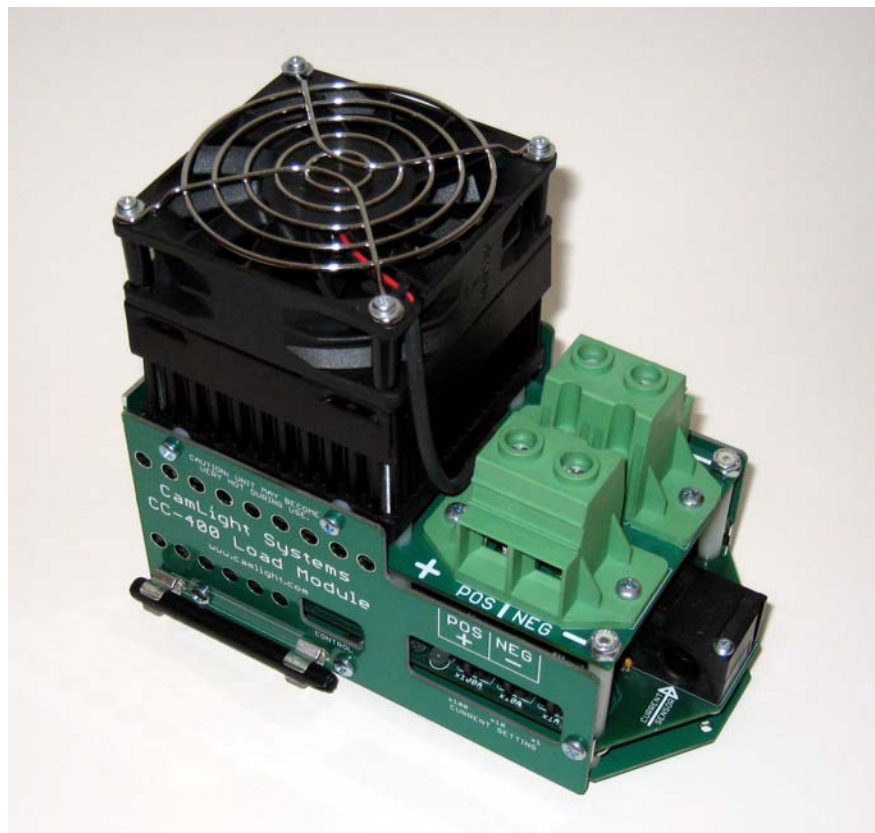


# CamLight Systems Model CC-400 User's Guide

400W, 150A Constant Current  
Programmable Electronic Load  
(Limited to 100A at 0.9V)



## **CAUTION!**

Read and understand all parts of this guide before using your CC-400.

Failure to understand and comply with the warnings and operating instructions in this guide can damage your CC-400 and the cells or battery packs you're discharging, possibly causing serious personal injury.

This document is Copyright © 2008-2009 by John Muchow. All rights reserved.

No part of this document may be reproduced or transmitted in any form or by any means, analog, digital, electronic or mechanical, including imaging, photocopying and recording, for any purpose other than the reader's personal use without the written permission of John Muchow.

All other company, brand and product names mentioned in this manual are service marks, trademarks or registered trademarks of their respective owners.

The material in this manual is subject to change without notice. John Muchow or CamLight Systems assumes no liability resulting from errors or omissions in this document, or from the use of information contained herein.

John Muchow and CamLight Systems reserve the right to make changes in this document and the product described within without notification to its users.

CamLight and CamLight Systems are Service Marks (SM) of John Muchow.

## **User's Guide Release Notes**

### **V1.75**

- Updated the **Additional Information about your CC-400** section to reflect that Volts vs. Minutes graphs will be correct when using any number of CC-400's with a CBA. Additional information was also added regarding Volts vs. WattHrs and Volts vs. AmpHrs data.

### **V1.70**

- Added information on using a CC-400 with West Mountain Radio's CBA Software Version 2 Pro upgrade.
- Added info about using battery or welding cable for larger-gauge hookups if silicone-insulated cable is not available.

### **V1.60**

- Added an outline of the differences between the CBA's Duty Cycle mode and the CC-400's Burst Mode to the **CC-400 Overview** section.

## **NEVER USE THE CC-400 WITHOUT HEEDING ALL WARNINGS BELOW!**

**WARNING:** Never leave a discharging cell or battery pack unattended. Always disconnect the cell or battery pack from the CC-400 as soon as the discharge is complete. The CC-400 is designed for use in a controlled environment and must not be used around children or pets.

**WARNING:** Never leave a discharging cell or battery pack on a heat-sensitive or flammable surface. Always keep it inside a fire-proof container during the discharge and until it has cooled down after the discharge has finished.

**WARNING:** Discharging cells or battery packs at higher than the manufacturer's recommended levels is dangerous. Never exceed these recommendations! The cell or battery pack can catch on fire and/or violently rupture, causing property damage and personal injury.

**WARNING:** Never allow a discharging cell or battery pack to become hot to the touch or to exceed the manufacturer's maximum recommended temperature. If this happens, immediately stop the discharge, disconnect the cell or battery pack from the CC-400 and allow the cell or battery pack to cool inside a fire-proof container.

**WARNING:** Operate the CC-400 only in a cool, dry location, away from direct sunlight. Never operate it at an ambient temperature above 86 °F./30 °C. or in direct sunlight.

**WARNING:** The CC-400 can get very hot during use. Keep all materials away from the CC-400 while it's operating. **DO NOT TOUCH IT DURING A DISCHARGE!!**

**WARNING:** Never block the cooling fans or the sides, top, or bottom of the CC-400. Doing so can cause overheating and damage it.

