

Main Menu > Load Data|Site Setup

To access any site screen, insert a memory card into the Cellcorder, then select Site Setup. If the memory card has no sites, the New Site screen appears with Change, Save, and Cancel options.



**Figure 6. Data Setup**

If sites exist, Site 001 of XXX appears, where XXX is the number of sites on the memory card. Available options are Select, New, More, and Cancel. Pressing More displays Change, Delete, and Back.

**TIP:** To step through sites, use the Right/Left Arrows. To scroll screens or lists, use the Up/Down Arrows. To go back a screen, exit a function, or return to the Main Menu, press Back, Cancel or Esc.

The left column lists items to which you may assign values. Descriptions appear when an item is highlighted. To edit an item, press Change, then use the keypad or arrow keys. Most alphanumeric keypad key types four characters: a number and three letters. The blank space character is on the 9 key. The cursor advances two seconds after pressing an alphanumeric key, or you may use the Right Arrow. To type a name, for example, press a key then wait or press the Right Arrow.

Location, battery, and string names have a limited number of characters, and other parameters have minimum/maximum values. When Temperature and SG summary thresholds are exceeded, the Cellcorder beeps twice, displays reverse video, and prints out in the Thresholds section. The following table lists editable items and the keys to use (up/down/left/right arrows, alphanumeric keypad).

After editing an item on an existing site, some screens display Accept while others display Save. Press Accept or Save to save the change to the site file.

**Space Key and Deleting Characters** - Use 9 on the keypad to type spaces in location, battery, string or model names. To delete characters, highlight the character and press Delete Char (F1). You cannot use the space key with file names.

## Setting Up and Editing a Site

| Item                                                                        | Description                                          | Edit Text Using    |
|-----------------------------------------------------------------------------|------------------------------------------------------|--------------------|
| LOC                                                                         | Location name. 39 characters max.                    | L/R arrows, keypad |
| BAT                                                                         | Battery name. 18 characters max.                     | L/R arrows, keypad |
| STG                                                                         | String name. 15 characters max.                      | L/R arrows, keypad |
| MOD                                                                         | Model number of battery. 39 characters max.          | L/R arrows, keypad |
| CEL                                                                         | Total number of cells. Defaults to 256.              | L/R and U/D arrows |
| DAT                                                                         | Battery installation date.                           | L/R and U/D arrows |
| OPT                                                                         | Options. Sets the ripple filter (AC line) frequency. | U/D arrows         |
| HV, LV                                                                      | High / low cell voltage. Sets limits.*               | L/R and U/D arrows |
| HR, LR                                                                      | High / low internal cell resistance. Sets limits.*   | L/R and U/D arrows |
| HI1, HI2, HI3, HI4                                                          | High intercell resistance 1, 2, 3, 4. Sets limits.*  | L/R and U/D arrows |
| HT, LT                                                                      | High / low cell temperature. Sets limits.*           | L/R and U/D arrows |
| HSG, LSG                                                                    | High / low specific gravity. Sets limits.*           | L/R and U/D arrows |
| TST                                                                         | Sets Amp hours for load test and intercell type.     | F2 and F3 key      |
| * During testing, two beeps and reverse video indicate limits are exceeded. |                                                      |                    |
| max = maximum. L/R = left/right. U/D = up/down                              |                                                      |                    |

**Figure 7. Definable Site Items**

## 8.2 Setting Up a Site Before Test

Main Menu > Load Data|Site Setup *and New if needed*

To create a new site, select Site Setup. If the memory card has no sites, the New Site screen appears. If sites exist, press New to display New Site.



**Figure 8. New Site**

To begin site setup, highlight LOC with the Up/Down Arrows. To edit, press Change. Using the keypad, type the location name and press Save. To correct a mistyped entry, repeat the process.

Press the Down Arrow to highlight BAT, press Change, type, then Save. Complete all items in the list. Note some items use Accept instead of Save.

After assigning all values, press Save on the New Site screen.

Site NNN of XXX appears. NNN is this site number; XXX is the number of sites on the memory card. If, while setting up the site, you inadvertently return to the Main Menu, refer to *Editing an Existing Site*.

### 8.3 Linking a File to a Site After Test

Linking a .CDF file to a site embeds site setup into the file. When transferring data to the computer, this lets the BAS program set up a new .ADF battery file if one does not exist. Also, the .CDF file can be viewed using the CRT-300 Previewer. If cell readings were taken with no site selected, or saved to a .CDF file not associated with a site, you can link the file to a defined site (or create a new site, then link the file). If the readings are only in Cellcorder temporary storage, first save them to the memory card.

Main Menu > Load Data|Cell Data|▲ or ▼|Select

To open the data file you want to link to a site, select Cell Data. Highlight a .CDF file name, then press Select. After the data loads into memory, the Main Menu appears.

To confirm the file is not already linked to a site, press Shift+Site. The Active Site screen should not display location, battery or string names. To return to the Main Menu, press Cancel. If Active Site displays names, you can link the .CDF file to a different site by loading the new site and saving the file.



**Figure 9. Active Site**

Main Menu > Load Data|Site Setup|◀ or ▶|Select

To select the site you want linked to the .CDF data file, select Site Setup, press the Right/Left Arrows to step to the desired site, then press Select. (Or press Load from the Active Site screen, then select a site.)

Setting Up and Editing a Site

To save the linked data file to the memory card, press Shift+Save. Type the file name and press Save. After the file is saved, you may confirm the site/file correlation by pressing Shift+Site. If Active Site displays the correct site names, press Cancel. To select a different site, press Load.

**TIP:** To determine at any time what site is selected, press Shift+Site.

8.4 Unlinking a File and Clearing Thresholds

Main Menu > Shift+Site|Clear

If you want to have no site associated with a file that has been linked, press Shift+Site to display the location, battery, and string names of the site currently selected. To unlink, press Clear on the Active Site screen to return setup to default. This unlinks the data file from the site. To clear threshold settings, select Yes on the Clear all thresholds screen.



Figure 10. Restore Messages

To accept the changes on the Active Site screen, press Cancel. Press Shift+Save to save the file.

8.5 Editing an Existing Site

Main Menu > Load Data|Site Setup|◀ or ▶|▼|More|Change

To edit an existing site, whether associated with a .CDF data file or not, select Site Setup, press the Right/Left Arrows to step to the site to edit, then press More. To edit an item, highlight the item, then press Change. Using the keypad or Arrows, type the new data and press Save or Accept. To edit another item, repeat the process. When editing is done, you may select the site by pressing Back then Select.

8.6 Deleting a Site

Main Menu > Load Data|Site Setup|◀ or ▶|More|Delete

To delete a site, select Site Setup, then press the Right/Left Arrows to step to the site. To delete the site, press More|Delete. At the confirm screen, press Yes. The site deletes and the number of sites decrements by 1.

If the deleted site was the currently selected site, press Shift+Site to display the Active Site screen. Press Load and select a new site or press Clear to have no site selected. Refer to *Unlinking a File and Clearing Thresholds* for more about Clear.

NOTE: When a site is deleted, the last site shifts to fill the deleted site. For example, if site 003 of 006 is deleted, site 006 becomes 003 of 005. You may use the BAS program or CRT-300 Previewer to sort the sites on location, battery or string name.

## 8.7 **Selecting a Site for Test**

Before reading voltage or resistance, you should select a site. A site setup is not required for testing, but is useful for managing many sites. If a site is selected before testing, both the readings and site setup will be saved in the **.CDF** file.

Main Menu > Load Data|Site Setup

To select a site, at the Main Menu, select Load Data|Site Setup. Press the Right/Left Arrows to step to a site, then press Select.

Shift+Site

If a site has been selected and you want to take readings with no site selected, press Clear. Refer to *Unlinking a File and Clearing Thresholds* for more about Clear. To select a different site, press Load.

**TIP:** To determine at any time what site is selected, press Shift+Site.

## 9 Measuring Voltage

Before testing cell voltage, you should select a site, though not mandatory.

**WARNING:** Do not test any cells when the Cellcorder AC Power indicator is lit. Injury to personnel or damage to equipment could result.

Use the Voltage mode and voltage probes to take float voltage readings. The Cellcorder ignores polarity in Voltage mode, so you may connect the leads either way. When the probes contact a cell, the Cellcorder displays the voltage and beeps to indicate the reading is stored in temporary storage. When the probes are lifted off the cell, the Cellcorder steps to the next cell number.

**WARNING:** The maximum voltage the Cellcorder can read is 20V. Do not attempt to read Overall Volts (OV). The Cellcorder calculates OV based on cell voltage readings.

### 9.1 Taking Voltage Readings

Before taking readings, you should select a site.

Main Menu > Test Mode|Volt

Connect the voltage test leads to the Cellcorder, then select Volt. The screen displays the cell number and voltage and either Resume testing or Stored in Memory. To display another cell number, type the number then press Enter, or use the Up/Down Arrows.

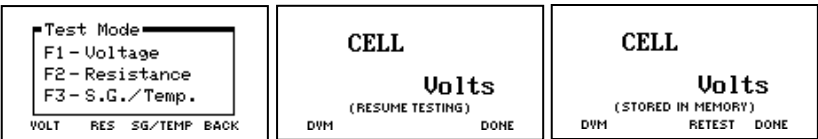


Figure 11. Voltage Displays

**Resume testing** means no reading exists for the cell number. Place the voltage probes onto the cell. The Cellcorder reads the voltage and beeps. Move the leads to the next cell; the screen displays the next cell number.

**TIP:** To display another cell number, type the number then press Enter, or use the Up/Down Arrows.

**Stored in memory** indicates the cell number was previously read. During testing, you may review or retest previously read cells. To return to a cell number, use the Arrows or keypad. To test again, press Retest, place the probes onto the cell, and wait for the beep. Lift the leads; the next cell number appears. If the next cell number was also previously read, you can either retest or change the number using the Arrows or keypad.

After testing is done, remove the leads from the cell under test and press Done. To save, refer to *Saving the Readings*.

## **9.2    *Digital Voltmeter Test Mode***

Main Menu > Test Mode|Volt|DVM

You may use the Cellcorder as digital DC voltmeter. Connect the voltage test leads to the Cellcorder, then select DVM. The screen displays voltage readings as they are taken. The readings cannot be saved.

**WARNING:** Do not measure any voltage higher than 20VDC.

To leave the voltmeter mode and return to a previous screen, press Cancel. The DVM mode is also accessible from other Cellcorder screens.

## **10 Measuring Resistance**

Before testing cell resistance, you should select a site, though not mandatory.

**WARNING:** Do not test any cells when the Cellcorder AC Power indicator is lit. Injury to personnel or damage to equipment could result.

Use the Resistance mode and three clip resistance probes to take internal cell resistance and intercell connection resistance readings on each cell.

**WARNING:** Do not attempt to read internal resistance of an open cell/module while the battery is on-line. An open cell can be determined by the unusually high voltage across it and the lower (nominal) voltage across all other cells/modules.

### **10.1 Resistance Test Overview**

In the Resistance mode, the user connects the leads and initiates testing. The CRT-300 reads cell float voltage, unless previously stored using voltmeter mode. Based on cell voltage, the unit determines the correct range, connects a fixed resistance across the cell and intercell under test, and briefly applies 60 Amps (on 2V cells). Test current changes from 5 to 60 Amps depending on cell/module voltage (1V to 16V). During load condition, the unit reads cell voltage, current, and intercell voltage drop and calculates internal cell and intercell resistances. At completion, the internal cell resistance ( $R_c$ ) and the intercell resistance ( $R_{ic}$ ) is displayed.

The CRT-300 transfers test data to a computer using memory card or IR (infrared) communication. The Battery Analysis System (BAS) program analyzes the data, displays data in bar graph format, and generates standard and custom reports.

### **10.2 Skewing Effect**

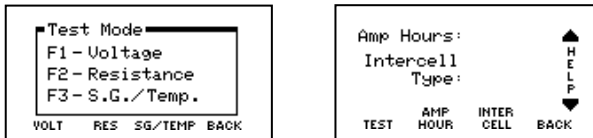
When reading resistance, a skewing effect of the cell voltages leads to a small error. As the first half of the cells are resistance tested, those voltages become depressed until the charger brings them back to normal float levels. This means that the voltages of the remaining cells increase to make up the difference, since the charger controls the overall voltage. The skewing effect is particularly noticeable on small and weak cells. For large batteries, such as mini-tank cells, the effect is not as noticeable, but there is still a small error in the voltage readings.

**Avoiding the Skewing Effect** - When reading resistance, if no float voltages exist, a message asks if you want to read voltages. It is suggested you choose Yes, take voltage readings, then resume resistance testing. If you select No, the Cellcorder concurrently reads voltage and resistance for each cell. (Voltage is read, then the load is applied.) Concurrent readings are subject to the skewing effect.

### 10.3 Setting Amp Hours and Intercells

Main Menu > Test Mode|Res then Amp Hour then Intercell

Connect the resistance test leads to the Cellcorder, but not to the cell under test. Select Resistance (Res). On the Amp Hour / Intercell screen, select battery size (smaller or larger than 1000 Ah) by pressing Amp Hour to display <1000 or >1000 Ah. This sets the length of time the Cellcorder applies a load.



**Figure 12. Amp Hour/Intercell Type Setup**

To select how many intercell (IC) connections per cell will be read (one to four), press Intercell to display Single, Dual, Triple, Quad, Combined or Computed. Refer to *Application Note CC-002* to determine the number.

