



Cellpro Revolution 4s Charger

Model LIPOCH4S04-A123, for use with LiPo, Li-Ion and A123 battery packs with node connectors
4 Amp model for automatic and manual charging with cell balancing and overcharge protection



Features

- Simple to operate: just connect the Cellpro Revolution 4s charger between a power source and a pack. No jumpers, plugs or dials to set! Charger automatically determines pack capacity and sets optimal current, then dynamically adjusts charge rate as needed. Manual charge rates of 0.25A to 4A (in 0.25A increments) allow for special situations.
- Charges Lithium Polymer, Lithium Ion, Lithium Manganese and A123[®] chemistries. Adapters are available from FMA Direct.
- Each cell is charged independently, providing exceptional charging safety and elevating RC packs to the safety level of cellphones.
- Charges LiPo packs having one to four cells and any capacity up to 32Ah. Typical packs of up to 4Ah capacity charge in 50 minutes or less using charger's 2C Auto Current Mode.
- Multifunction display shows operating mode, individual cell voltages, charge current, supply voltage, and amount of charge (mAh) put into pack. Plus, the unique Fuel display shows percent capacity remaining in a pack.
- Viewer software (a free download) displays real-time data and graphs.
- Latest technology provides the ultimate in safety. Even charges packs having hidden physical damage without danger of fire. A pack will not charge if individual cell voltages don't equal total pack voltage.
- Cell balancing to 10mV and automatic overcharge protection assure longest pack life. Automatic temperature monitoring prevents pack overcharging at low ambient temperatures and charger damage at high ambient temperatures.
- Low Voltage Restore feature automatically attempts to repair overdischarged packs. Cells discharged as low as 0.5V may be repaired to as much as 98% of capacity.
- Cold Weather Charge stops charging at 4.10V/cell when temperature is below 55°F to prevent cell damage.
- Operates from any 12–16V DC, 5A (minimum) power source. Inputs and outputs are protected against reverse polarity.

Precautions

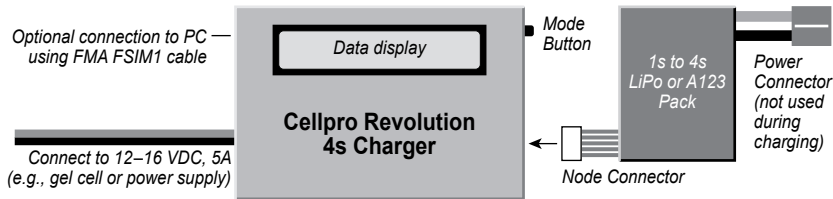
- Follow all instructions in this manual to assure safe operation.
- Always watch LiPo packs while they are charging. Never leave LiPo packs unsupervised during charging.
- See additional warning sheets provided with this charger and FMA LiPo packs.
- Follow all guidelines for charging, discharging, handling and storing LiPo cells.



Connecting the charger

Connecting packs with a Cellpro connector

Connect Cellpro Packs as shown in this diagram:



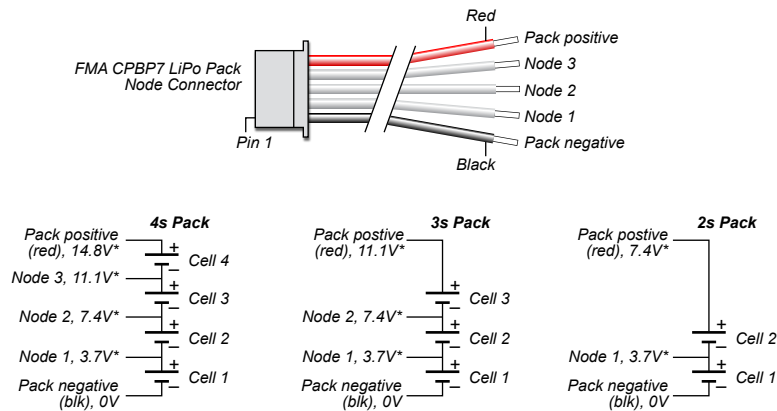
WARNING: Power supply must provide at least 5A at 12V (60 Watts). Failure to comply will void the charger warranty.