**WARNING:** Be extremely careful when connecting/disconnecting the cell or battery pack. Accidentally shorting out one of these connections can cause damage to the cell or battery pack.

**WARNING:** Never connect a cell or battery pack to the CC-400 with an open-circuit (disconnected) voltage greater than 60V. Doing so can damage the CC-400 and possibly the cell or battery pack.

**WARNING: Never connect or disconnect a cell or battery pack while a discharge is in progress. Doing so can damage the CC-400 and possibly the cell or battery pack.**

**WARNING: Never reverse the cell's or battery pack's connections to the CC-400!! Always connect the cell's/pack's positive lead to the POS terminal on the CC-400 and the negative battery lead to the NEG terminal. If the connections are reversed, even for a second, the CC-400 and the battery can be damaged or destroyed.**

## CC-400 Overview

### Introduction

The CC-400 is an “electronic load” that you use to extend the capabilities of other devices to discharge your batteries over a wide range of current settings. It's not a stand-alone discharger. It's tool to be used with devices such as the CBA or data loggers to increase their ability to discharge, or monitor the discharge, of any type of battery. This includes Lithium (all types), NiCd/NiMH, and Lead-Acid cells and battery packs, from 0.5V to 60V, up to 400W continuous and up to 500W for 15 seconds.

NOTE: “Battery”, as used in this document, refers to the cell, cells, or battery pack being discharged. “CBA”, as used in this document, refers to the West Mountain Radio Computerized Battery Analyzer. “CBA Software”, as used in this document, refers to the West Mountain Radio Computerized Battery Analyzer Software Version 2.

The CC-400 offers 3 modes of operation:

1. **CC Mode:** Discharges the battery at a constant current level, from 1A-150A, in 1A steps, limited to 400W (500W if the jumper is removed). The current level does not change as the battery voltage drops during the discharge. This is the standard method for testing cells and packs.
2. **Burst Mode:** Discharges the battery by alternating between two different current levels, each independently timed, limited to 400W (500W if the jumper is removed). The current levels can vary from 1A-150A, in 1A steps, and the timing can vary from 0.1 second to 99.9 seconds, in 0.1 second steps.

Sometimes a constant-current discharge doesn't give the user an idea of how a battery might behave in certain applications. Burst Mode creates a discharge profile that can better approximate the conditions the battery might see without having to record a profile to be “played back” with the CC-400 in Throttle Mode.

If using more than one CC-400 at a time, you can create more complex discharge profiles by setting each CC-400 to different “baseline” and “burst” current levels and timing.

NOTE: The CC-400's Burst Mode is different from the CBA Software Pro upgrade's Duty Cycle test mode of operation. Burst Mode allows the selection of two completely independent discharge current levels. A CBA Duty Cycle test only turns the single current level you've selected (in the software) on and off.

3. **Throttle Mode:** Discharges the battery at a current level determined by an external throttle (servo) signal, limited to 400W (500W if the jumper is removed). The current level varies from approximately 200mA for a 0% throttle signal to a maximum programmed by you for a 100% throttle signal, in steps as small as 50mA.

For example, if you wanted the 0%-100% throttle to vary the current from approx. 200mA to 50A, you would program the maximum current

level to 50A and then input the throttle signal to the CC-400. At 0% throttle, the current will be approximately 200mA. At 50% throttle, the current will be 25A. At 100% throttle, the current will be 50A. The current level will never exceed 50A.

For all throttle settings, the current level will not change if the throttle signal is held steady. That is, it will be a constant-current discharge if the throttle setting does not change.

This mode is ideal for “playing back” an actual flight profile recorded by a data logger or for creating custom profiles with analyzers/loggers that allow you to do so with a PC/Mac. You can easily tailor the profile for different batteries by setting the maximum current level to match the battery. This allows you to test using the same profile, but at several different current ranges to see how the battery will perform.

If necessary, The CC-400 can be calibrated to handle throttle signals using a pulse-widths outside the standard 1mS - 2mS range.

## Using the CC-400

The CC-400 can operate alone, with any logger/wattmeter that offers an servo/throttle output, or under control of an analyzer/discharger such as the CBA. Using a CBA to control the CC-400 offers an easy way to increase the CBA's power handling. The CC-400 automatically starts and stops when the CBA does and offers both the CC Mode and Burst Mode of operation. Just pass one of the CBA's battery leads thru the CC-400's current sensor, run the CBA at 1A or higher, and the CC-400 is now under CBA control. There are no electrical connections between them other than their connections to the battery and no modifications to make to your CBA.

The CC-400 allows you to operate your CBA at a lower power level and temperature but still use its software to plot test results. In addition, having only 1A pass through the CBA means that the voltage drop is minimized and detection of the battery's actual voltage will be more accurate.

If using the CBA Software Pro upgrade, you can use up to two CC-400's for discharges up to 1000W (800W continuous) and have the CBA Software accurately plot the data. Not every discharge current selection is available though. See **Using the CC-400 with the CBA Software Version 2** in the **Additional Information about your CC-400** section for more information.

The CC-400's twin terminal blocks allow easy paralleling of multiple CC-400's to increase the power handling of your logger or CBA to any level. Currently, using six CC-400's, our in-house test load operates at 2400W, up to 600A. With alternate wiring, it can easily operate at up to 900A. Or, if not paralleling CC-400's, you can have two different sets of battery connections. For example, one set of 12AWG wires with Dean's or PowerPole connectors and another set with bare-end 4AWG wires to clamp directly to a cell.

NOTE: To make adjusting current settings easier, we have included a rod with a slot cut into its end. Use the slot in this rod to “grab” the current setting switch's knob. If the slot is a bit too wide and is sliding off the knob, you can use a bit of tape in the slot to decrease its width.