**Combined** - Combined testing is done in one step using two leads. Attach the leads to the positive terminals of two jars connected with an intercell connection, then perform the resistance test. The reading combines the cell  $R_c$  plus the intercell  $R_{ic}$ . Using Combined, no  $\mu\Omega$  values are displayed for  $R_{ic1}$  to  $R_{ic4}$ . Combined is faster than Computed, but does not separately indicate cell and intercell resistance values, whereas Computed does.

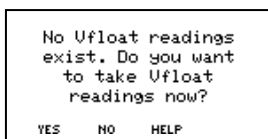
**Computed** - Computed testing requires two steps using two leads. First, attach the leads to the positive and negative terminals of a jar connected to a second jar via an intercell connection, then perform the resistance test. Then, move the negative lead to the positive terminal (with the intercell connection) of the second jar and perform the resistance test. The CRT-300 subtracts the lower  $R_c$  and displays two resistance readings: the cell  $R_c$  and the computed intercell  $R_{ic}$ . Use Computed to determine if a problem is in the cell or in the intercell connection. Refer to *Application Note CC-002* for connection diagrams.

## 10.4 Taking Resistance Readings

Main Menu > Test Mode|Res|Test|Test

Before taking readings, you should select a site. When taking resistance readings, a skewing effect of cell voltages produces a small error.

Press the F1 or orange Test button. If float voltage readings exist, the Resistance screen flashes Ready to Test. If not, a message appears; select Yes (recommended) to switch to Voltage mode, insert the voltage leads, and select the cell number to read voltage. Resume resistance testing when finished.



**Figure 13. No VFloat Readings Message**

If you select No, the Cellcorder concurrently reads voltage and resistance for each cell.

**TIP:** Taking voltage readings before resistance readings, rather than concurrently, avoids the skewing effect on voltage measurements.

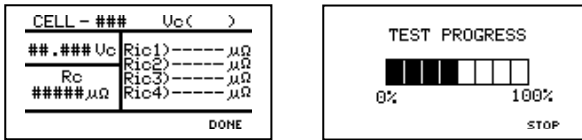
When Ready to Test is flashing, connect the three clip resistance probes to the cell and intercell under test. If testing cells with single intercell connectors, connect the probes as follows:

- 1) Red clip to the positive post of the cell being tested.
- 2) Red/Black clip to the negative post of the cell being tested.
- 3) Black clip to the positive post of the next cell.

If testing requires two to four intercell measurements, refer to *Application Note CC-002* for probe connection diagrams.

**NOTE:** The standard jaws may not provide the best connection to some cell posts. If you encounter poor post connection, contact Albér for alternate or custom jaws at nominal cost.

The Resistance screen displays Vc(act) or Vc(mem). Vc(act) shows the actual cell voltage being read. Vc(mem) means the cell voltage was read earlier and is in memory.



**Figure 14. Resistance and Test Progress**

Press the orange Test key. After the cell or Ric1 intercell resistance appears, move the probes to the next cell or intercell and press Test. The cell or intercell number advances when the leads are moved.

**TIP:** While the test progress indicator is on the screen, to stop the resistance test, if required, press Stop.

If the cell requires two or more IC (intercell) resistance readings, move the black/red and black leads to the next IC connection, then press Test for each IC measurement. (Refer to *Application Note CC-002* for lead placement.) The first Ric reading displays when Test is initially pressed; the next one displays after the leads are moved and Test is pressed again. In this case, the cell number does not increment until the last intercell is read.

**NOTE:** You can step to the next cell number using the Up Arrow, but then you may have unread cell or intercell numbers. Use the Arrows primarily to review readings upon test completion.

If you press Test before moving the probes to the next cell, Reading exists. Overwrite? appears. To read the same cell/intercells, select Yes. If not, select No and move to the next cell.

If you press Test too soon, Initializing appears while internal components cool down. Testing may halt if components get too hot.

Continue measuring all the cells. After testing is done, remove the leads from the cell under test and press Done. You may save the readings from the next screen. Refer to *Saving the Readings*.

## 11 Measuring S/G and Temperature

The optional hydrometer reads specific gravity (SG) and temperature. The data storage module, which holds data for up to eight strings *A* to *H*, mounts on the hydrometer. You may transfer SG and temperature readings from the module in three ways: (1) module to Cellcorder via IR, (2) module to computer via IR, or (3) module to computer via RS-232. The module IR port interfaces with the Cellcorder, computer or PDA; the RS-232 port transfers data to the computer. When using RS-232, refer to the *Battery Analysis System User's Guide*.

Main Menu > CRT Setup|Thresh|▼|Temp

**Fahrenheit or Celsius** - When SG/Temp is selected, temperature displays in degrees Fahrenheit (°F) or Celsius (°C). The universal setting for °F or °C is under CRT Setup|Thresholds|Temperature.

### 11.1 Hydrometer Data to Cellcorder via IR

Transfer SG and temperature data from the hydrometer to the Cellcorder via IR as follows:

1. Main Menu > Load Data|Cell Data|▲or ▼|Select  
Before transferring data, you should select a cell data file into which SG and temperature readings will be added. Select Cell Data, highlight a .CDF file name, then press Select.
2. Main Menu > Test Mode|SG/Temp|Import  
Select SG/Temperature, then press Import.
3. Press the hydrometer data module On button.
4. On the data module, press Sel to select the channel (string) A through H from which data will be transferred. The module LEDs indicate memory status as follows:  
**Fast** - If the LED next to A through H is flashing fast, that channel has data and is selected.  
**Steady** - If the LED is on, that channel has data but is not selected.  
**Slow** - If the LED is flashing slowly, the channel is selected but has no data.
5. Align the data module IR port with the IR port on the right side of the Cellcorder.
6. On the Cellcorder, press Continue. The Cellcorder displays Receiving Data, and the data module flashing LED stays lit.

7. When all readings have been loaded, the data module LEDs resume flashing, and the Cellcorder displays the SG/Temp for Cell 001.
8. To save the file with the SG/Temp data, press Shift + Save, type the file name, then press Save.
9. The data module powers off after about one minute of inactivity.
10. To delete data on a data module channel, select the channel and press Del until the flashing LED goes out.

Refer to the data module and hydrometer manuals for additional instructions.

## **11.2 Hydrometer Data to Computer**

Use the CRT-300 Previewer or BAS program to transfer SG/temperature from the hydrometer data module to the computer via IR or RS-232 serial cable. To transfer data, refer to the *CRT-300 Previewer User's Guide* or the *Battery Analysis System User's Guide*.

## 12 Working with Files

**Firmware** - The CRT-300 stores firmware and updates in Flash memory, and cell data, thresholds, and calibration in EEPROM. Both types of memory retain data with power off. Site setup and readings are stored in EEPROM and then stored to the removable memory card when Save is selected.

**Memory Card** - After saving cell readings to the memory card, you may clear Cellcorder temporary storage and take readings on another battery. You may use Microsoft Explorer to transfer memory card files to a computer. Readings in temporary storage can also be sent to a computer via IR.

**Memory Card Files** - The **CLC300.CCF** configuration file holds setup data for all sites on a memory card and is accessed when reading or saving site setup. The **.UPG** file contains CRT-300 firmware updates. Cell readings are in **.CDF** data files, which can be imported by the BAS program into an **.ADF** accumulated data file, or viewed separately using the CRT-300 Previewer program.

When the CRT-300 creates a **.CDF** file, it also creates a **.CSV** file with the same name. Microsoft Excel uses **.CSV** (comma separated value) files to display data in spreadsheet format. If the **.CDF** file is overwritten, the **.CSV** file will be overwritten.

**TIP:** At Load Data|Cell Data, the Cellcorder screen displays only CDF cell data files. Other file formats are handled automatically.

**CAUTION:** Use only one memory card. If you use two (or more) cards, each card will contain a Site 001, Site 002 and so on because each will contain a **.CCF** configuration file.

### 12.1 Saving to the Memory Card

Shift+Save

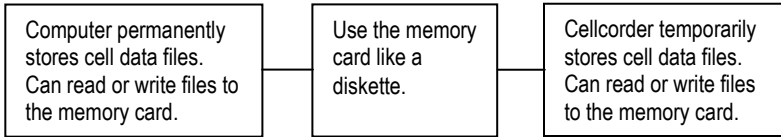
To save readings, press Shift+Save. At Enter File Name, type a name, up to eight characters, no spaces. Press Select Names to select an existing name. To save to the memory card, press Save. After saving, if you copy the file from memory card to computer, you may delete the file from the card if space is needed. Note the memory card does not support subdirectories; save to the root directory. Note also, saving readings to the memory card does not delete them from Cellcorder temporary storage.

**TIP:** You cannot insert a space in a file name.

## 12.2 Loading and Appending a File

Main Menu > Load Data|Cell Data|▲ or ▼|Select

**Loading a File** - Select Cell Data to load a data file from the memory card to temporary storage to append voltage, resistance or hydrometer readings or to send the file to a computer. Highlight a file name using the Arrows, then press Select to load.



**Figure 15. Memory Card as a Disk**

Main Menu > Test Mode|Volt or Res or SG/Temp

**Appending a File** - After loading the data file, to append voltage or resistance readings, select Volt (Voltage) or Res (Resistance). To append SG/Temp readings, refer to *Test Mode: Specific Gravity / Temperature*.

In Voltage mode, data for Cell 001 appears, if available. In Resistance mode, you must complete selections before data displays. To display a cell number, type a number and press Enter or use the Arrows. Resume testing on cells with no data (not yet tested) or press Retest to test cells previously tested.

**Storing Data for Multiple Strings** - To read and store data for a new battery, first save the previous battery data to the memory card, then clear the data from Cellcorder temporary storage.

## 12.3 Deleting a File

Main Menu > Load Data|Cell Data|▲ or ▼|Delete

You can delete a .CDF cell data file from a memory card in two ways:

- (1) Insert the card into the computer and delete using Windows Explorer, or
- (2) Insert the card into the CRT-300 and delete as follows.

To delete a file, press Cell Data. Using the Arrows, highlight the file to delete, then press Delete. At the confirm screen, press Yes. When Data File Deleted appears, press Continue.

## **12.4 Sending Readings via IR to a Computer**

While the fastest way of transferring readings from Cellcorder temporary storage to a computer is with the memory card, data can also be sent via IR using the BAS or Previewer programs. Refer to the *Battery Analysis System (BAS) User's Guide* or *CRT-300 Previewer User's Guide* for more about creating and importing into an .ADF file. To send readings via IR, do the following. (If using a Palm PDA, refer to the PDA portion of this manual.)

### **Shift+Send**

Start the BAS program, then click the Start the Cellcorder Interface button. On the next box, select CRT-300. Align the computer and CRT-300 IR ports. On the CRT-300, press Shift+Send.

In the Battery Data area on the CRT-300 Interface box, to include site configuration data, click Include Configuration. Click Capture. If an .ADF file is not open, select or create one. On the Battery Data Capture box, select the number of cells to download, the starting cell number, and the read date, then click OK. The Cellcorder displays Sending data for cells.

When done, the CRT-300 Interface box displays Data transfer completed. Click Close. On the computer Main Menu, select File|Save, name the file, and click Save to store the .ADF file under Programs/Alber/Alber Battery Analysis/Cellcorder ADF Files.

## **12.5 Printing Test Results**

You may print test results using the optional thermal printer that interfaces to the Cellcorder via IR, or you may transfer data to a computer and send to any printer on your system. A complete test printout contains the following:

### **Site Information:**

Location ..... Location name.  
Battery..... Battery name.  
String..... String name.  
Model # ..... Battery model number.  
Total V ..... The string overall voltage (OV).  
# cells ..... Number of cells in the string.  
Installed..... Battery installation date.  
Read ..... Date Cellcorder readings were taken.

Summary and Thresholds. A summary of average, minimum, and maximum values:

- Volt ..... Cell voltage.
- Res ..... Cell resistance.
- SG ..... Specific gravity.
- Temp ..... Temperature.
- Int R1, 2, 3, 4 ..... Intercell resistance 1, 2, 3 and 4.

Cell Data listed for each cell:

- Volt ..... Cell voltage.
- Res ..... Cell resistance.
- Int R1 ..... Intercell resistance R1.
- Int R2 ..... Intercell resistance R2.
- Int R3 ..... Intercell resistance R3.
- Int R4 ..... Intercell resistance R4.
- SG ..... Specific gravity.
- Temp ..... Temperature.

Set the thermal printer power switch to on. If the Status LED is on, connect the printer charger. A flashing Status LED means high temperature or paper out. Refer to the printer manual on the program CD.

**CAUTION:** Charge the battery with printer power off. The printer cannot operate from the charger. Minimum charge time is one hour. Do not leave the charger connected; this will shorten battery life.

Shift+Print

To print to the thermal printer, press Shift+Print. On the Select Headers screen, select items for the report: site information, statistics, faults, and thresholds. Press Next, select data you want included, then press Next.