CAUTION: When two LiPo packs are connected in series, **do not** connect them to two separate chargers that are wired to a single power source. This sets up the dangerous condition in which the series-connected packs are being charged in parallel (the power source provides a common ground). **One or both chargers, as well as the packs, will be damaged.** This condition will be avoided if the chargers are driven from two **unconnected** power sources (e.g., two lead acid batteries). For safest charging of series-connected packs, disconnect the packs from each other before connecting them to chargers.

Connecting non-Cellpro packs

FMA Direct offers plug-and-play adapters for charging LiPo packs equipped with node connectors made by other vendors. Check the Cellpro section at www.fmadirect.com for the latest adapters.

If an adapter isn't available for the pack you want to charge, or if the pack doesn't have a node connector, the FMA CPBP7 LiPo Pack Node Connector cable assembly will make the pack compatible with the Cellpro Revolution 4s Charger. The diagrams below show how the Node Connector attaches to packs of various configurations. Additional assembly information is provided with the Node Connector.



* Nominal voltage with respect to pack negative.

Charger specifications

For battery type	Lithium Polymer, Lithium Ion, Lithium Manganese and A123 packs; charger can be used with 1s to 4s packs having node connectors and connected to charger with an appropriate FMA adapter cable
Pack capacity	250mAh to 32Ah (charge time limited to maximum of 8 hours)
Input voltage	12 to 16VDC*, reverse polarity protected
Input current	5A minimum*
Power conversion	62.5kHz switcher operating at 90% efficiency
Nominal output voltage	4.20 volts per cell for all except A123 packs 3.60 volts per cell for A123 packs
Output current	Up to 4A, reverse polarity protected; 3A on 4s packs
Number of cells (output)	1 to 4 cells in series
Cell balancing	To within 10mV
Voltage calibration	Cell voltage measurements are factory calibrated to a standard traceable to NIST; calibration is to $\pm 6\text{mV}$
Current calibration	Charge current is factory calibrated on a 4A standard; calibration is to $\pm 6\text{mA}$
Measurement accuracy	Voltage: $\pm 10\text{mV}$ Charge current: $\pm 1\%$ Capacity added to pack: $\pm 1\%$ Percent capacity ("Fuel"): $\pm 5\%$
Serial data output	19.2kbps, 8 bits, 1 start bit, 1 stop bit, no parity

***WARNING:** Power supply must provide at least 5A at 12V (60 Watts). Failure to comply will void the charger warranty.

FMA limited warranty

FMA, Inc. warrants this product to be free of manufacturing defects for the term of one year from the date of purchase. Should any defects covered by this warranty occur, the product shall be repaired or replaced with a unit of equal performance by FMA or an authorized FMA service station.

Limits and exclusions

This warranty may be enforced only by the original purchaser, who uses this product in its original condition as purchased, in strict accordance with the product's instructions. Units returned for warranty service to an FMA service center will be accepted for service when shipped postpaid, with a copy of the original sales receipt or warranty registration form, to the service station designated by FMA.

This warranty does not apply to:

- Consequential or incidental losses resulting from the use of this product.
- Damage resulting from accident, misuse, abuse, neglect, electrical surges, reversed polarity on connectors, lightning or other acts of God.
- Damage from failure to follow instructions supplied with the product.
- Damage occurring during shipment of the product either to the customer or from the customer for service (claims must be presented to the carrier).
- Damage resulting from repair, adjustment, or any alteration of the product by anyone other than an authorized FMA technician.
- Installation or removal charges, or damage caused by improper installation or removal.

Troubleshooting

Operating errors appear as safety codes in the display. To determine the problem, look up the code in the table below. Correct the error. If errors continue, contact FMA Customer Service.