## Maximum Power Rating for the CC-400

The CC-400 is shipped with a jumper installed to limit its maximum continuous power rating to 400W. Over 400W discharges can be run, up to a maximum of 500W, for 15 seconds before the CC-400 stops the discharge to prevent overheating.



If desired, the jumper can be removed to permanently increase the CC-400's power rating to 500W continuous. But, at this higher power level certain CC-400 components will run at their absolute maximum temperature rating. This can shorten their life span and potentially damage the CC-400.

Consequently, though we have run CC-400's for several thousand hours at 500W, CamLight Systems cannot be responsible for any CC-400's that are damaged by running at over 400W for longer than 15 seconds.

Once the jumper is removed and the CC-400 turned on, the new power rating permanently takes effect.

**CAUTION: This cannot be undone! Once the jumper is removed and the CC-400 is turned on, placing the jumper back onto the header block will not bring the rating back down to 400W.**

## Hooking up your CC-400

### Connecting a single CC-400 for a discharge:

1. Place the CC-400 on a hard, flat surface. Do not block the fan intake holes on the bottom of the CC-400 by placing it on a carpeted, or similar, surface.
2. Set the current-setting switches to **000**.
3. Connect the “wall-wart” power supply to the circular connector on the rear of the bottom circuit board. It can be used with mains with a voltage of 100VAC-240VAC, 50/60Hz.

NOTE: The power supply has a North American twin flat-blade configuration. For mains outlets with different configurations, like twin circular pins, use an adapter. You do not need a voltage converter, the CC-400's power supply can handle 100V-240V, 50/60Hz.

4. Plug the wall-wart power supply into an AC mains socket and move the power switch to the ON position. The fan will perform a 4-second test to make sure it is operating properly and then stop. After the power-up test, the LED will start slowly blinking red until battery is connected.

NOTE: If the LED blinks red in groups of 5 after the unit is turned on, the fan is not working or jammed and must be replaced. No discharges can be done if this has occurred. Contact CamLight Systems for further information (see the end of this document for contact info.).

5. Pass one of the wires to the cell or battery pack through the CC-400's current sensor. The sensor is bidirectional so the direction of current flow through the wire does not matter. Any current flow greater than 1A through this wire will start the CC-400. If the current drops below 100mA, the CC-400 will stop its discharge.

NOTE: The current sensor will only allow an object up to 0.43" in diameter to pass through it. If your connector is wider than this, you will have to remove it, pass the wire through the sensor, then reattach it.

NOTE: Be sure that the device you are using to start the CC-400 can be set to the current level you wish to use for starting the CC-400.

NOTE: For scalable output data when using the CBA as a controller, it is recommended that the CBA be set to carry 1/10 of the required current and the CC-400 should carry 9/10 of the current. For a 100A load the CBA would carry 10A and the CC-400 would carry 90A for a total 100A discharge. See **Using the CC-400 with a CBA and the CBA Software Version 2** in the **Additional Information about your CC-400** section for more information.

6. Before connecting your battery to the CC-400, be sure the wire leads from the CC-400 are sized correctly. For discharges up to 50A, 12AWG or 10AWG silicone-insulated wiring is large enough. From 50A-100A, we recommend 8AWG or 6AWG. For 100A-150A discharges, never use anything smaller than 4AWG wire with silicone or other high-temperature rated (150-degrees C. or higher) insulation.

NOTE: You can use welding or battery cable if the insulation is one of the high-temperature rated rubber/neoprene types. Do not use cable with plastic insulation unless it has a 150-degrees C., or higher, rating.

**WARNING: Damage to the CC-400's terminal blocks can occur if the wiring you use is too small for the current passing through it. It is always better to oversize the wiring. In addition, if the insulation fails, the wires can short together and damage or destroy the battery being discharged.**