**TIP:** Use the Arrows to highlight an item, then press Enter to select or unselect it.

|                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                  |                               |                                     |                               |                              |                               |                                |                               |                                                                                                           |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|-------------------------------|-------------------------------------|-------------------------------|------------------------------|-------------------------------|--------------------------------|-------------------------------|-----------------------------------------------------------------------------------------------------------|
| <p>Select Header(s):</p> <p><input type="checkbox"/> Site    <input type="checkbox"/> Stats</p> <p><input type="checkbox"/> Faults   <input type="checkbox"/> Thresholds</p> <p>      NEXT    WFLP   CANCEL</p> | <p>Select Data:</p> <table><tr><td><input type="checkbox"/> Voltage</td><td><input type="checkbox"/> IcR1</td></tr><tr><td><input type="checkbox"/> Resistance</td><td><input type="checkbox"/> IcR2</td></tr><tr><td><input type="checkbox"/> S/G</td><td><input type="checkbox"/> IcR3</td></tr><tr><td><input type="checkbox"/> Temp.</td><td><input type="checkbox"/> IcR4</td></tr></table> <p>      NEXT    BACK    CANCEL</p> | <input type="checkbox"/> Voltage | <input type="checkbox"/> IcR1 | <input type="checkbox"/> Resistance | <input type="checkbox"/> IcR2 | <input type="checkbox"/> S/G | <input type="checkbox"/> IcR3 | <input type="checkbox"/> Temp. | <input type="checkbox"/> IcR4 | <p>Place a printer with an IRDA port within one meter of the IR port.</p> <p>      CONTINUE    CANCEL</p> |
| <input type="checkbox"/> Voltage                                                                                                                                                                                | <input type="checkbox"/> IcR1                                                                                                                                                                                                                                                                                                                                                                                                        |                                  |                               |                                     |                               |                              |                               |                                |                               |                                                                                                           |
| <input type="checkbox"/> Resistance                                                                                                                                                                             | <input type="checkbox"/> IcR2                                                                                                                                                                                                                                                                                                                                                                                                        |                                  |                               |                                     |                               |                              |                               |                                |                               |                                                                                                           |
| <input type="checkbox"/> S/G                                                                                                                                                                                    | <input type="checkbox"/> IcR3                                                                                                                                                                                                                                                                                                                                                                                                        |                                  |                               |                                     |                               |                              |                               |                                |                               |                                                                                                           |
| <input type="checkbox"/> Temp.                                                                                                                                                                                  | <input type="checkbox"/> IcR4                                                                                                                                                                                                                                                                                                                                                                                                        |                                  |                               |                                     |                               |                              |                               |                                |                               |                                                                                                           |

Figure 16. Print Options

Align the Cellcorder and printer IR ports, and press Continue. The printer Status LED flashes while data is being received.

### 13 Viewing Results

Main Menu > View Results

When data is in Cellcorder temporary storage, the Status screens display the total number of cells with data, overall voltage (OV), averages, min-max values, and threshold violations (faults).

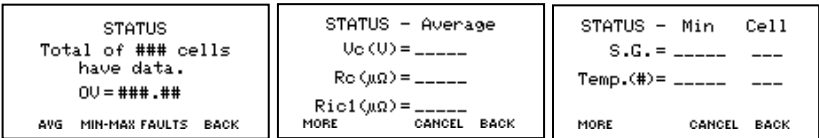


Figure 17. Status Displays

**TIP:** To go back a screen, exit a function, or return to the Main Menu, press Back, Cancel or Esc.

#### 13.1 Overall Voltage (OV) Data

Main Menu > View Results

The Cellcorder adds the cell voltages in a string and calculates overall voltage (OV). Press View Results to display the number of cells that contain data and the calculated OV of those cells. You may also view OV using the BAS program and print OV in reports. The OV value cannot be typed in.

#### 13.2 Status Screen: Average

Main Menu > View Results|Avg|More

Press Avg to display the average cell voltage (Vc), cell resistance (Rc), and intercell resistance (Ric). Press More to display more average Ric, specific gravity (SG), and temperature values.

#### 13.3 Status Screen: Min-Max

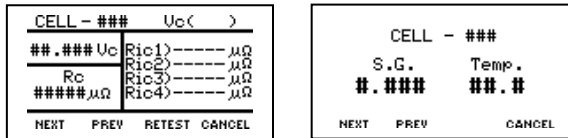
Main Menu > View Results|Min-Max|More

Press Min-Max to display minimum and maximum values for Vc, Rc and Ric, and the associated cell numbers. Press More to display more min-max Ric, SG, and temperature values.

#### 13.4 Status Screen: Faults

Main Menu > View Results|Faults|Volts or Rc or More|S/G or Temp or Ric

To display values that exceed thresholds, press Faults, then the item for which you want faults displayed: Volts, Rc (internal cell resistance), S/G, temperature or Ric (intercell resistance). To retest a voltage or resistance reading that violates thresholds, press Retest.



**Figure 18. Fault Displays**

Voltage/resistance fault screens indicate cell number and fault type: Voltage, Internal or Intercell. The reading at fault is highlighted. SG/temperature screens show cell number, with the problem SG/Temp value highlighted. To display more faults, press Next or Prev (Previous).

## 14 Diagnostics Menu

Warning and error messages indicate operation and connection status. On power up, the Cellcorder displays uploadable flash memory and boot memory versions. If errors occur during use, messages appear. For Smart Media card numeric error codes, refer to *Error Codes*.

If the Cellcorder malfunctions, Diagnostics may help determine the cause. To display Diagnostics, press Shift+Diag. To view more menu items, press the Up/Down Arrows.



**Figure 19. Diagnostics Menu (Typical)**

**TIP:** To go back a screen, exit a function, or return to the Main Menu, press Back, Cancel or Esc.

### 14.1 Keypad

Shift+Diag|Keypad

To test key functionality, select Keypad. Press any key except Power and the screen indicates the key pressed. If you press Shift, press it again before continuing with other keys. Do not press Esc twice or you will exit.

### 14.2 Display

Shift+Diag|Display

To cause the LCD screen to display a series of letters and numbers, select Display.

### 14.3 IR Port

Shift+Diag|IR Port

To test the IR communication port with a computer or printer, select IR Port, then select PC Interface or Printer Interface. Follow on-screen instructions. This test requires a PC or printer with IR interface.

## **14.4 Safety Relay**

**WARNING:** Disconnect the CRT-300 Cellcorder test leads from any equipment before initiating this Safety Relay diagnostic. If the diagnostic is enabled while the CRT-300 is connected to a voltage source, the unit can be damaged.

Shift+Diag|Safety Relay

Select Safety Relay to test the internal relay that protects Cellcorder circuitry. The relay clicks while this diagnostic is active.

## **14.5 Memory Card**

Shift+Diag|▼|Memory Card

To test the input/output (I/O) to the Smart Media memory card, select Memory Card. When testing is successful, the screen displays Memory Card I/O Good.

## **14.6 Load Module**

**WARNING:** This diagnostic draws up to 60 Amps from the voltage/current source.

Shift+Diag|▼|Load Module

Select Load Module to test the circuitry that applies a load current to the battery under test. On the Select Load menu, select the voltage range, then connect the resistance load leads to the voltage source. If the leads are not connected, only the 1 to 2 volt range operates. Requires test leads and voltage source to test all conditions. AC Power indicator must not be lit while test leads are connected.

## **14.7 A/D Linearity**

Shift+Diag|▼|A/D Linearity

To display the readings from the analog to digital converter, select A/D Linearity. Use this diagnostic only when instructed by Albér technical support. Menu selections are described below.

### **14.7.1 Voltage Channel**

Voltage Channel displays the voltage connected to the standard (two lead) set of voltage leads supplied with the unit. This input is for the cell voltage readings. Input voltage must not exceed 20 volts.

### **14.7.2 Test I Channel**

Displays current when voltage is applied to test pins. Internal jumpers need to be changed and an external voltage applied. Move the jumper on JP9 from pins 2 and 3 to pins 1 and 2. Move the jumper on JP10 from pins 2 and 3 to pins 1 and 2. Inject up to a 65mV signal on pins 10(+) and 12(–) on the test lead connector. Input voltage must not exceed 65mV. The display indicates 1 Amp for each 1 mV. Replace the jumpers to their original positions after testing. Do not use this diagnostic for calibration.

### **14.7.3 ICr Channel**

Displays the voltage connected to the black clip and the red/black sense clip on the resistance (three lead) lead set. This input is for the voltage reading across the intercell connector under a test condition. Input voltage must not exceed 130mV.

### **14.7.4 A/D Reference**

Displays the internal reference for the analog to digital converter. The raw count A/D value should be approximately 10000.

## **14.8 Protection Circuit**

Shift+Diag|▼|Protection Ckt

To test the circuitry that protects the Cellcorder against overload conditions, select Protection Circuit (Ckt).

## **14.9 Modem**

Shift+Diag|▼|▼|Modem

Disregard this diagnostic. Modem is not supported at this time. Tests the Cellcorder internal modem and telephone line. Requires a modem connection from the Cellcorder to a Telco line or line simulator. The modem connector is under the accessory cover.

## **14.10 Buzzer**

Shift+Diag|▼|▼|Buzzer

Tests the beeper that provides audible feedback for keystrokes and alarm conditions.

## **14.11 Fan**

Shift+Diag|▼|▼|Fan

Tests the Cellcorder fan that prevent overheating.

## 14.12 Temperature Sensors

Shift+Diag|▼|▼|Temp Sensors

Displays temperatures of the CRT-300 circuit board (Load Temperature) and regulator (Ambient Temperature). When the load temperature rises due to continual testing, the fan turns on. If the load temperature goes too high, testing circuitry is disabled and a warning appears.

## 14.13 Error Codes

Memory card error messages display text such as Card not detected or Out of memory, or numeric error codes. Determine if the problem is the memory card or the card drive.

**CAUTION:** Do not insert or remove the memory card when the Cellcorder Smart Media Card LED is lit.

Remove the troublesome card and, if available, insert a known-good card. If the Cellcorder reads the card, the problem is the first memory card.

Attempt to read the defective memory card using the card drive attached to the computer. If neither the Cellcorder nor the computer can read the card, the card is defective or data on the card is corrupted.

If the computer reads the data successfully, copy the data to another memory card and see if the Cellcorder can read it. If not, remove the memory card from the Cellcorder.

Power down and restart the Cellcorder. Insert the memory card and attempt to read it. If the error message still appears, the problem may be in the Cellcorder. Contact the factory for assistance.

# 15 Service Menu

Shift+Serv

The password protected Service Menu has the Calibration, Factory Defaults, and Change Password options. The Service menu is not used during normal use. To calibrate the CRT-300, refer to the Calibration section of this manual. To display the Service Menu, press Shift+Serv. The password screen appears.

**TIP:** To go back a screen, exit a function, or return to the Main Menu, press Back, Cancel or Esc.

## 15.1 Entering the Password

Shift+Serv|Password

The factory-set default password is 1234. If the password is unknown, contact Albér for a password based on the randomly generated four numbers following Service Code.

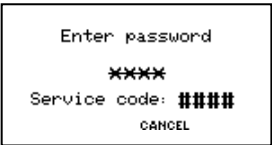


Figure 20. Password Screen

After you type the password, press Enter to display the Service Menu.

## 15.2 Changing the Password

Shift+Serv|Password|Chg Password

You may change the password to any four digit number. Press Shift|Serv, type your current password, press Enter, then select Change Password. At Enter New Password, type the new, four digit password but do not press Enter. Type the new password again in the Confirm New Password area, then press Accept.



Figure 21. Change Password

If New Password and Confirm Password agree, the Service Menu appears.

## 15.3 *Factory Defaults*

Resetting to factory defaults resets the calibration constants, sets the password to 1234, resets threshold settings, resets the values of any site in temporary memory, and restores display settings.

**WARNING:** The Cellcorder loses calibration when reset to factory default and must be recalibrated.

**WARNING:** Unplug any test leads from the Cellcorder before initiating a firmware reset.

Shift+Serv|Password|Factory Defaults

To reset the CRT-300 to factory settings, select Factory Defaults. At the message prompt to restore to default settings, press Yes.

# 16 CRT-300 Calibration

This section describes how to calibrate the Cellcorder. Use the Cellcorder Calibration Form (available on the Alber Web site) to record before and after readings and keep track of calibration discrepancies.

**CAUTION:** High voltage or current may be present on the test equipment and test leads. Only qualified personnel should perform the operations described in this section.

## 16.1 Equipment Required

The following equipment is required to calibrate the CRT-300.

Variable DC voltage source, 0V to 20V at 80 amps.

Martel LCC-421 (or equiv) battery operated 0 to 200mV DC source.

Two 100A/100mV shunts.

HP8840 (or equiv) multimeter as a 5 1/2 digit voltmeter (DVM).

### 16.1.1 Flash Code

The current for the 8V to 12V Load (I3) test depends on the Cellcorder flash code. Power up the CRT-300 and, after the initial screen, note the flash code, which either has no asterisk ( \* ), such as 02.00A08, or has an asterisk, such as 02.00A08\*. Refer to the screen shot in the following section. Note the presence or absence of an asterisk on the Calibration form.

## 16.2 Opening the Calibration Screen

Shift+Serv|Password|Calibration

To display the password protected Service menu and Calibration menus, press Shift+Serv (Shift key, release, then Serv.) At the password screen, type the password and press Enter. (Default password is 1234.) At the Service screen, select Calibration.



Figure 22. Flash Version, Service and Calibration

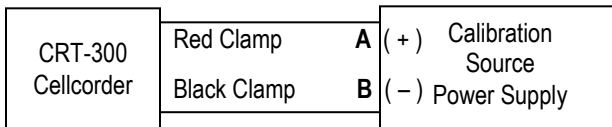
### 16.3 Recording the As Found K-Constants

Shift+Serv|Password|Calibration|Cal-K|▼

Record the before-calibration K-Constants onto the Calibration Form. To display the constants, from the Calibration menu, press F2 Cal-K. Press the Up/Down arrows to display three screens of K-constants. Record these values in the Calibration Form K-Constant Before Cal column. When finished, press Cancel.

### 16.4 Voltage Channel Setup

To calibrate the Voltage Channel, connect the Cellcorder voltage leads and calibration source power supply as shown in the following figure.