SAFETY CODE 23
Push to Reset

Typical error message

Code	Cause	Resolution
1	Low-cell-voltage timeout on startup	Try charging again no more than 2 times. Cell may have internal short.
2	Input voltage below 10 volts	Lower charge amps, get a bigger power source (power source must output at least 5A).
3	Input voltage above 16 volts	Power source voltage is too high. Lower voltage.
4	Input voltage unstable	Power source is too small. Lower charge current. Check for loose connections or thin wires.
5	Cell voltage above 4.30 volts	Discharge pack.
6	Cell removed too many times (charger attempted to charge, but failed) or red node wire not connected	Ensure red (pack +) wire is properly connected. If error continues, pack or charger may have a problem.
7	Bad mode number	Factory error. If error persists, send charger for repair.
8	Checksum error	Factory error. Send charger for repair.
9	Overcurrent	Power source may be unstable. If power source voltage is stable, send charger for repair.
13	Overvoltage shutdown	Factory error. If error persists, send charger for repair.
14	Bad EEPROM write	Factory error. If error persists, send charger for repair.
15	System soft start	Check for bad power connection or low source voltage.
16	Firmware corruption	Factory error. If error persists, send charger for repair.
17	Cell voltages don't total correctly	Cycle charger power. Pack may have a bad cell. Ensure red node wire is properly connected.
18	Cell balancing stopped after 8 hours	Raise charge current. Pack may be bad, or too big.
20	Fast charge stopped after 8 hours	Raise charge current. Pack may be bad, or too big.
21	Bad cell count	Check individual cell voltages (each cell must be above 0.5V).
22	Charge current too low	If pack is not full, try raising current above 1A.
23	Pack detect ran 8 times without finishing a single charge	Pack may have bad cell. Check individual voltages. If one cells is full and another cell is empty, pack cannot be safely charged
24	Cell dropped below 3 volts during charge	Pack may have bad cell.
28	Pack detect failed	Check individual cell voltages (each cell must be above 0.5V). Ensure all node wires are properly connected to cells, and black (pack -) node wire is properly connected. Ensure battery ground is not connected to power source ground. Charger may be wet. A123 pack drained to 0V may have damaged cell.

Charging modes

The Cellpro Revolution 4s Charger provides several charging modes. Please become familiar with them before charging packs.

Normal charging modes

The Cellpro Revolution 4s Charger provides both automatically controlled and fixed charging current modes:

- In **4.00A A123 3.60V Mode**, cells are individually charged to 3.60V per cell. This is for A123 brand of high current Lithium Ion cells that handle charge rates up to 5C. Charge current is fixed at 4.0A.

Important: Only one mode is available for charging A123 packs. The 4.00A A123 3.60V Mode charges A123 chemistry to 3.6V per cell. Do not attempt to use any other mode to charge A123 packs. Other modes will overcharge A123 packs to 4.2V per cell.

- In **1.0C LiPo 4.20V Mode**, LiPo/Li-Ion cells are individually charged to 4.2V per cell. The charger measures pack parameters and sets an optimal charge current.
- In **2.0C LiPo 4.20V Mode**, LiPo/Li-Ion cells are individually charged to 4.2V per cell. Charge current is slightly higher than 1.0C LiPo 4.20V Mode. Packs smaller than 4Ah will charge completely in about 40 minutes.
- In **3.0C LiPo 4.20V Mode**, LiPo/Li-Ion cells are individually charged to 4.2V per cell. Charge current is automatically set to 3 times capacity. Typical charge time for packs under 1.5Ah is 30 minutes. Cycle life on high discharge packs (12C and greater) is not affected by the Cell Pro 3C charge current.
- In **STORE LiPo @ 50% Mode**, LiPo/Li-Ion cells are individually charged to 3.842V or 50% capacity. This is a good charge level for long term storage or shipping by mail.
- In **0.25A thru 4.00A LiPo 4.20V Mode**, LiPo/Li-Ion cells are individually charged at the current you select. Charge voltage is 4.2V per cell.

When first connected to a power source, the charger is set for 3.00A A123 3.60V Mode (the factory default). You can change to another current setting at any time by holding the Mode Button. The charger remembers the charging mode and current setting when disconnected from the power source, and will start in that configuration the next time it is used.

CAUTION: Only FMA balancing chargers can safely charge packs above 1C. Other chargers don't charge individual cells, and are limited to a 1.0C rate. Charging at greater than 1.0C with those chargers increases the risk of fire. Always follow charger and pack manufacturers' recommendations for maximum charge rate.