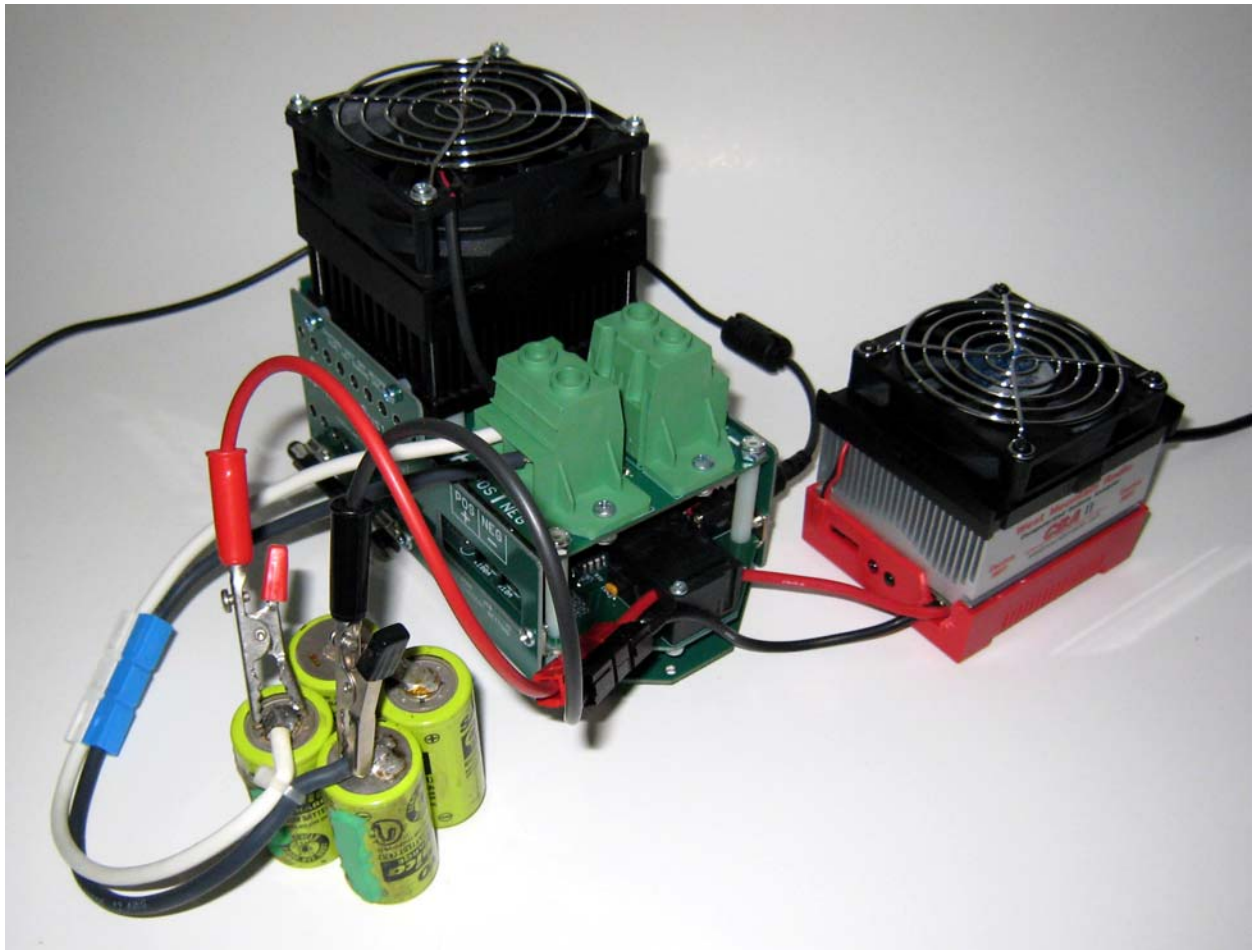
7. Carefully connect your 0.5V-60V battery to the CC-400's terminal blocks. The battery's positive lead must go to the terminal marked "POS". The battery's negative lead must go to the terminal marked "NEG".

**WARNING: DO NOT REVERSE POLARITY!! The battery will immediately start discharging through the CC-400 and might become damaged.**

**WARNING: Never exceed 60V at the battery connections!**

**WARNING: Never connect or disconnect a battery while a discharge is in progress!**

8. The LED will turn a steady green to indicate that the battery is connected and the CC-400 is ready to use.
9. If you have connected your battery and the LED is still blinking red, carefully recheck your connections.



## Connecting multiple CC-400's:

When using more than one CC-400 at the same time to increase the maximum power and current ratings for a discharge, you can connect them in two different ways (or a combination of the two), depending on how you want the current ratings to "add up".

- **"Series" Discharging:**

- Each CC-400's battery wires feed directly into the next CC-400, from the rear terminal block of one to the front terminal block of the next. The first CC-400's front terminal block is used to connect to the battery.
- The power handling increases 400W for each additional CC-400 used, but the maximum discharge current level is still 150A since the current passes through each CC-400 on the way to the next one.
- For example, four CC-400s hooked up in series can handle 1600W at 150A.
- The advantage of this method is that it's the easiest to hook up and takes up less room.

- **"Parallel" Discharging:**

- Each CC-400's battery wires run separately to a separately purchased large 2-pole terminal block. Two very large wires then run from the terminal block to the battery.
- The power handling increases 400W for each additional CC-400 used. But the maximum discharge current level also increases 150A for each additional CC-400 used since the current to each CC-400 is run independently (from the large terminal block).
- For example, four CC-400s hooked up in parallel can handle 1600W at 600A.
- The advantage of this method is that it allows for greater current handling.

If desired, you can also mix & match the two methods described above. For example, four CC-400's can be hooked up as two parallel sets of two series CC-400's. This gives you a 1600W power rating at a 300A current rating, 150A from each series group of two. This lets you save some of the room required for running four sets of cables to a large terminal block, for an all-parallel setup, but still gives you a higher current rating than using all four CC-400's in series.