**Figure 23. Voltage Channel Setup**

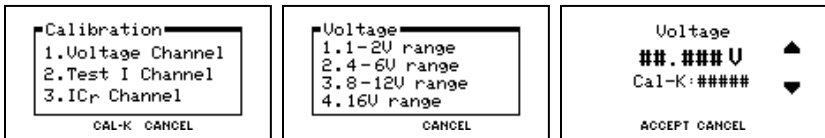
- 1) With the Calibration (Cal) source at 0 volts, connect the DVM to points A and B at the Cal source.
- 2) Calibrate the four voltage ranges as follows.

### 16.5 Voltage Channel Calibration

Shift+Serv|Password|Calibration|Voltage Channel | *select voltage range*

The following four sections describe voltage calibration.

NOTE: If Linearity tests fail to meet min/max range, do not adjust the Up/Down arrow keys. You must recalibrate the initial setting where you used the arrow keys, then retest linearity.



**Figure 24. Voltage Channel Menus**

### **16.5.1 1V to 2V Range**

Shift+Serv|Password|Calibration|Voltage Channel | 1-2V Range

- 1) From the Calibration menu, select Voltage Channel, then 1 - 2V range.
- 2) Adjust the Cal source for 2.000 volts  $\pm 100\text{mV}$  as indicated on the DVM.
- 3) Press the Up/Down arrows on the CRT until the voltage displayed on the CRT matches the reading on the DVM.
- 4) Record the actual input and the CRT reading on the Calibration form.
- 5) Press F2 Accept when finished.
- 6) From the Calibration menu, select Voltage Channel, 1 - 2V range.
- 7) Linearity Check: Adjust the Cal source to 1.000V  $\pm 100\text{mV}$  on the DVM and record the actual input and CRT reading.
- 8) Linearity: Adjust the Cal source to 2.350V  $\pm 100\text{mV}$  on the DVM and record the actual input and CRT reading.
- 9) Press F3 Cancel.

### **16.5.2 4V to 6V Range**

Shift+Serv|Password|Calibration|Voltage Channel | 4-6V Range

- 1) From the Calibration menu, select Voltage Channel, then 4 - 6V range.
- 2) Adjust the Cal source to 5.000 volts  $\pm 100\text{mV}$  on the DVM.
- 3) Press the Up/Down arrows until the voltage on the CRT matches the DVM.
- 4) Record the actual input and the CRT reading on the form.
- 5) Press F2 Accept.
- 6) From the Calibration menu, select Voltage Channel, 4 - 6V range.
- 7) Linearity: Adjust the Cal source to 4.000V  $\pm 100\text{mV}$  on the DVM and record the actual input and CRT reading.
- 8) Linearity: Adjust the Cal source to 7.000V  $\pm 100\text{mV}$  on the DVM and record the actual input and CRT reading.
- 9) Press F3 Cancel.

### **16.5.3 8V to 12V Range**

Shift+Serv|Password|Calibration|Voltage Channel | 8-12V Range

- 1) From the Calibration menu, select Voltage Channel, then 8 - 12V range.
- 2) Adjust the Cal source to 10.000 volts  $\pm 100\text{mV}$  on the DVM.
- 3) Press the Up/Down arrows until the voltage on the CRT matches the DVM.
- 4) Record the actual input and the CRT reading on the form.
- 5) Press F2 Accept.
- 6) From the Calibration menu, select Voltage Channel, 8 - 12V range.
- 7) Linearity: Adjust the Cal source to 7.800V  $\pm 100\text{mV}$  on the DVM and record the actual input and CRT reading.
- 8) Linearity: Adjust the Cal source to 13.200V  $\pm 100\text{mV}$  on the DVM and record the actual input and CRT reading.
- 9) Press F3 Cancel.

### **16.5.4 16V Range**

Shift+Serv|Password|Calibration|Voltage Channel | 16V Range

- 1) From the Calibration menu, select Voltage Channel, then 16V range.
- 2) Adjust the Cal source to 17.500 volts  $\pm 100\text{mV}$  on the DVM.
- 3) Press the Up/Down arrows until the voltage on the CRT matches the DVM.
- 4) Record the actual input and the CRT reading on the form.
- 5) Press F2 Accept.
- 6) From the Calibration menu, select Voltage Channel, 16V range.
- 7) Linearity: Adjust the Cal source to 15.200V  $\pm 100\text{mV}$  on the DVM and record the actual input and CRT reading.
- 8) Linearity: Adjust the Cal source to 19.200V  $\pm 100\text{mV}$  on the DVM and record the actual input and CRT reading.
- 9) Press F3 Cancel.
- 10) Remove the DVM leads from points A and B.
- 11) Set the Cal source to 0 volts.

### 16.6 Test I Channel Setup

To calibrate the Test I (current) Channel, connect the Cellcorder resistance leads, shunts, and calibration source power supply as shown in the following figure.

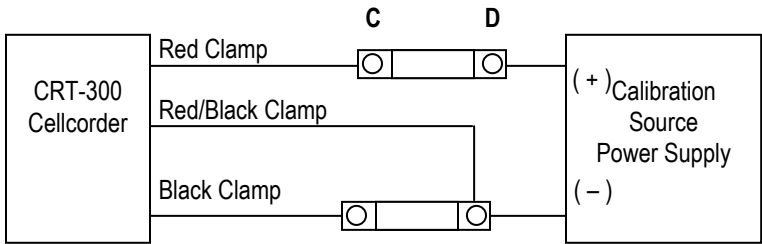


Figure 25. Current Channel Setup

- 1) With the Cal source at 0 volts, connect the DVM to points C and D at the shunt.
- 2) Calibrate the four load ranges as follows.

### 16.7 Test I Channel Calibration

Shift+Serv|Password|Calibration|Test I Channel | *select load range*

The following four sections describe current channel calibration. After you press Start, current flows for five seconds. Press the Up/Down arrow keys during this time.

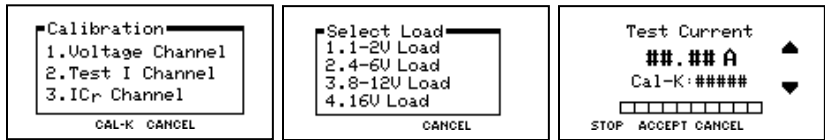


Figure 26. Current Channel Menus

Current Limiting Power Supply If you are using a current limiting power supply, set the supply voltage to 2.0V, 5.0V, 10.0V and 17.5V respectively for the following 1-2V, 4-6V, 8-12V and 16V load tests. You will then adjust the current limiting control to the current needed for each test.

### **16.7.1 1V to 2V Load (I1)**

Shift+Serv|Password|Calibration|Test I Channel | 1 - 2V Load

- 1) From the Calibration menu, select Test I Channel, then 1 - 2V Load.
- 2) On the CRT, press F1 Start.
- 3) Adjust the Cal source so the DVM across the shunt indicates 44 to 46mV, which equals 44 to 46A through the shunt.
- 4) On the CRT, press F1 Start to start the test.
- 5) Press the Up/Down arrows on the CRT until the test current displayed on the CRT matches the mV reading on the DVM.
- 6) Record the actual input and the CRT reading on the Calibration form.
- 7) Press F2 Accept.

### **16.7.2 4V to 6V Load (I2)**

Shift+Serv|Password|Calibration|Test I Channel | 4 - 6V Load

- 1) From the Calibration menu, select Test I Channel, then 4 - 6V Load.
- 2) Press F1 Start.
- 3) Adjust the Cal source to 26 to 27mV on the DVM.
- 4) Press F1 Start.
- 5) Press the Up/Down arrows until the test current on the CRT matches the DVM.
- 6) Record the actual input and the CRT reading on the form.
- 7) Press F2 Accept.

### **16.7.3 8V to 12V Load (I3)**

Shift+Serv|Password|Calibration|Test I Channel | 8 - 12V Load

Current for this load test depends on the flash code version, as described at the start of this section. If the flash version has no asterisk ( \* ), such as 02.00A08, set the Cal source so the DVM indicates 16 to 17mV. If the code has an asterisk, such as 02.00A08\*, set the Cal source to 31 to 32mV.

- 1) From the Calibration menu, select Test I Channel, then 8 - 12V Load.
- 2) Press F1 Start.
- 3) Adjust the Cal source to 16 to 17mV or 31 to 32mV on the DVM.
- 4) Press F1 Start.
- 5) Press the Up/Down arrows until the test current on the CRT matches the DVM.
- 6) Record the actual input and the CRT reading on the form.
- 7) Press F2 Accept.

### **16.7.4 16V Load (I4)**

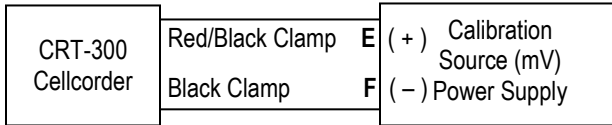
Shift+Serv|Password|Calibration|Test I Channel | 16V Load

- 1) From the Calibration menu, select Test I Channel, then 16V Load.
- 2) Press F1 Start.
- 3) Adjust the Cal source to 6.1 to 6.4mV on the DVM.
- 4) Press F1 Start.
- 5) Press the Up/Down arrows until the test current on the CRT matches the DVM.
- 6) Record the actual input and the CRT reading on the form.
- 7) Press F2 Accept.
- 8) Remove the DVM leads from points C and D.
- 9) Set the Cal source to 0 volts.

## 16.8 ICr Channel Setup and Calibration

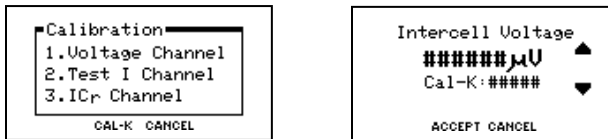
Shift+Serv|Password|Calibration|Test ICr Channel

To calibrate the ICr (intercell) channel, connect the Cellcorder resistance leads (red lead not used) and mV calibration source power supply as shown in the following figure.



**Figure 27. Intercell Channel Setup**

NOTE: If Linearity tests fail to meet min/max range, do not adjust the Up/Down arrow keys. You must recalibrate the initial setting where you used the arrow keys, then retest linearity.



**Figure 28. Intercell Channel Menus**

- 1) With the millivolt (mV) Cal source at 0 volts, connect the DVM to points E and F at the Cal source.
- 2) From the Calibration menu, select ICr channel.
- 3) Adjust the Cal source so the DVM indicates 21mV  $\pm$ 1mV.
- 4) Press the Up/Down arrows on the CRT until the voltage on the CRT matches the reading on the DVM.  
NOTE: The CRT displays voltage in microvolts ( $\mu$ V).
- 5) Record the actual input and the CRT reading on the Calibration form.
- 6) Press F2 Accept.
- 7) From the Calibration menu, select ICr channel.
- 8) Linearity: Adjust the Cal source to 0.6mV  $\pm$ 0.05mV on the DVM and record the actual input and CRT reading.
- 9) Linearity: Adjust the Cal source to 80mV  $\pm$ 1mV on the DVM and record the actual input and CRT reading.
- 10) Press F3 Cancel.
- 11) Remove the DVM leads from points E and F.
- 12) Set the Cal source to 0 volts.

## Calibration

After calibration is finished, confirm that the readings from the CRT-300 Cellcorder are within tolerance as compared to the values in the Actual Input column. If any reading is out of tolerance, the unit must be recalibrated. If all readings are within specifications, proceed with the next section.

### **16.9 Recording the As Left K-Constants**

Shift+Serv|Password|Calibration|Cal-K|▼

Record the after-calibration K-Constants onto the Calibration form. To display the constants, from the Calibration menu, press F2 Cal-K. Press the Up/Down arrows to display three screens of K-constants. Record these values in the Calibration Form K-Constant After Cal column. When finished, press Cancel.

### **16.10 Backing Up and Restoring the Calibration**

Refer to the *Cellcorder Battery Analysis System User's Guide* for information about backing up and restoring Cellcorder calibration.

## 17 Battery Maintenance Schedule

The CRT-300 Cellcorder can easily take periodic maintenance readings. An effective maintenance program that meets the recommendations of most battery manufacturers calls for the following measurements:

| PARAMETER                          | INTERVAL                                                             |               |          |
|------------------------------------|----------------------------------------------------------------------|---------------|----------|
|                                    | Quarterly                                                            | Semi-Annually | Annually |
| Cell Voltages                      | X                                                                    |               |          |
| Inter-cell Resistance              |                                                                      |               | X        |
| Internal Resistance - Vented Cells |                                                                      |               | X        |
| Internal Resistance - Sealed Cells | X                                                                    |               |          |
| Specific Gravity                   |                                                                      | X             |          |
| Temperature Profile                | X                                                                    |               |          |
| Capacity - Vented Cells            | Every 3 to 5 years until signs of degradation, then once every year. |               |          |
| Capacity - Sealed Cells            | Every year.                                                          |               |          |

**Figure 29. Battery Maintenance Schedule**

NOTE: VRLA or sealed cells must be tested more often because of their shorter life expectancy and lower reliability.

Use Cellcorder resistance measurements in conjunction with baseline data on the batteries being maintained. Obtain cell resistance baseline data from the battery manufacturer or Albér, or acquire it with a capacity test.

Take Cellcorder readings according to the Maintenance Schedule table; the resistance readings dictate which battery string should be subjected to capacity testing. If one or more cells exhibit cell resistance 30% to 40% higher than the average or baseline value, then capacity test those cells using a single cell tester, such as the Albér SCT-200. If most cells are above the normal expected readings, then capacity test the entire string.

## **18 Upgrading the Firmware**

Upgrade CRT-300 Cellcorder firmware using the memory card or the IR ports on the computer and CRT-300. Upgrades are on the Web at [www.alber.com](http://www.alber.com).