Other charging modes

- In **Low Voltage Restore Mode**, the charger automatically attempts to repair overdischarged packs. Cells discharged as low as 0.5V may be repaired to as much as 98% of capacity.
- In **Safety Charging Mode**, the charger detects that at least one cell is seriously out of balance, and automatically lowers charge current to 0.5A. To disable Safety Charging Mode, disconnect the pack, then reconnect it.

CAUTION: When the charger's display shows SAFETY CHARGING, the connected pack is damaged. Treat damaged packs with caution. Do not charge them on a flammable surface, and do not charge them unattended.

- In **Cold Weather Balancing Mode**, charging automatically stops at 4.10V/cell when temperature is below 55°F to prevent cell damage.

How to charge a pack

Tip: Because FMA's cell balancing technology monitors individual cells, you don't need to cool a pack before charging it. Go from flying to charging to flying again without waiting. FMA cell-balancing chargers are the only ones that can charge a pack immediately after discharge without damaging the pack.

1. Connect the charger to a power source and a pack as shown on the previous page.

WARNING: Power supply must provide at least 5A at 12V (60 Watts). Failure to comply will void the charger warranty.

2. If you want a different charging mode or current:
 - a. Press and hold the Mode Button. The display will cycle through available charging modes and currents.
 - b. Release the Mode Button when the desired charging mode or current is displayed.

Tip: More information about the display—and how to navigate it—is provided on the next page.

Note: You can change charger modes at any time, whether or not a battery is connected to the charger. However, be careful. If you are charging an A123 pack (in 4.00A A123 3.60V Mode, of course), you shouldn't enter the menu (by pressing and holding the Mode Button). Doing this could put the charger into a LiPo mode, which would overcharge the pack. If you do change modes when a pack is connected, always make sure the chemistry shown in the display (LiPo or A123) matches the connected pack.

3. Under normal conditions, the charger will beep at the following times:

- When pack has been charged to 90% of capacity.
- When pack has been charged to 100% of capacity.

About Cellpro Revolution LiPo Packs

Cellpro Revolution Packs are the next-generation Lithium Polymer technology. Manufactured by WorleyParsons and marketed by FMA Direct, this unique power technology offers high energy density, low weight, long life, safe operation and environmentally-friendly chemistry. FMA Direct offers a full line of LiPo packs and compatible electronics at www.fmadirect.com. LiPo technical and application information is available in the Support section of the Web site.

Charger Viewer Software

Use the Charger Viewer Software to monitor pack voltage, cell voltages, charge current and safety codes on your PC.

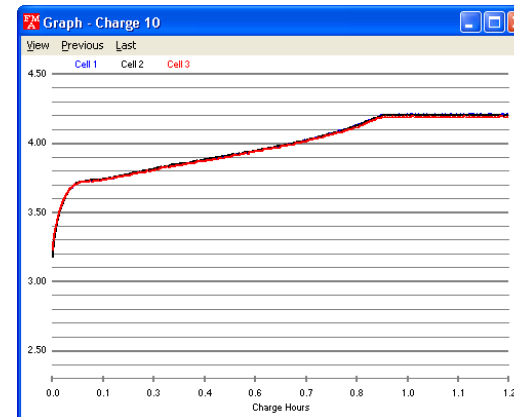
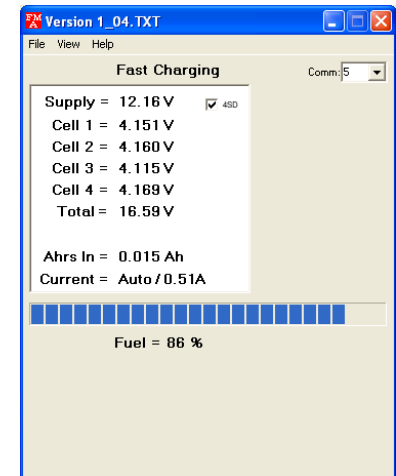
Requirements for using the Charger Viewer Software:

- Windows 98 or later computer.
- Microsoft .NET Framework, which must be installed before installing the Charger Viewer Software. The .NET Framework is a free download from Microsoft at www.microsoft.com/downloads.