### Connecting a CBA:

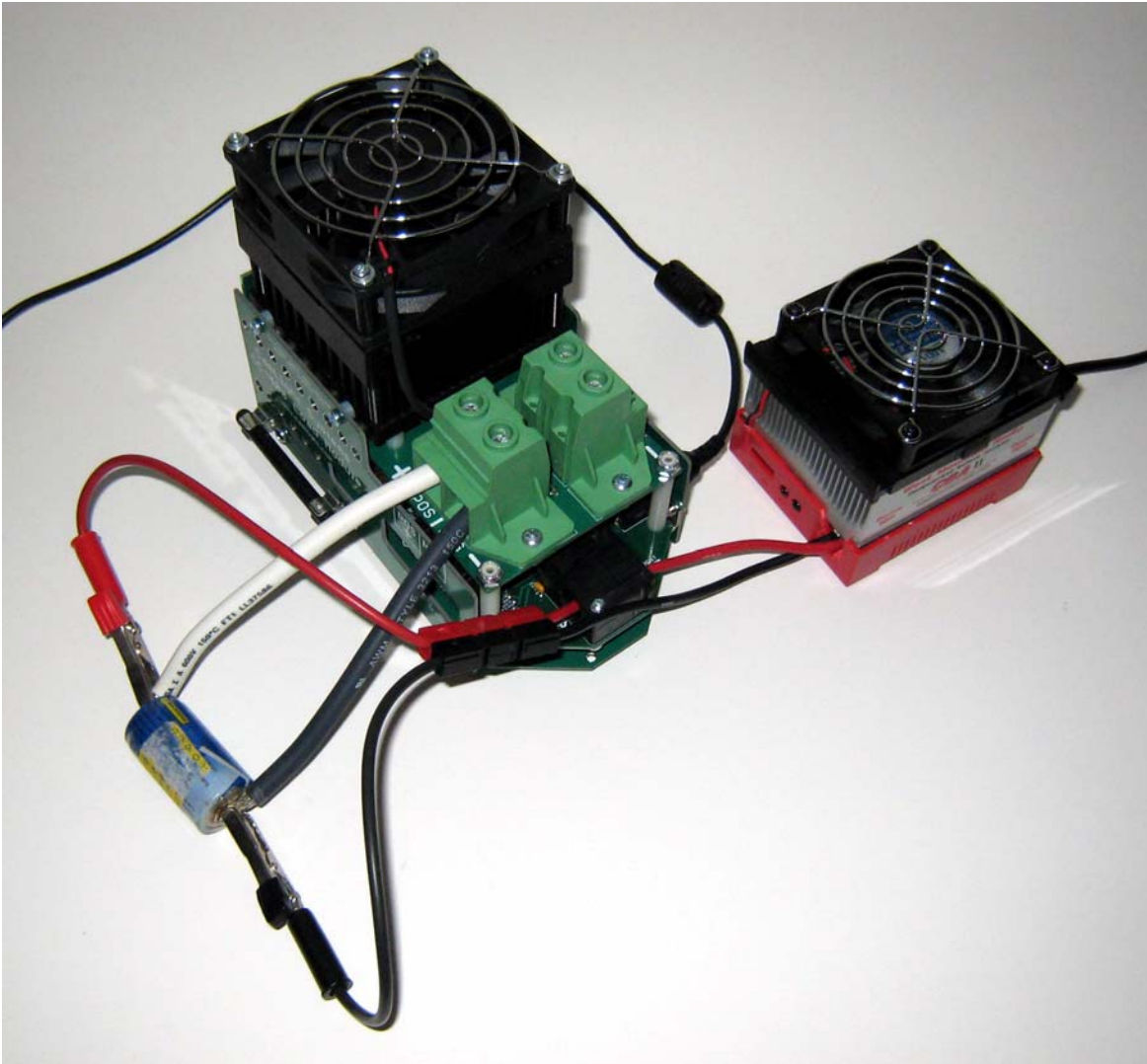
Once you pass one of the CBA's leads through the CC-400's current sensor, you can connect the battery two different ways:

- "Local" voltage sensing
  - The battery is connected to one set of the CC-400's terminal blocks and the CBA is connected to the other set.
  - While easier to set up, the voltage sensing for this connection method isn't as accurate as the remote sensing method described below. Any voltage drops along the battery leads will trick the CBA into thinking that the battery voltage is lower than it really is. But, for lower current discharges, it's the easiest way to connect the battery, CBA and CC-400 together.



See **Using the CC-400 with a CBA and the CBA Software Version 2** in the **Additional Information about your CC-400** section for more information.

- Remote voltage sensing
  - The battery is connected to one set of the CC-400's terminal blocks and the CBA's leads are connected directly to the battery's terminals or tabs.
  - Since the CBA measures the voltage of the battery directly at its terminals or tabs, it's the most accurate method. It's recommended for higher-current discharges as it bypasses any voltage drop along the battery leads and connection points. There's no need to calibrate out the voltage drop in the CBA's leads.



See **Using the CC-400 with a CBA and the CBA Software Version 2** in the **Additional Information about your CC-400** section for more information.

## Constant-Current (CC) Mode Discharging

### Introduction

This mode discharges the battery at a constant current, from 1A-150A, in 1A steps, limited to 400W (500W if the jumper is removed). The current level does not change as the battery voltage drops during the discharge. This is the standard method for testing cells and packs.

### Set up the CC-400 and your battery:

1. Follow the instructions as described in the **Hooking up your CC-400** section above.

### Setting the current levels:

1. Rotate the current setting switches to the desired setting (001A -150A). The starting power level (current setting multiplied by the open-circuit voltage of the battery) must be 500W or less.  
NOTE: The minimum current setting is 1A. Setting the CC-400 to 0A will result in a discharge of approximately 200mA.  
NOTE: The CC-400 is limited to approximately 100A at 0.9V. If you wish to discharge a NiCd/NiMH cell at greater than 100A, you must use two cells in series or a second CC-400.  
**WARNING: Unless the jumper is removed, the discharge must not exceed the 400W maximum continuous power rating for more than 15 seconds or the CC-400 will stop the discharge. If the jumper is removed, you can discharge up to 500W continuously. See the CC-400 Overview section for more information.**
2. If the LED starts blinking red after you set the current, you have exceeded the 500 watt maximum power rating for the beginning of a discharge. Reduce the voltage of the battery or select a lower current setting.
3. For all three switches, be careful that you have not selected "5" when you wanted to select "0", or vice-versa. Both selections have the knob oriented vertically, but the cutout in the dial face will tell you which value has been selected.
4. Set the current level for the device (e.g., CBA or logger) being used to start the CC-400. This value must be at least 1A to start the CC-400's discharge.  
NOTE: the current sensor will not be damaged by using a current value higher than 1A.

### Starting/finishing a CC discharge:

1. Start the discharge from the software for the device being used to activate the CC-400 or, if applicable, from the device itself. The CC-400 will automatically turn on when the current flowing through the wire in its current sensor reaches approximately 1A (typically 0.7A-0.8A).

2. The CC-400 will turn off when the current flowing through the wire in the current sensor drops to below approximately 100mA.
3. If the starting power level exceeds 400W for more than 15 seconds, the CC-400 will stop its discharge and the LED will blink red. After a 15 second cooldown period, during which the fan will continue running, the CC-400 must be turned off for a second and then back on again to reset it. You will not be able to start a discharge until this reset (power off, then power on) has been performed.