**TIP:** Upgrading using the memory card is much faster than via IR.

**WARNING:** Do not continue until you have the .UPG upgrade file ready. You will be clearing the current firmware.

### **18.1 Upgrading Using the Memory Card**

Download the .UPG file from the Albér Web site or an Albér CD to Program Files/Alber/Alber Battery Analysis, then use Windows Explorer to copy the file to the memory card.

ESC+Power On

With Cellcorder power off, insert the memory card into the Cellcorder. To start in upgrade mode, press Esc+Power On. At the message System is ready to clear Flash memory for new program, press Continue.

At System ready to receive upgrade file. Select file transfer method, press Smart Media. File transfer in progress appears and the frame number counts down. When Upgrade successful. System is running Version nn.nnnnn appears, press Continue.

### **18.2 Upgrading Using the IR Port**

Download the .UPG file from the Albér Web site or an Albér CD to Program Files/Alber/Alber Battery Analysis.

ESC+Power On

With Cellcorder power off, to start in upgrade mode, press Esc+Power On. At the message System is ready to clear Flash memory for new program, to upgrade press Continue.

At System ready to receive upgrade file. Select file transfer method, press Infrared. File transfer in progress appears. The frame number does not count down.

On the computer desktop, start the Battery Analysis System (BAS) program. On the menu bar, click the Start the Cellcorder Interface button. On the next box, click the CRT-300 button, then OK.

Align the computer and Cellcorder IR ports.

On the CRT-300 Interface dialog box, in the Firmware Update area, click Load Update. Select the .UPG file, then click Open. On the Cellcorder screen, the frame number counts down. When Upgrade successful. System is running Version nn.nnnnn appears, press Continue. On the computer, close the CRT-300 Interface box.



# **Cellcorder® PDA Mobile Software User's Guide**



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## 19 PDA Mobile Software

The Palm-OS based CRT-300 Palm PDA Mobile Software program is available as a download for the optional PDA. This manual describes program operation.

### 19.1 General Description: PDA

The PDA Mobile Software, which interfaces the PDA to the Cellcorder, printer, and DMA-35N hydrometer, can store, edit, print, and analyze battery test data. Some PDA's with Windows Internet connection can e-mail Cellcorder and hydrometer data files.

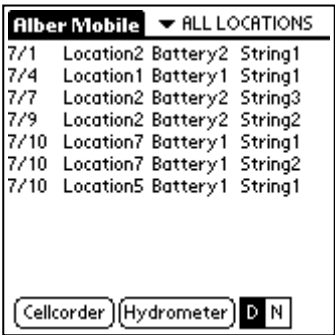
### 19.2 System Requirements: PDA

The following are the minimum system requirements for the CRT-300 Palm PDA Mobile Software:

Palm OS 3.2 or later for standard operation (IRDA file transfer).  
Palm OS 4.0 or later and e-mail software for enhanced file transfer options.

## 20 Main Page File Database

Power up the PDA, then select the Albér icon. The Main Page lists strings of battery test data. If there are several pages, press the Up-Down arrows on the screen to view additional string names.



**Figure 30. Typical Main Page**

To sort files by date or name, press the D or N buttons. To filter by location name, press All Locations (or other name) on the screen, then select a name from the drop-down list. After filtering, you can again sort by date or name.

The Palm PDA HotSync operation can back up the database to a computer. The **DB3\_AlbJobDB.PDB** database can be loaded onto another PDA or the original PDA if the device requires a reset.

## 21 Options Menu

To display the Options menu, on the Main Page, press Albér Mobile. The drop-down menu displays User Preferences, Delete All Strings, and About.

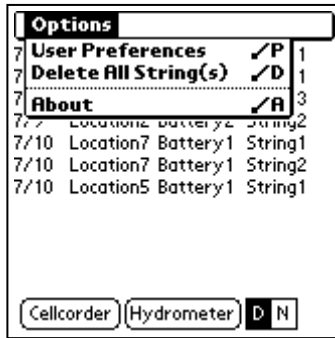


Figure 31. Options Menu

### 21.1 User Preferences

Select User Preferences to define the temperature units (F/C), date format (USA/Europe/China), and charger frequency (50Hz/60Hz) associated with data uploaded to a computer. To change a preference, press the down arrow next to the item to change, then select from the drop-down menu.

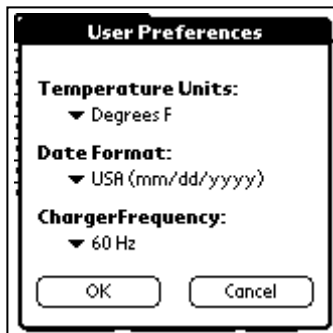


Figure 32. User Preferences

**21.2 Delete All Strings: PDA**

Delete All Strings removes all the strings and battery test data stored in the PDA. This action cannot be undone. To delete all the strings, press OK on the Delete all string data page.

**CAUTION:** Delete cannot be undone; however, you can re-install the backup database **DB3\_AlbJobDB.PDB** automatically stored on the computer during a HotSync operation.



**Figure 33. Delete All Data**

**21.3 About**

The About page displays the software version and copyright information.

## 22 Data Transfer to PDA via IR

This section describes how to transfer cell data from a Cellcorder and specific gravity (SG) / temperature readings from a hydrometer to the PDA via the IR (infrared) interface.

### 22.1 File Transfer from Cellcorder to PDA

Before transferring data to the PDA, load the data in Cellcorder temporary memory, press the Cellcorder Shift+Send, then make menu selections. On the PDA Main Page, press Cellcorder, follow screen instructions, then press Download to transfer.



Figure 34. Download Cellcorder

The Cellcorder displays Sending data for Cell *nnn* during transfer. Upon completion, the PDA displays Cellcorder Download Complete. Press OK to store the file. On the Cellcorder, return to the Main Menu. If you need to edit location, battery or string names, refer to *Site Information*.

### 22.2 Data Transfer from Hydrometer to PDA

To transfer hydrometer module SG and temperature readings to the PDA, on the module, select a string A to H. On the PDA Main Page, press Hydrometer, follow screen instructions, then press Download to transfer.

The hydrometer module LEDs go off during transfer. Upon completion, the PDA displays Hydrometer Download Complete. You may edit location, battery or string names on this page, then press OK to store the file.

**To edit location, battery or string names:** Press the stylus on the text or number to be edited, then press the ABC or 123 button on the PDA. Edit the text or number, then press Done.



Figure 35. Download Hydrometer

## 23 Viewing and Editing Readings: PDA

This section describes how to view, edit, insert, and delete readings.

### 23.1 View String Data

To display string data, on the Main Page, use the stylus to select the string name. The View String Data page displays data in tabular format. To view a cell, slowly drag the stylus along the vertical scroll bar until the cell number appears. To view additional columns of data, slowly drag the horizontal scroll bar.

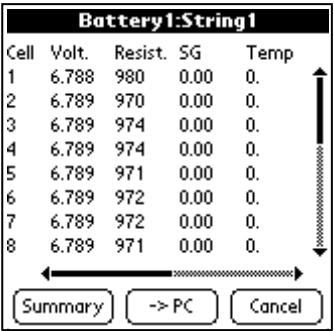


Figure 36. View String Data

## 23.2 Edit Cell Data

On the Main Page, select the string name. To edit readings for a cell, on the View String Data page, select that cell number. The Edit Cell box appears.

| Cell | Volt. | Resist. | SG    | Temp |
|------|-------|---------|-------|------|
| 1    | 6.788 | 980     | 1.234 | 77.7 |
| 2    | 6.789 | 970     | 0.00  | 0.   |
| 3    | 6.789 | 974     | 0.00  | 0.   |

**Edit Cell#: 005**

Voltage: 6.789 Intercell R1: 1652  
 Int. R: 971 Intercell R2: 1653  
 SG: 1.233 Intercell R3: 1652  
 Temp: 75.8 Intercell R4: 1652

Insert Delete OK Cancel

**Figure 37. Edit Cell Data**

The figure above shows a typical page with Cell 5 selected. Edit the readings and press OK.

**To edit readings:** Press the stylus on the data to be edited, then press the 123 button on the PDA. Edit the number, then press Done.

## 23.3 Insert Readings

On the Main Page, select the string name. On the View String Data page, select the cell you want to insert a reading before or after, then press Insert on the Edit Cell box. On the Insert Readings box, enter the new data, select Insert Before or Insert After, then press OK.

**Insert Readings**

Voltage: ..... Intercell R1: .....  
 Int. R: ..... Intercell R2: .....  
 SG: ..... Intercell R3: .....  
 Temp: ..... Intercell R4: .....

☒ Insert before cell#: 004  
☐ Insert after cell#: 004

Status: Pending

OK Cancel

**Figure 38. Insert Readings**

### 23.4 Delete Readings

On the Main Page, select the string name. On the View String Data page, select the cell you want to delete, then press Delete on the Edit Cell box. On the Delete Cell box, press OK to delete the readings.

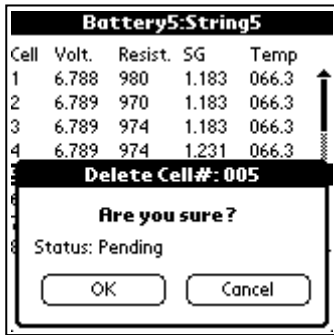


Figure 39. Delete Cell Readings

## 24 Analyzing Cell Data

On the Main Page, select the string name. To display the Options menu, press the title bar on the View String Data page.

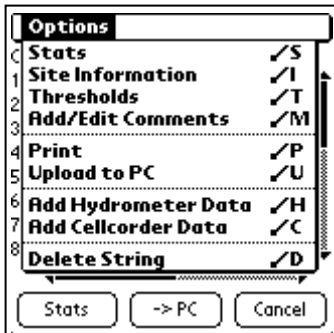


Figure 40. String Options Menu

## 24.1 Stats (Statistics)

To display a summary of string data, select Stats from the Options menu or press the Stats button on the View String Data page. The Stats page appears.

| Stats    |        |       |       |
|----------|--------|-------|-------|
|          | Avg.   | Max.  | Min.  |
| Voltage: | 6.500  | 6.791 | 0.995 |
| Resist:  | 977    | 1045  | 964   |
| SG:      | 1.079  | 1.231 | 0.786 |
| Temp:    | 61.7   | 72.8  | 7     |
| Int. R1: | 1649   | 1659  | 1642  |
| Int. R2: | 1649   | 1660  | 1642  |
| Int. R3: | 1649   | 1660  | 1642  |
| Int. R4: | 1648   | 1660  | 1642  |
| #Cells:  | 20     |       |       |
| Total V: | 129.10 |       |       |

OK

Figure 41. Stats Page

The Stats (Statistics) page displays average and minimum-maximum values for cell voltage, cell internal resistance, SG, temperature, intercells 1 to 4, and the number of cells and OV.

## 24.2 Site Information

Use the string Site Information page to edit location, battery, and string names, model number, and the install and read dates. To display the page, select Site Information from the Options menu. All parameters are editable except Overall Voltage (OV) and Number of Cells. The OV and Number of Cells change as cell data is added.

| Site Information |           |
|------------------|-----------|
| Location:        | Location1 |
| Battery:         | Battery1  |
| String:          | String1   |
| Model #:         | Model5    |
| Overall V:       | 129.10    |
| # Cells:         | 20        |
| Installed:       | 7/18/02   |
| Read:            | 7/4/03    |

OK      Cancel

Figure 42. String Site Information

### 24.3 Thresholds

To display the Threshold page for a string, select Thresholds from the Options menu. All thresholds are editable. Setting a threshold to 0 (zero) or no value disables it.

|               | High  | Low   |
|---------------|-------|-------|
| Voltage:      | 16.00 | 0.900 |
| Resistance:   | 60000 | 0     |
| Specific G:   | 0.00  | 0.00  |
| Temp:         | 0     | 0     |
| Intercell R1: | 2000  |       |
| Intercell R2: | 2000  |       |
| Intercell R3: | 2000  |       |
| Intercell R4: | 2000  |       |

OK Cancel

Figure 43. String Thresholds

### 24.4 Add/Edit Comments

To display or edit comments for a string, select Add/Edit Comments from the Options menu. Type comments on the Add/Edit Comments page that appears.

Battery1:String1

Add/Edit Comments

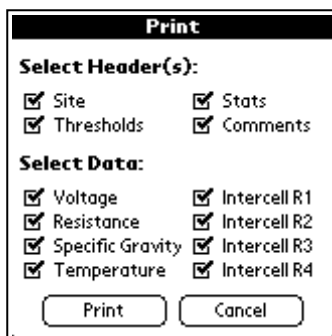
Type comments here.

OK Cancel

Figure 44. Add String Comments

## 25 Printing

To print string information from the PDA to an IRDA equipped printer, select Print from the Options menu. The Print Options page appears, with all print options selected. Select a box to check or uncheck an option.