1. Download "Charger 4s Viewer" from the **Support** page at www.fmadirect.com. Double-click the downloaded file and follow the installation instructions.
2. Connect Charger to pack and to power supply.
3. Connect Charger to PC using an RS232C cable and FMA P/N FSIM1. If PC doesn't have an RS232C port, use an RS232C-to-USB adapter to connect cable to USB port.
4. Launch Charger Viewer. Program checks ports until it finds charger data, or open **Comm** list and select a port.

- To add notes: **View > Battery Notes**.

- To see voltage versus time:
View > Graphs. Then in **Graph** window, **View > Charge Voltage** or **View > Discharge Voltage** as needed.



Tip: Resize the **Graph** window to see more detail.

Estimating performance factors

If you don't have a way to directly measure your propulsion system's electrical parameters, the Cellpro Revolution 4s Charger enables you to estimate them using before- and after-flight measurements.

Collect data

- Charge pack.
- ↓
- When charging is finished, record **Fuel %** and **total pack voltage** (i.e. sum of cell voltages).
- ↓
- Fly plane (or test on the ground). Record **flight time in minutes**.
- ↓
- Connect pack to charger. Record **Fuel %** and **total pack voltage**.

Calculate performance factors

$$\frac{(\text{Fuel \% before flight}) - (\text{Fuel \% after flight})}{100} \times (\text{Pack capacity, Ah}) = \text{Capacity consumed during flight, Ah}$$

$$\frac{(\text{Capacity consumed during flight, Ah}) \times 60}{(\text{Flight time, minutes})} = \text{Average current during flight, A}$$

$$\frac{(\text{Pack voltage before flight, V}) + (\text{Pack voltage after flight, V})}{2} = \text{Average voltage during flight, V}$$

$$(\text{Average voltage during flight, A}) \times (\text{Average current during flight, V}) = \text{Average power during flight, Watts}$$

$$\frac{(\text{Average power during flight, Watts})}{(\text{Model weight, pounds})} = \text{Watts per pound}$$