NOTE: If you have removed the jumper, you can discharge at up to 500W continuously.

## Throttle Mode Discharging

### Introduction

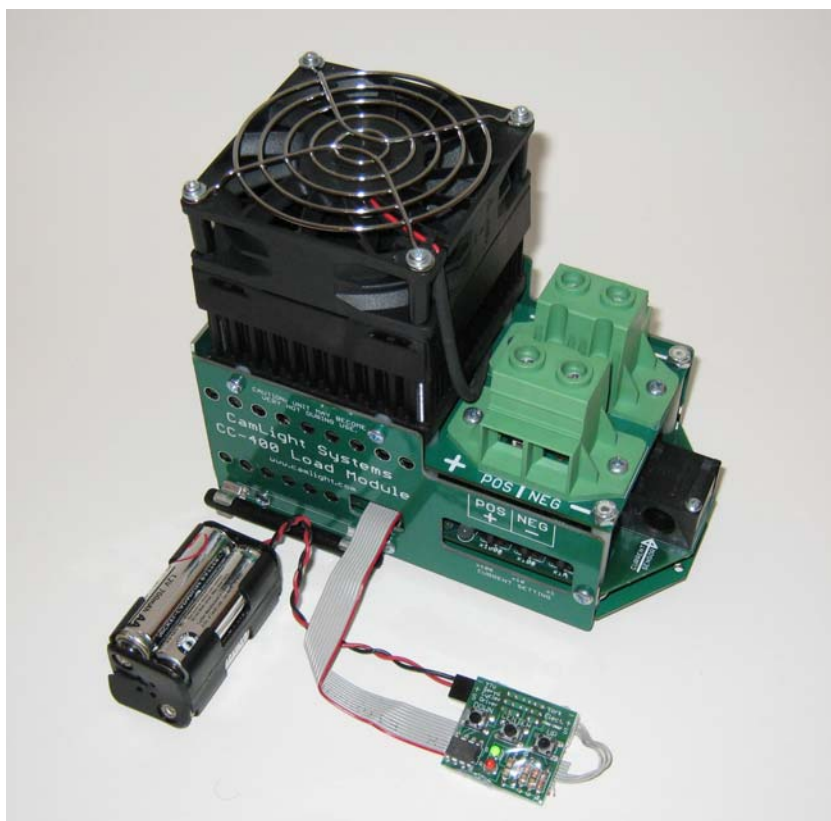
This mode discharges the battery at a current level determined by an external throttle (servo) signal, limited to 400W (500W if the jumper is removed). The current level varies from approximately 200mA for a 0% throttle signal to a maximum programmed by you for 100% throttle.

For example, if you wanted the 0%-100% throttle signal to vary the current from approx. 200mA (the minimum possible) to 50A, you would program the maximum current level to 50A and then input the throttle signal to the CC-400. At 0% throttle, the current will be approximately 200mA. At 50% throttle, the current will be 25A. At 100% throttle, the current will be 50A. The current level will never exceed 50A.

For all throttle settings, the current level will not change if the throttle signal is held steady. That is, it will be a constant-current discharge if the throttle setting does not change.

This mode is ideal for “playing back” an actual flight profile recorded by a data logger or for creating custom profiles with analyzers/loggers that allow you to do so with a PC/Mac. You can easily tailor the profile for different batteries by setting the maximum current level to match the battery. This allows you to test using the same profile, but at several different current ranges to see how the battery will perform.

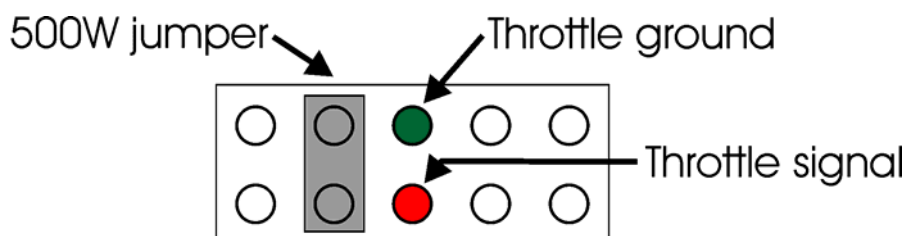
The photo below shows a Mile High Wings eFlightWatt logger hooked up to a CC-400 to allow playback of a flight profile recorded by the eFlightWatt. Battery and power supply connections are omitted for clarity.



**Connect the external throttle signal:**

The throttle signal is connected in one of two ways:

1. If the device generating or playing back the throttle signal is in any way connected to the battery:
  - a. Connect only the throttle signal to the bottom middle pin of the 10-pin CONTROL connector on the front of the CC-400.
  - b. Do not connect the throttle signal ground to the CC-400!
2. If the device generating or playing back the throttle signal is not connected to the battery in any way:
  - a. Connect the throttle signal to the bottom middle pin of the 10-pin CONTROL connector on the front of the CC-400.
  - b. Connect the throttle ground to the top middle pin of the 10-pin CONTROL connector on the front of the CC-400.

**CONTROL connector**

**CAUTION: Do not connect the throttle ground to the CC-400 if the device that creates the throttle signal is connected to the battery in any way!!**

**For example, when using an “inline” logger like the Mile High Wings eFlightWatt that measures current flowing from the battery to the CC-400, connect only the throttle signal wire from the eFlightWatt. If you also connect the throttle ground wire then the CC-400 is connected to the battery directly and also through the eFlightWatt. This causes a “ground loop” and current can flow through the CC-400 and eFlightWatt in ways that they were not designed to handle.**

**Calibrating the CC-400 to the throttle signal:**

While a “standard” throttle signal uses pulses from 1mS - 2mS in width (repeated 50 times a second) to indicate 0% - 100% throttle, several devices offer a “turbo” or extended throttle that extends beyond this 1mS - 2mS range. Calibrating the CC-400 to the throttle signal range of the device you’re using to control the CC-400 ensures proper operation.