**Print**

**Select Header(s):**

☒ Site ☒ Stats

☒ Thresholds ☒ Comments

**Select Data:**

☒ Voltage ☒ Intercell R1

☒ Resistance ☒ Intercell R2

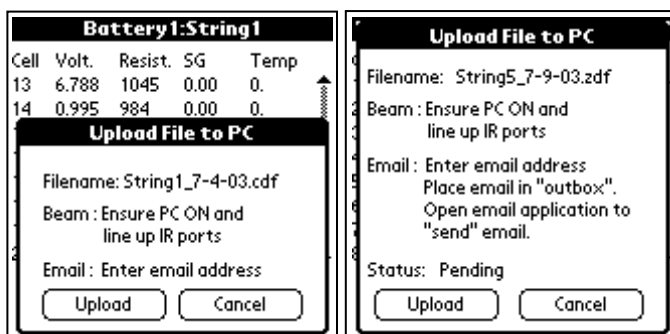
☒ Specific Gravity ☒ Intercell R3

☒ Temperature ☒ Intercell R4

Figure 45. Print Options Page

## 26 File Transfer from PDA to PC

The PDA can transfer cell data to a computer using the standard IRDA Palm interface or other Palm interfaces, such as e-mail attachment. To transfer the file, select Print from the Options menu or press the (→PC) button on the View String Data page. The Upload File to PC box appears.



**Battery1:String1**

| Cell | Volt. | Resist. | SG   | Temp |
|------|-------|---------|------|------|
| 13   | 6.788 | 1045    | 0.00 | 0.   |
| 14   | 0.995 | 984     | 0.00 | 0.   |

**Upload File to PC**

Filename: String1\_7-4-03.cdf

Beam: Ensure PC ON and line up IR ports

Email: Enter email address

**Upload File to PC**

Filename: String5\_7-9-03.zdf

Beam: Ensure PC ON and line up IR ports

Email: Enter email address  
Place email in "outbox".  
Open email application to "send" email.

Status: Pending

Figure 46. Upload File to PC

A non-editable file name is created based on the string name and date of readings. Press Upload; if the PDA can send e-mail attachments, a Send With option box appears. To send via IR, select Beam; to transfer via e-mail (3.75M maximum attachment size), select MultiMail-send.

## 27 Adding or Replacing String Data

To add or replace data in an existing file with data downloaded from the Cellcorder or hydrometer, on the Main Page, select the string name. On the View String Data page, press the top bar to display the Options menu and select Add Cellcorder Data or Add Hydrometer Data. Follow screen instructions, then press Download to transfer data. When transfer is done, press OK to store the new file.

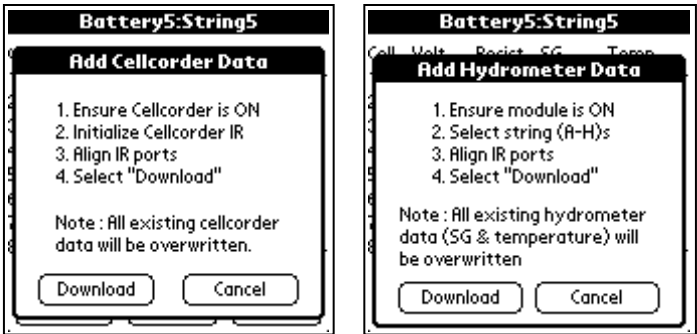


Figure 47. Adding or Replacing Cellcorder / Hydrometer Data

For help using the Cellcorder or hydrometer, refer to *File Transfer from Cellcorder to PDA* or *Data Transfer from Hydrometer to PDA*.

## 28 Delete String Data

To delete one string, on the Main Page, select the string name. On the View String Data page, press the top bar to display the Options menu and select Delete String. On the Delete String box, press Delete to delete the string. This action cannot be undone.



Figure 48. Deleting String Data

## 29 Serial Errors

If the PDA detects an error during a data download from the hydrometer or Cellcorder, the Serial Receive Error page appears. Follow screen instructions and transfer the data again.



Figure 49. Serial Receive Errors



## **30 Cellcorder Parts List**

One each of the following:

CRT-300 Cellcorder Unit, 1000-055, Serial No:

Charger Module for Cellcorder, 4000-033

Memory Card (8MB), 2030-001

Memory Card Reader, 2025-032

Voltage Lead Cable Set (2 Leads), 1100-222

Resistance Test Cable (3 Leads), 1100-221

Cellcorder CRT-300 User's Guide (this manual), 4200-038

Battery Analysis System (BAS) and Previewer software, 2027-014

BAS Manual, 4200-002

Carrying Case, 3800-028

Carrying strap, 3800-029

Warranty Card

Checked By: \_\_\_\_\_

Date: \_\_\_\_\_

## **31 CRT-300 Specifications**

### **Physical**

|            |                                         |
|------------|-----------------------------------------|
| Dimensions | 12"H x 7"W x 3"D (305mm x 178mm x 76mm) |
| Weight     | 3.4 pounds (1.5Kg)                      |
| Keypad     | Rubber keys with polyurethane coating   |

### **Display**

|               |                       |
|---------------|-----------------------|
| Type          | LCD - STN Reflective  |
| Viewing Area  | 2.619" x 1.309"       |
| Resolution    | Graphics LCD 128 x 64 |
| Viewing Angle | 40°                   |
| Backlight     | White EL              |

### **Memory**

|                    |                                                                                                |
|--------------------|------------------------------------------------------------------------------------------------|
| Type               | Smart Media card                                                                               |
| Supported Sizes    | 8MB (supplied) and 16MB, 32MB, 64MB and 128MB                                                  |
| Storage Capability | 71 strings with 256 cells per megabyte of card size.<br>(8MB size card can store 568 strings.) |
| Data Retention     | 10 years                                                                                       |

### **Communication**

|                |                                                                                           |
|----------------|-------------------------------------------------------------------------------------------|
| Infrared       | Fully IrDA compliant for PDA/PC interface. Physical IrDA compliant for printer interface. |
| Internal Modem | V32bis                                                                                    |

### **Battery**

|             |                             |
|-------------|-----------------------------|
| Type        | 4 cell, 8800mAh lithium ion |
| Voltage     | 4.2V                        |
| Charge Time | 8 hours                     |

### **AC Adaptor**

|                |              |
|----------------|--------------|
| Input Voltage  | 90 to 264VAC |
| Output Voltage | 5VDC         |
| Output Current | 4.0A         |
| Frequency      | 47 to 63Hz   |

## Environmental

### Temperature Range

Operating 32°F to 104°F (0°C to 40°C)  
 Storage -20°F to 140°F (-29°C to 60°C)  
 For extended periods: <77°F (<25°C)

Humidity Range 0% to 80%RH (non-condensing) at 0°C to 31°C  
 0% to 50%RH (non-condensing) at 32°C to 40°C

Insulation Category II

Pollution Degree 2

Altitude 0 to 2000 meters above sea level

## Accuracy

| Input     | Test Current | Resistance Resolution<br><small>±0.1% of reading</small> | Voltage Resolution<br><small>±0.1% of reading</small> | Intercell Range Resolution<br><small>±1% of reading</small> |
|-----------|--------------|----------------------------------------------------------|-------------------------------------------------------|-------------------------------------------------------------|
| 2V        | 60A          | ±5μΩ                                                     | ±1mV                                                  | ±2mΩ                                                        |
| 4V to 6V  | 25A to 35A   | ±25μΩ                                                    | ±3mV                                                  | ±3.3mΩ                                                      |
| 8V to 12V | 15A to 30A   | ±75μΩ                                                    | ±6mV                                                  | ±5mΩ                                                        |
| 16V       | 5A           | ±400μΩ                                                   | ±10mV                                                 | ±20mΩ                                                       |

**Warranty** One year limited warranty

## Ordering Information

CRT-300 Cellcorder, including software, carrying case, battery charger, cables and clamps

## Optional Accessories

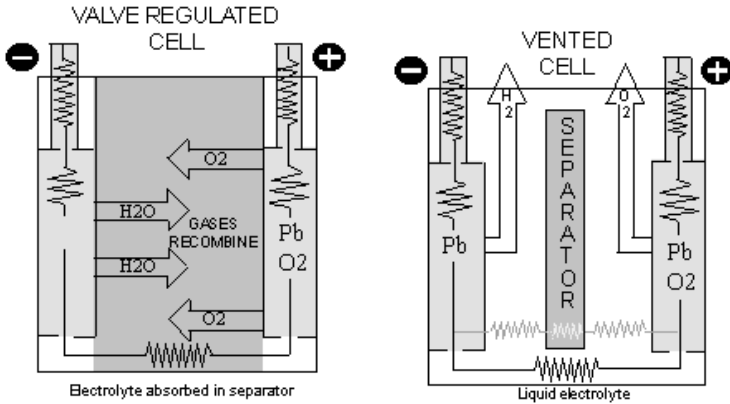
2025-124 Printer with IRDA interface  
 2025-031 Internal modem  
 2030-002 Smart Media card, 128MB

*Note: Specifications are subject to change without notice.*

## 32 Application Note CC-001

### Internal Resistance and the Cellcorder

(This document is available at [www.alber.com](http://www.alber.com))



### INTRODUCTION

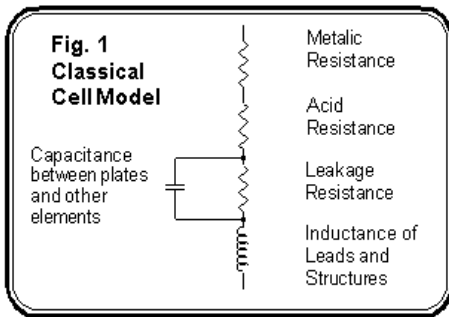
With the changeover from “vented” cells to “sealed,” VRLA cells, and the proliferation of UPS systems, an even greater impetus has been placed in finding economical and reliable ways to establish the state of a battery’s capacity and its conduction path. In this Application Note, the primary focus will be on a new, relatively low cost aid in determining a battery’s health by virtue of its cells’ internal resistances together with float voltages and intercell connection resistances. All three of these variables are rapidly measured and conveniently recorded by the Albécorp Cellcorder, the storage battery multimeter.

### THE SEARCH

The search for new approach to capacity and conduction path testing has been ongoing. Traditionally, a battery’s capacity to store energy has been specified by its manufacturers as its ability to supply a *constant* amount of current, or power, to the load for a defined time period to a final voltage. The real test of the battery’s *actual* capacity as opposed to its rated capacity frequently involves hours of manpower and load and data acquisition equipment.

Unfortunately, a new approach has yet to gain industry-wide acceptance. The consensus of battery experts is still that load testing under controlled conditions is the *only method with certainty* of establishing a battery's actual capacity. This is reflected in several national standards; the latest of which was issued in 1995.<sup>1,2</sup>

However, after many years of experience, studies and experiments, a wealth of information about battery behavior and measurements has been produced and some light has been shed on new tools that will help assess a battery's condition.



As early as 1959, the equivalent circuits of cells and typical circuit values were published.<sup>3</sup> (See Figure 1.) These circuit models of a battery's cell, are critical to understanding how its condition relates to cell internal parameters, conduction paths and capacity.

## THE BASICS:

### RESISTANCE, INDUCTANCE AND CAPACITANCE

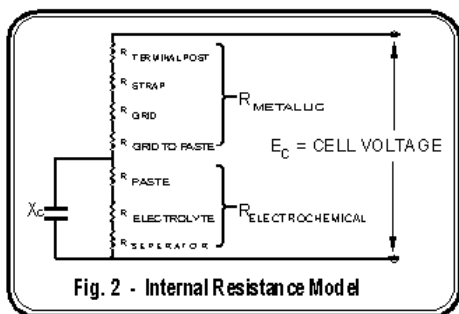
The models' circuit elements are resistance, capacitance and inductance. Researchers have investigated battery parameters from DC through several thousand hertz and have made measurements in all units. They tried to relate those to cell capacity, often with mixed or conflicting results.

In almost all typical battery applications, the inductance has no practical impact on battery performance because of its small magnitude (from 0.05 to 0.2 *microhenries*.) On the other hand, the actual capacitance of cells is surprisingly large, as much as 1.7 Farads per 100 Amp-Hours. This cell characteristic is put to good use by charger manufacturers. They depend on it to filter their charger output.<sup>3</sup>

However, little evidence has evolved that ties capacitance with the actual capacity of a cell. It's worth noting that one researcher felt capacitive reactance "obscures" the predominant indicator of cell capacity, electrochemical resistance. More so, as the test frequency is increased. Impedance and admittance measurements include both capacitance and inductance in their readings.

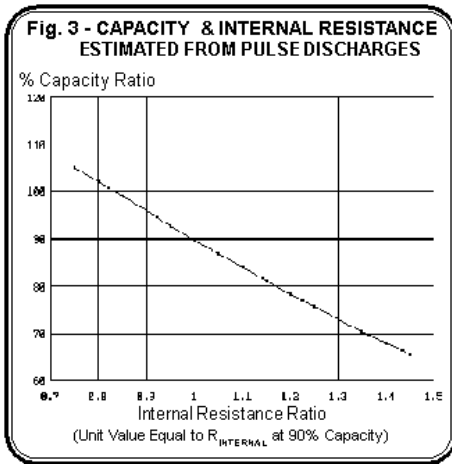
## THE NATURE OF INTERNAL RESISTANCE

At Albér, we have centered our efforts on cell internal resistance. A refined cell model has been developed which subdivides the internal resistances of a cell, as shown in Figure 2, into its metallic and electrochemical components. These resistances do not change with test frequency. Indeed, researchers have concluded that a zero frequency, DC, or extremely low frequencies, yield the best results when studying capacity relationships.<sup>4,5</sup>

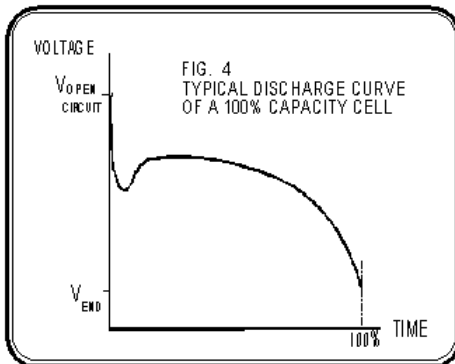


Another group focusing on internal resistance is prestigious Nippon Telephone and Telegraph. Their research and field personnel have shown that a major result of the lead acid battery deterioration mechanism is an increased internal resistance. A 500 microsecond duration pulse technique is used to measure cell internal resistance. Test results lead them to conclude that battery deterioration (capacity) can be estimated within  $\pm 10\%$  by internal resistance measure.