Evaluate results

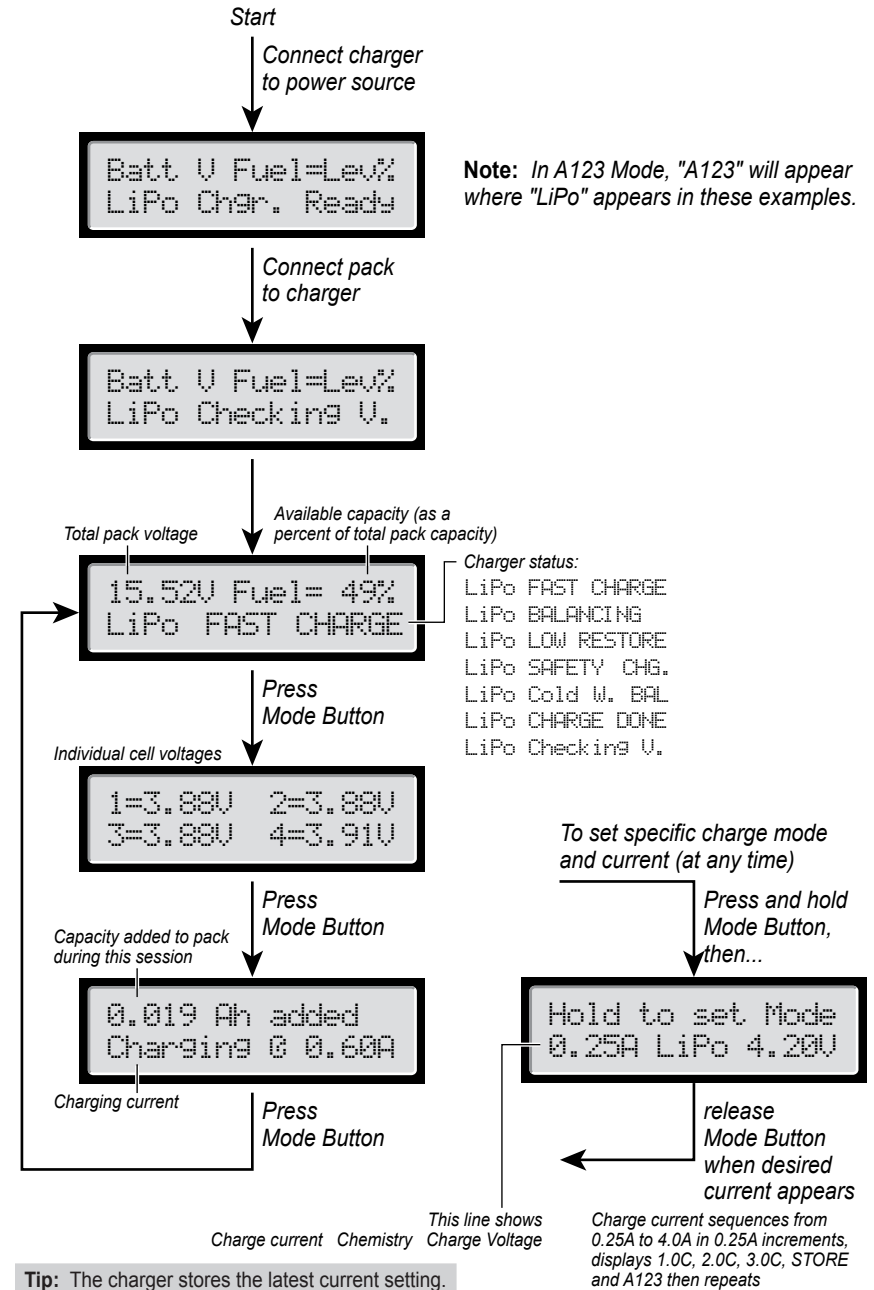
- **Average current during flight** gives you a rough idea whether system components—ESC, motor, connectors and wiring—are operating within their current ratings. Keep in mind that peak current during flight may greatly exceed the average current you calculated.
- **Watts per pound** is an approximate indicator of aircraft performance (other factors influencing performance include lift, drag and motor type). Here are some guidelines:
 - 25 to 30 watts per pound: level flight.
 - 40 to 50 watts per pound: take off from smooth surface, climb.
 - 50 to 75 watts per pound: take off from grass, sport aerobatics.
 - 75 to 125 watts per pound: pattern aerobatics.
 - Over 125 watts per pound: 3D.

Tip: For more direct electrical measurements, consider these FMA products:

- 60A Current Shunt (Model DVM-SHUNT-60)
- Digital Multimeter (Model DVM-VC890D)

About the data display

The diagram below explains the data display, how to view data about the pack being charged, and how to manually set the charge current.



Practical information about the Cellpro Revolution Charger

General information

- Cells in a pack have different voltages when they are discharged. The Cellpro Revolution 4s Charger balances (equalizes) cell voltages while it is charging the pack.
- During charging, cells that charge the fastest are the weakest cells in the pack. At the end of charging, cells with the highest voltage are weakest. This happens because weaker cells have lower capacity, and they charge faster than stronger cells.
- If the Cellpro Revolution 4s Charger displays LOW VOLT RESTORE, the pack was overdischarged during its last use. The charger will attempt to repair LiPo cells measuring between 0.5V and 2.7V, or A123 cells measuring 0V to 2.0V. To avoid additional damage to restored cells, do not overdischarge a repaired pack.
- By definition, end of life for a LiPo cell is when the cell can only be charged to 80% of its original capacity rating. The number of charge/discharge cycles a cell undergoes before reaching end of life depends on several factors, including cell quality, discharge rate, internal heat generated during use, and other parameters. Cells in an older pack may be more out of balance, but the Cellpro Revolution 4s Charger will still balance them to within 10mV by the end of charge. For this reason, it may take longer to balance older packs. The charger may show FUEL=99% for several hours while it is balancing a high capacity (3Ah and up) “veteran” pack that is severely out of balance.
- The charger is open at both ends to provide cooling. Don’t cut the shrink wrap off the charger, as it protects the circuit boards on the bottom. To protect the charger while it is in a tool box, place it in a small box, pouch or camera bag.