NOTE: We recommend calibrating the CC-400 every time a different device is connected. There’s no need to recalibrate every time the same device is used unless something changed the 0%-100% throttle pulse width range.

To calibrate the CC-400 to the throttle signal:

1. Turn the CC-400 off.
2. Connect the device that will output the throttle signal to the CC-400.

3. Set the device to its 0% throttle setting.
4. Rotate the CC-400's 100's digit current setting switch to the "9" position.
5. Turn the CC-400 on.
6. The LED starts blinking red/green very quickly for 10 seconds. Leave the throttle at its 0% setting for 1 second and then quickly adjust it to 100%.
7. After 10 seconds, the LED will turn off for 1 second and then blink red/green slower. As soon as the slower blinking begins the CC-400 has been calibrated for that throttle signal.
8. Turn the CC-400 off.

NOTE: You must leave the throttle at its 0% setting for a second when the fast blinking starts. In addition, you must complete the change to a 100% throttle setting in the next 8 seconds to allow the 100% throttle to be read by the CC-400 for a second. If you are not sure if you did this, turn off the CC-400 and start the calibration sequence again.

### **Setting the current level for the 100% throttle setting:**

Rotate the three current setting switches to the desired 100% throttle current setting. This is the maximum discharge current level that is possible for the discharge (assuming that a throttle calibration has been done).

### **Entering Throttle Mode and starting/finishing the discharge:**

1. Turn the CC-400 off.
2. Set the current-setting switches to 000.
3. Connect the device that will output the throttle signal to the CC-400.
4. Set the throttle signal to 0%.
5. Rotate the 100's digit current setting switch to the "5" position.
6. Turn the CC-400 on. The LED blinks red/green very quickly for 2 seconds and then stops.
7. Once the blinking stops, rotate the 100's digit current setting switch to the "0" position. The CC-400 is now in Throttle Mode and will only respond to a throttle signal input until it is reset (turned off for a second and then back on).
8. Set the current-setting switches to the value you want to use at 100% throttle. This will be the maximum current drawn from the battery.
9. Set the throttle signal to the desired level or begin "playing back" a stored flight profile. Remember that a 100% throttle signal will automatically scale to the current setting on the CC-400.
10. When done, set the throttle signal to 0% and turn the CC-400 off.
11. Disconnect the device used to output the throttle signal to the CC-400.

NOTE: The minimum level for a Throttle Mode discharge is approximately 200mA (0% throttle).

NOTE: Holding the throttle at 0% will result in the fans turning off after about 30 seconds. If the throttle rises above the 1%, the fans will turn back on and the discharge will continue.

## Burst Mode Discharging

### Introduction

This mode discharges the battery by alternating between two different current levels, each independently timed, limited to 400W (500W if the jumper is removed). The current levels can vary from 1A - 150A and the timing can vary from 0.1 - 99.9 seconds, in 0.1 second steps.

Sometimes a constant-current discharge doesn't give the user an idea of how a battery might behave in certain applications. Burst Mode creates a discharge profile that can better approximate the conditions the battery might see without having to record or create a more complex profile that could be used in the CC-400's Throttle Mode.

NOTE: For a quick test of this mode, your CC-400 has a profile already programmed into it. It's 5A for 1 second followed by 1A for 1 second (repeating). To run this profile, see the **Entering Burst Mode and starting/finishing a discharge** section below.

### Setting the current levels and timing:

1. **The following instructions for each of the timing settings and current levels must be followed exactly for them to be correctly programmed into the CC-400. Once programmed, the settings will not change until the CC-400 is reprogrammed. Just start the CC-400 in Burst Mode to use them.**
2. Programming the profile's Step 1 duration (timing):
  - a. Turn the CC-400 off.
  - b. Rotate the 100's digit current setting switch to the "3" position.
  - c. Turn the CC-400 on.
  - d. While the LED blinks red/green very quickly for 10 seconds, rotate the three current setting switches to the desired Step 1 duration (00.0 - 99.9 seconds).
  - e. After 10 seconds, the LED will turn off for 1 second and then blink red/green slower. As soon as the slower blinking begins, the setting has been stored.
  - f. Turn the CC-400 off.
3. Programming the profile's Step 1 current level:
  - a. Turn the CC-400 off.
  - b. Rotate the 100's digit current setting switch to the "4" position.
  - c. Turn the CC-400 on.
  - d. While the LED blinks red/green very quickly for 10 seconds, rotate the three current setting switches to the desired Step 1 current level.
  - e. After 10 seconds, the LED will turn off for 1 second and then blink red/green slower. As soon as the slower blinking begins, the setting has been stored.

f. Turn the CC-400 off.

NOTE: The minimum setting for a Burst Mode discharge is 1A.

4. Programming the profile's Step 2 duration (timing):

a. Turn the CC-400 off.

b. Rotate the 100's digit current setting switch to the "6" position.

c. Turn the CC-400 on.

d. While the LED blinks red/green very quickly for 10 seconds, rotate the three current setting switches to the desired Step 2 duration (00.0 - 99.9 seconds).

e. After 10 seconds, the LED will turn off for 1 second and then blink red/green slower. As soon as the slower blinking begins, the setting has been stored.

f. Turn the CC-400 off.