Note that Capacity vs. Normalized  $R_{INTERNAL}$  curve, shown in Figure 3, is *somewhat curved*. Some feel the relationship between most cell internal parameters and capacity is not a simple straight line as has been described in recent times but rather a more complex *curvi-linear* function.<sup>6</sup>



Part of this belief that a straight line cannot describe a capacity relationship is rooted in the differences exhibited during battery discharges from cells with metallic vs. electrochemical resistance problems. The typical discharge curve of a cell at 100% capacity is shown in Figure 4.



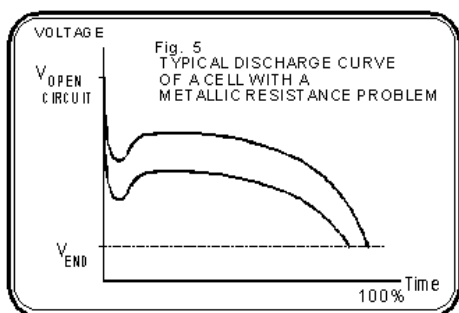
A battery's capacity is adversely affected by *an increased* internal resistance. Obviously, the power is dissipated internally,  $I^2 \times R_{INTERNAL}$ , and is not available where it is really needed . . . at the load. Thus, *actual* capacity is diminished. However, during *discharge* this reduction in capacity appears differently depending upon whether the resistance change is primarily metallic or electrochemical in nature.

## METALLIC RESISTANCE

This portion of the internal conduction path troubles most battery test experts. It is here that deterioration of a cell can occur most rapidly and then will often go undetected between the yearly integrity tests or, even less frequently, the capacity tests.

The tear down of failed batteries with abnormal internal resistances has proven that the terminal posts and the internal straps and grids are most often the victims of corrosion, poor welds or "burns."<sup>7</sup> Where found, contact surfaces of a copper insert can corrode or loosen from its surrounding lead post. The Cellcorder easily detects these types of problems.

Fig. 5 clearly shows the loss of capacity due to a high internal *metallic* resistance. The available voltage at the battery's terminals is reduced from the start of the discharge and continues to the end.

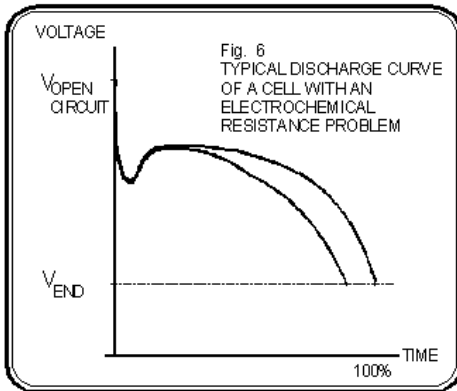


## ELECTROCHEMICAL RESISTANCE

Cell paste, electrolyte and separators form the electrochemical part of cell internal resistance. Long-term increases in  $R_{\text{ELECTROCHEMICAL}}$  can be caused by loss of active material or paste due to aging. Short-term changes also occur naturally during parts of the charge or discharge processes when the specific gravity is altered; or when the contents of the separators varies and/or the chemical composition of the surfaces change.

Separator compression, clogging or shorts, and conditions like sulfation are frequently causes of abnormal, increased electrochemical resistance; however, ***accelerated electrolyte dryout appears to be public enemy #1*** when it comes to VRLA failures.

Figure 6 reveals how a battery with an *electrochemical* resistance problem behaves. Its reduced capacity does not become apparent until much further into the discharge, like “running out of fuel.” On the other hand, the metallic resistance problem can be viewed as pinching the fuel line! In either case, the worse the resistance, the greater the shortfall between the cell’s *rated* and *actual* capacity.



### BATTERY AGING AND INTERNAL RESISTANCE

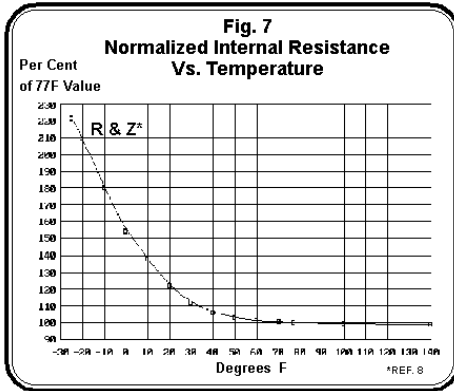
Internal resistance provides a clue to aging. The aging process of a battery’s cells is based upon the rates at which their materials and construction deteriorate under design conditions. For example, the life of nearly all stationary cells is specified at 77°F, under particular float charge conditions and discharges of stipulated depth and frequency.

*Very slow* corrosion of conduction paths, the loosening of active materials from plates, grid deformation and, in the case of VRLA cells, dry out of electrolyte are all *natural* processes that push a cell to its end life. This aging process is marked by increasing cell internal resistance and decreasing capacity. It is generally agreed that below 80% actual capacity, the cell’s deterioration will accelerate rapidly and replacement is recommended.

The internal resistance increases slowly but, toward the end of a cell’s life, it accelerates greatly. Its end-life value is normally about 25% or so above its initial value, but can be as high as 50%.

## TEMPERATURE AND INTERNAL RESISTANCE

Being aware of the effect of temperature on internal resistance is important. Figure 7, for a typical AGM VRLA cell, clearly shows rapid internal resistance and impedance increases below temperatures of about 45°F.<sup>8</sup>



In temperate climates, VRLA cells in *unconditioned* temperature environments may show considerable internal resistance variation between quarterly measurements. Recording of the ambient temperatures at the time of measurement will might save you further testing and false alarms. Similarly, cells chilled by air conditioning exhibit higher readings than their sheltered neighbors. If possible, try to re-direct the air flow.

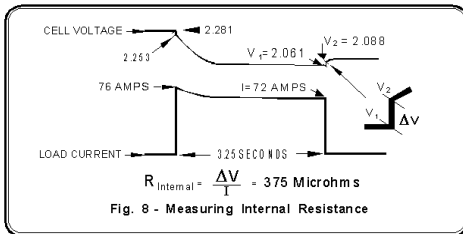
## THE CELLCORDER

The Cellcorder is invaluable in determining what a battery or cell's internal resistance is and in helping to identify abnormal conditions and normal aging. *While a battery or cell is on-line*, it accurately and repetitively measures the internal resistance using DC techniques. The AC filtering currents, stray 60 hertz fields, noise and normal float currents have virtually no effect on its readings.

The authors can't help but wonder what earlier researchers could have accomplished if they had access to microprocessor and solid state technology. The microprocessor of the Cellcorder permits it to not only control measurements, but to also precisely time the readings and performs calculations. To boot, it can tell whether a reading is valid and then records the results.

The battery manufacturers have customarily determined the internal resistance of cells using simple Ohms Law. They usually measure the voltage differences and current during a battery discharge.

The Cellcorder does the same thing, but very quickly and accurately. Figure 8 reveals what happens when a battery is subjected to a load. The instantaneous voltage drop when the load is applied, or the instantaneous voltage recovery when the load is removed, is due to the internal resistance. The Cellcorder reads the current and the cell voltage just prior to removal of the load and then measures the recovered cell's voltage. The resultant resistance is simply  $R_{INTERNAL} = \Delta V / I$ .<sup>9</sup>



## THE MOMENTARY TEST DISCHARGE

This is a feature worth your time to understand. It is, in part, what distinguishes the Cellcorder from most instruments presently on the market and will help provide readings in which you can be confident.

For rated cell capacities of less than 1000 amp-hours, the discharge is short, only three to four seconds, in the order of 20 to 75 amps. For larger capacities, the duration is close to 10 seconds.

To prove a point about safety and the effects of *short-term* high currents, we performed the following experiment. We imagined an internal conductor corroded down to the size of a dot.

*We found that passing the Cellcorder's test current through a skinny wire (27 inches of #20 gauge wire) caused no damage nor barely heated it. Try it! The reason is that very little energy is involved. It amounts to only a maximum of 5 watts per 1000 microhms and lasts only seconds.*

***In an actual test, within milliseconds of starting, the Cellcorder senses the current level. If there is a very high internal resistance, the current will be low and the discharge will be instantaneously terminated.*** Thus, a cell with an exceptionally corroded internal conductor will not be further damaged.

After tens of thousands of cell tests, there have been no reports indicating that the Cellcorder's test discharge has caused a cell to open circuit. Interestingly, many battery specialists feel disappointed that their most severely corroded cells have not opened. They would rather have them open during a supervised test than during an actual emergency when no one is around!

## **ALBÉR RESEARCH**

Carefully conducted Albér experiments have revealed other important properties of cell internal resistance. One is the relationship between metallic resistance and electrochemical resistance.

Many would expect that as the energy stored in a fully charged cell diminishes, the internal resistance of the cell would increase both *proportionately and significantly*. This belief is widely held because of how the lead acid cell electrochemistry is envisioned.

Measured amounts of energy were methodically removed and each time the internal resistance was read. It was found that the internal resistance rose no more than 3% after removal of 32% of the cell's energy. Upon continued discharge, the internal resistance increased rapidly in a non-linear fashion.

Since it is extremely unlikely that the cells' metallic resistance could have changed while the cells were discharged, it can be concluded that:

- 1) the changes noted in total internal resistance were due exclusively to electrochemical resistance change;
- 2) the electrochemical resistance change is a small part of total internal resistance as the stored energy drops from 100% to substantially lower levels of charge.<sup>9</sup>

In the real testing world, this is good news. It means that a battery can be reliably tested by the Cellcorder at float, open circuit voltage and even partially discharged.

## **THE "BASELINE" AND WHEN BEST TO GET IT**

The fantasy of a "battery literate" person is that *complete* capacity and internal resistance test data, from *day zero*, is available for analysis. He seeks to determine the typical internal resistance of cells at 100% and 80% as well as the trend from 100% through 80% capacity.

The fantasy begins with the battery's installation. An acceptance capacity test is conducted and the cells' internal resistances measured. The results should be fairly uniform and he would safeguard this data. He knows it serves as the ideal baseline, or "reference" per IEEE/ANSI P-1188, for future internal resistance tests. He will then be able to make *cut and dry* decisions about maintenance or cell replacement.

Unfortunately, it's a fantasy in most environments because, in the rush and tumult of getting a facility on-line, establishing a baseline usually has low priority. As a result, we are then left to getting data in the best ways possible.

The second best time to obtain a set of data is shortly after capacities have been determined on *the same model cells of the same age*. Lastly, try obtaining data on *the same model cells* of any age. Over time, data to the end-life or 80% capacity level will be accumulated.

#### **-CAUTION-**

**Internal resistance data taken *without* the benefit of correlated known capacities is often referred to as "as-found comparative values."** This as-found data could be used to set a baseline, but be *very cautious*. It is not unusual to find an entire string of cells of uniform internal resistances, and normal appearance on float, but with *failing capacities*. In this situation, we highly recommend at least a crude service/load test be performed to lend some credence to the internal resistance measurements.

#### **THE COURSE OF ACTION**

If you do not have end-life or 80% baselines developed from significant samples of the same cells, age, etc., you should use the following rough rules-of-thumb based upon Cellcorder user reports and in-house experience.

#### ***If the internal resistance is:***

***20%-50% above the 100% baseline, then the cell be load tested . . . the sooner the better if it's towards the high end;  
at 50% or above the baseline, the cell be replaced.***

Surprisingly, the IEEE/ANSI VRLA P-1188 proposed standard is more liberal in this matter. It recommends that from 25% to about 43%, the cell's manufacturer be contacted. Above 43%, a load test be done ASAP. Actually, the standard is expressed in the reciprocal of internal resistance, conductance (*mhos*.)

## DATA ANOMALIES

Another part of the battery literates' fantasy is also likely to be shattered: that *all* the data gathered for the baseline, or test readings taken afterward, would fall reasonably close to any trend line. That is, higher capacity cells will have uniformly lower internal resistances and lower capacity cells will have proportionately higher internal resistances. Even cells fresh off of a tightly controlled production line fail to completely conform with this expected behavior.<sup>5</sup>

In the course of your own testing, you will find *tested*, high capacity cells with an unusually *high* internal resistance. Similarly, there will be cells with the *low* internal resistance characteristic of a good cell that would fail a capacity test. Unfortunately, the current state of the art does not permit impedance, conductance, admittance or resistance testing to definitively identify the cells with anomalies - without the assistance of a load test.

If you are fortunate to have large amounts of both capacity and corresponding internal resistance data, developing a baseline should be no problem. When a program is just starting, or there are few cells of a particular model, some educated "guess-timating" helps in sorting out data. If you need baseline data try calling us or the cell's manufacturer.

## INTERNAL RESISTANCE TEST FREQUENCY

The whole purpose of the internal resistance check is to determine whether a cell has deteriorated and if so, how much and how fast. Logically, checks are done periodically. At least quarterly, check cells that have exhibited signs of abnormality either from inspection or an earlier capacity, integrity or internal resistance test.

Since neither specific gravity nor visual checks can be done on sealed cells, you would want to do much more frequent testing than on vented cells. For that reason, it's no surprise the P-1188 VRLA proposed Standard recommends internal measurements be taken quarterly.