Charging packs

- You can top off packs, or remove them when they are partially charged. There is no way to damage a pack when using the Cellpro Revolution 4s Charger.
- If a pack is at 80% or less of its capacity when connected to an auto-detect speed controller, the controller may lower its cut-off voltage. This could overdischarge the pack during the flight. Auto-detect speed controllers should properly set cut-off voltage if packs are charged to at least 90%.
- To save time, stop charging when the pack reaches about 95% of capacity. That last 5% takes the longest.
- Some cells may sag 0.10V within an hour after charging. This is normal as packs age.
- When charging an A123 pack that has been discharged very low, the charger initially may not be able to accurately count cells in the pack. To eliminate the possibility of an inaccurate count, the charger applies current to “wake up” the cells, then recounts.
- Overdischarging an A123 pack below 2.0V/cell will damage the cells (contrary to some reports). The Cellpro Revolution 4s Charger requires a minimum pack voltage of 1.5V to activate charging. If an A123 pack is below this voltage, do not try to repair the pack by boosting voltage. Even if you manage to repair the pack, it will not have many cycles left and the charger will reject it for multiple reasons (as indicated by displayed safety codes).

Storing packs

- For best results, packs (except A123 packs) should be stored at 50% of capacity. Use the charger’s **Store Mode**.
- A123 packs can be stored at 100% of capacity (fully charged). In this chemistry, the breakdown voltage is higher than the fully-charged voltage.

CAUTION: Do not use the charger’s **Store Mode** for A123 packs. **Store Mode** applies 3.84V per cell, which will damage A123 cells.

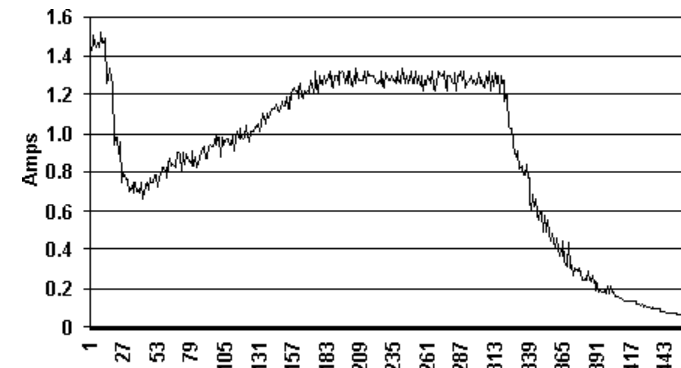
- Packs charged to 100% should not be cooled below room temperature. Cells at 90% or less capacity can be cooled below 32°F (0°C).

How Auto Current Mode works

The Cellpro Revolution 4s Charger’s Auto Current Mode precisely monitors individual cell fuel levels (cell voltages) in a pack. If the charger determines it is charging too fast, it slows down. Likewise, if it is charging too slow, it speeds up. The charger adjusts charge current at one minute intervals throughout the charge cycle.

When charging starts, it takes a short time for the charger to determine the correct parameters, so it may “hunt” for up to five minutes before it settles on the optimum current. This is normal, and doesn’t harm the pack. The longer the charge, the more accurate the calculation.

The plot below shows how Auto Current Mode adjusts the charger’s current when charging a 1.25Ah pack at 1.0C. Initially, the charge current is higher than 1.0C. Within a few minutes the charger adjusts the current downward, and it eventually reaches 1.0C (1.25A in this case). Current drops as the pack reaches full charge. When charge current drops to about 0.1C, the pack is fully charged.



Since Auto Current Mode always starts at the last current calculated during the previous charge cycle, the charger detects and adjusts for an overcurrent condition: if any cell’s voltage increases more than 10% during the first two minutes of charging, Auto Current Mode defaults to 0.5A. This prevents overcurrent if the previously charged pack had a substantially larger capacity.

With the 1.0C Auto Current Mode, a fully discharged pack is charged to its nominal capacity in about one hour. Auto Current Mode takes into account a pack’s starting charge level, so topping off a 50% discharged pack takes only about one-half hour.