On the other hand, the standard for vented batteries, 450<sup>1</sup>, doesn't specify this type of check. However, it does call for annual connection resistance readings and you would want to take the internal resistances at the same time.

**That's the nicest part of the Cellcorder... its "multimeter" functions measure and record both the internal and connection resistances at the same time! It saves you time and you don't even move the test leads for single post cells.** For detailed information, request Cellcorder Application Note CC002, *Intercell Resistance Measurement Procedures* which covers single and multiple-post cells measurements.

## **MANAGING THE CELLCORDER'S DATA FILES**

As a testing program progresses, the number of computer data files will increase rapidly... as many as four yearly per battery string if the P-1188 guidelines are followed.

To quickly identify these type files and manage them with minimum errors through DOS or through Windows File Manager, a file naming system can be important. Try to include in the filenames' eight characters as many descriptors as possible to reflect the data's date, location and battery. Thus, filename **941WPB1A.DAT** would describe the first test data, in 1994, for location WPB's battery 1, string A.

Whether you use numbers or characters, the important thing is to make the filename as recognizable as possible while avoiding duplicate filenames. This helps immensely in finding files and to avoid overwriting, deleting or copying wrong files, especially when using operating systems before version MSDOS 6.

## **SAFEGUARDING THE CELLCORDER**

By far, the most common cause of damage to the Cellcorder is from *grossly* excessive input voltages, particularly when taking UPS cell readings.

*AWARENESS* is the most important factor in avoiding these kind of problems. Before any testing begins, take five minutes to survey the battery bank to make sure that:

- cells are not misnumbered;
- the intertier cable routing is unmistakable;
- the main battery terminals and other spanable high voltage points are identified and temporarily covered.

Also, before making a measurement that includes a cable routed through a tray to another tier, use a voltmeter to identify the other end. Make sure no potentially damaging voltage is present.

*POWER-UP* the Cellcorder before connecting it to a battery. This activates additional protective circuitry.

*CLEAN-UP* is also important especially in preserving the jaws and clips of the test leads. Wipe off all grease and then apply an acid neutralizing solution.

## REFERENCES

- (1) ANSI/IEEE 450-1995, "*IEEE Recommended Practice for Maintenance, Testing and Replacement of Vented Lead-Acid Batteries for Stationary Batteries*," ANSI, New York, NY 1995
- (2) ANSI/IEEE PAR #1188, "*IEEE Recommended Practice for Maintenance, Testing and Replacement of Valve Regulated Lead-Acid Batteries for Stationary Batteries*," ANSI, New York, NY 1994
- (3) E. Willihnganz and P. Rohner, "*Battery Impedance: Farads, Milliohms, Microhenries*," AIEE, 1959
- (4) S. DeBardelaben, "*Determining the End of Battery Life*," Intelec '86, Toronto, Canada
- (5) S. Misra, T. Noveske, L. Holden, S. Mraz, "*Use of AC Impedance/Conductance and DC Resistance for Determining the Reliability of VRLA Battery Systems*", Intelec '93, Paris, France
- (6) Y. Konya, T. Takeda, K. Takano, M. Kohno, Et. Al., "*A Deterioration Estimating System for 200 AH Sealed Lead-Acid Batteries*", Intelec '94, Vancouver, B.C.
- (7) K. Peters, "*Ten Years Experience of VRLA Batteries in Telecommunications Service*," May 1994, 8th Battery Conference & Exhibition, Solihull, UK
- (8) Johnson Controls, "*Impedance and Conductance Testing*," Application Note Form 41-7271, Aug. 1994, Milwaukee, WI and Albér in-house data.
- (9) G. Alber, "*Are Internal Cell Parameter Measurements a Substitute or Supplement to Capacity Testing?*", Sep. 1994, NE Utilities Battery Conference, Albany, N.Y.

## 33 Application Note CC-002-A

### Internal Resistance Measurement Procedures

#### INTRODUCTION

Intercell resistance problems account for a great many battery system failures. In UPS or other high current applications, the failures can lead to explosions and fires that are not only costly but also represent safety hazards.

Most battery manufacturers, unfortunately, do not supply baseline resistance values, so presently users must establish their own values. The recommended procedures for establishing base lines are:

*New systems* . . . read all the resistance values after installation and calculate the average value.

*Older systems* . . . disassemble 10 sets of intercell connections; burnish, neutralize and clean them; reapply corrosion inhibiting compound, reconnect, retorque, and then calculate the average of the new readings.

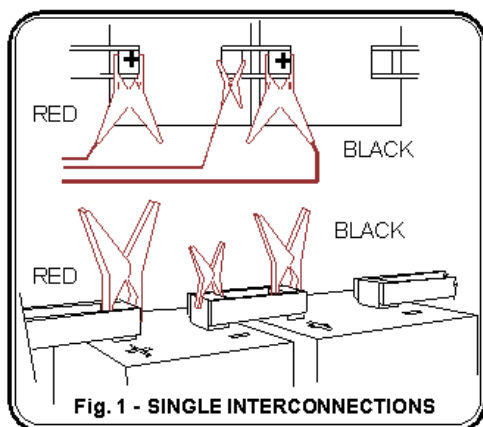
Intercell resistance measurements should be taken once a year of *all* cells (IEEE-450-1995 and forthcoming IEEE VRLA maintenance recommendations). Any connection that is 20% or greater than the baseline or installation value requires corrective action. The importance of these measurements is illustrated by the new VRLA standard that recommends *quarterly* sampling 25% of the intercell connection resistances. If an *upward trend* is detected, all connection resistances should be measured to aid in determining the cause and corrective actions.

#### HOW TO TAKE READINGS

When taking intercell connection resistance readings, it is important that:

a) the test leads are connected properly. Measurements should include the post to intercell connector resistance. Always check your connections and connect *only* to posts, *not* nuts, bolts or straps. (See figs. 1-5. This is the main area where connection problems occur;) and,

b) the test probe tips/fingers make a good connection, piercing any grease, lead oxide or crud coating the posts or straps. This is the leading cause of error messages after pressing the test button. Often jiggling the probe will lower the readings significantly and save you the heartache of unnecessarily reworking a connection.

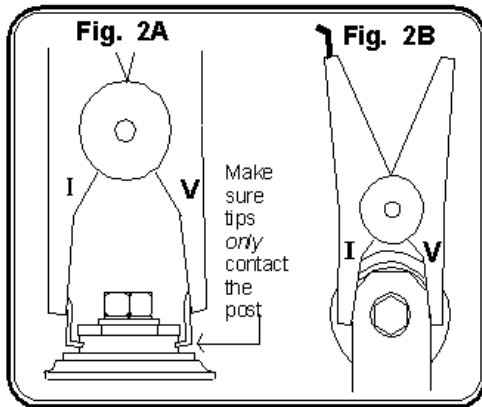


**Figure 1. Single Interconnections.**

### **SINGLE INTERCONNECTIONS**

Figure 1 shows how the Albér Cellcorder should ideally be connected to obtain the proper measurement. Note that, ideally, the reading includes both the intercell connector resistance and the post to intercell connection resistance.

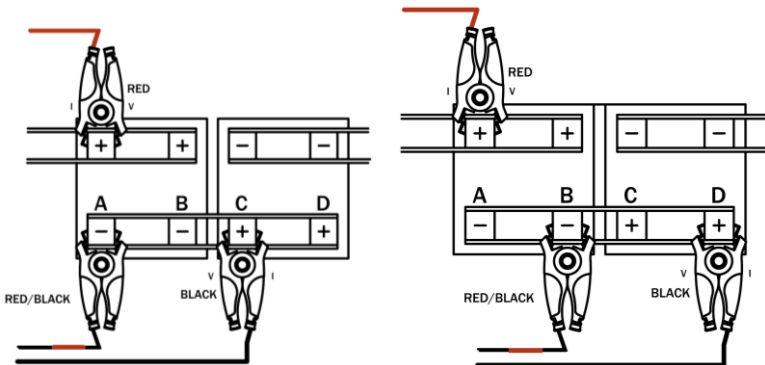
Figure 2A shows the connection for VRLA cells, such as the ABSOLYTE II batteries, where the terminal post *is* accessible. Figure 2B shows the connection for VRLA cells where the terminal post is *not* accessible. In this type of cell, the intercell to post connection resistance is included in the internal cell resistance measurement. NOTE: Do *not* connect to the stainless steel bolt heads to make this measurement.



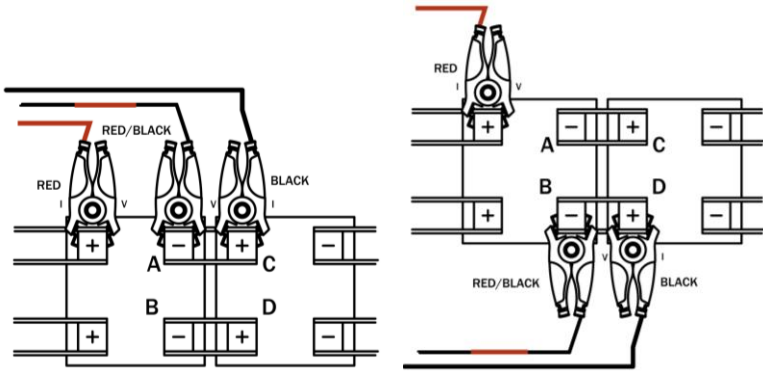
**Figures 2A and 2B. VRLA Cells.**

### DUAL INTERCONNECTIONS

Figures 3A and 3B show the typical intercell connections for dual post cells. This type of interconnection requires that two readings be taken. The first one shown should be with the intercell leads connected from Terminal Post A to Terminal Post C. Take the second reading with the intercell leads connected from Terminal Post B to Terminal Post D. The positive (a red clip) Cellcorder lead should remain connected (as shown) to the same terminal post for both measurements.



**Figure 3A. Connections for Dual Posts.**



**Figure 3B. Connections for Dual Posts.**

### TRIPLE INTERCONNECTIONS

Figures 4 and 5 show the typical intercell connections for triple post cells. For cells arranged as in Fig. 4, three readings are made. The first one, shown, should be with the intercell leads connected from Terminal Post A to Terminal Post D. Take the second reading with the intercell leads connected from Terminal Post B to Post E. The third reading is with the intercell leads connected from Terminal Post C to Post F.

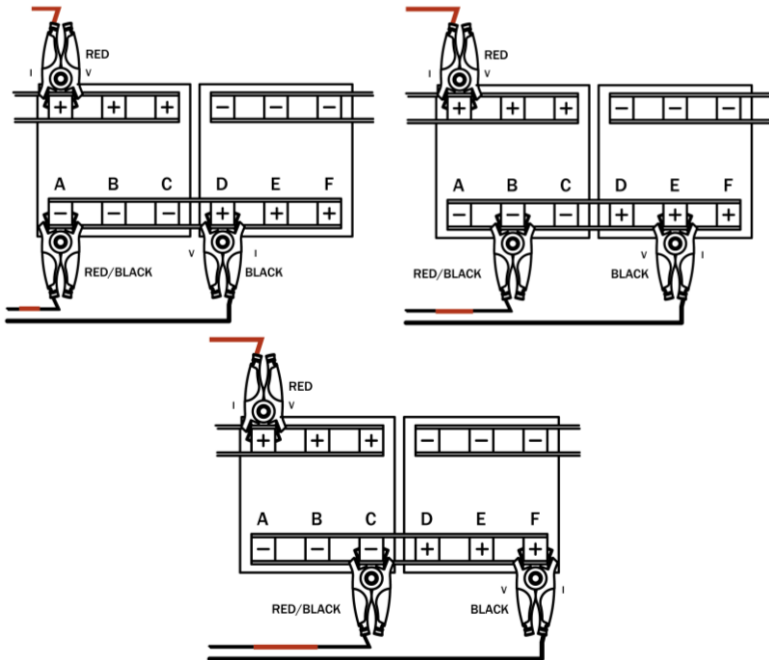


Figure 4. Connections for Triple Posts.

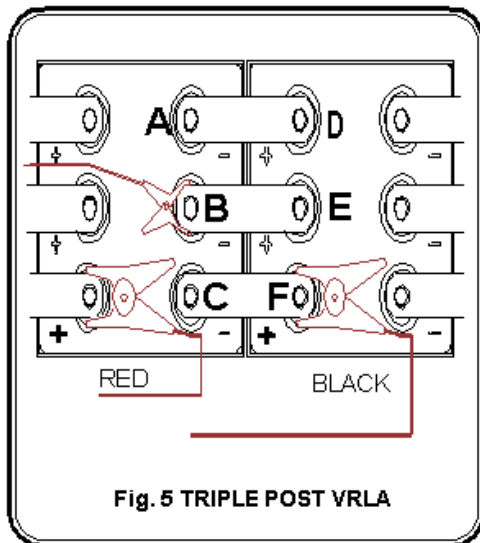


Figure 5. Connections for Triple Posts.

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For VRLA cells or flooded cells configured as shown in Figure 5, four readings are made, forming two “X’s.” Terminal Posts A to E then B to D, and B to F then C to E.

In all triple post strap measurements, the positive (a red clip) Cellcorder lead should remain connected (as shown) to the same terminal post for all readings.

## 34 Connection Options

For the latest connection options, see the Albér Web site at [www.alber.com](http://www.alber.com) or contact your local Albér sales representative.



For further information on which Cellcorder leads are best suited to your individual requirements, contact your local ALBER representative or ALBERCORP directly at:  
 Phone (561) 997-2299 Fax (561) 997-5588  
 990 S. Rogers Circle, Suite 11  
 Boca Raton, FL 33487

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