5. Programming the profile's Step 2 current level:

a. Turn the CC-400 off.

b. Rotate the 100's digit current setting switch to the "7" position.

c. Turn the CC-400 on.

d. While the LED blinks red/green very quickly for 10 seconds, rotate the three current setting switches to the desired Step 2 current level.

e. After 10 seconds, the LED will turn off for 1 second and then blink red/green slower. As soon as the slower blinking begins, the setting has been stored.

f. Turn the CC-400 off.

NOTE: The minimum setting for a Burst Mode discharge is 1A.

6. The current settings and timing for the Burst Mode's two steps have now been programmed into the CC-400.

7. Rotate the 100's digit current switch to the "0" position. If a battery is connected, the LED will turn green. The parameters for a burst discharge have now been stored in EEPROM memory and will not change until they are reprogrammed following the steps above, even if the CC-400 is turned off. See the steps below for starting a Burst Mode discharge.

NOTE: The current value must be set as a 3-digit number, with a range of 1A – 150A, in 1A steps. That is, for a 50A discharge, the switches must be set to **050**. Do not leave the 100's digit switch set to 3, 4, 6, or 7 when the 10-second period is over and the switch settings are stored.

NOTE: The timing value must also be set as a 3-digit number, with a range of 00.1 - 99.9 seconds, in 0.1 second steps. That is, for 3.5 second timing, the switches must be set to **035**.

NOTE: You must complete the setting of the switches before the 10 seconds has elapsed. If you are not sure, start the sequence for programming this setting over from step **a**.

NOTE: The 10's and 1's digit current setting switches can be preset when setting the current values and timing. For example, if you wanted a Step 2 current level of 55A you can set the three switches to **455**, turn on the CC-400, and then only have to rotate the 100's digit current setting switch from 4 to 5 (i.e., a setting of 55.0A) when the blinking stopped.

NOTE: You do not have to reprogram all four settings if you only want to change one of them. For example, if you have a profile consisting of a 1 sec., 10A step followed by a 5 sec., 2A step and wanted to increase the value of the current for the first step, just change that parameter. You do not also have to program again the timing for that step or the current/timing for the second step. After programming the new current level, start up in Burst Mode as you always do (see below).

NOTE: If you are ever unsure of the settings you might have entered, start over again. Do not use the Burst Mode of the CC-400 until you are sure the settings are correct as they are stored in EEPROM and will be used any time the CC-400 is set up for Burst Mode (until changed).

### **Entering Burst Mode and starting/finishing a discharge:**

1. Turn the CC-400 off.
2. Set the 100's digit current setting switch to "8".
3. Wait two seconds for the rapid LED blinking to stop and for the red LED to light. Once the LEDs stop blinking, the Burst Mode parameters have been read in from EEPROM memory and are ready for use.
4. Rotate the 100's digit current switch to the "0" position. If a battery is connected, the LED will turn green. The unit will now operate in Burst Mode until turned off. The discharge must still be initiated by a >1A current flow through the wire passing through the current sensor.
5. The CC-400 will stay in Burst Mode until turned off and back on again (to reset it).  
NOTE: The 100's digit current setting switch must be set to "0" or "1" to reset the CC-400 back to standard Constant-Current Mode.
6. Start the discharge from the software for the device being used to activate the CC-400 or, if applicable, from the device itself. The CC-400 will automatically turn on when the current flowing through the wire in its current sensor reaches 1A (typically 0.7A-0.8A).
7. The CC-400 will turn off when the current flowing through the wire in the current sensor drops below 100mA (typically).
8. If the starting power level exceeds 400W for more than 15 seconds, the CC-400 will stop its discharge and the LED will blink red. After a 15 second cooldown period, during which the fan will continue running, the CC-400 must be turned off for a second and then back on again to reset it. You will not be able to start a discharge until this reset is done.  
NOTE: If you have removed the jumper, you can discharge at up to 500W continuously.

## Additional Information about your CC-400

### Using the CC-400 with the CBA Software Version 2

The CBA Software lets you select one of three graphing options when setting up a new test (discharge):

- Volts vs. Minutes. (Minutes)
- Volts vs. AmpHrs (AmpHrs)
- Volts vs. WattHrs (WattHrs)

When using the CBA Software Pro upgrade, you can use any number of CC-400's to plot accurate data for the Volts vs. Minutes graph option. Any CBA and CC-400 current setting can also be used.

NOTE: If you export the data for a Volts vs. Minutes test, you will need to update the current levels to add on what the CC-400's were handling. This is not needed to correctly display the data in the CBA software since the current level is not any part of the display.

Up to two CC-400's can be used with the AmpHrs and WattHrs graph options and still have the CBA Software accurately plot the data. Since both of these tests display data that takes the current level into account (WattHrs or AmpHrs), the CBA must be set up correctly with the CC-400(s). If you use more than two CC-400's, the CBA software cannot be set to take their discharge current into account. More than two CC-400's can be used, but the ampere and ampere-hour (Ah) data the CBA Software displays and records will not be correct and will have to be adjusted by exporting to Excel. You can then re-graph the data to take into account the extra current. The voltage data the CBA records when using the AmpHrs or WattHrs graph option will be correct though.

NOTE: Be sure that the Amplifier setting is set to **No Amplifier** for a Volts vs. Minutes test.

### Setting up a Volts vs. AmpHrs or Volts vs. WattHrs test

For correct Ah data plotting of an AmpHrs or WattHrs discharge when using one or two CC-400's, not all of the CC-400's current settings are available. The chart below shows the available total discharge current levels when using CC-400's with the CBA and the CBA Software (with the Pro upgrade) for AmpHrs and WattHrs test (discharge) graphing.

NOTE: If you are exporting the AmpHrs or WattHrs data to Excel or using the Volts vs. Minutes graphing option, any discharge current setting is supported.

All the settings below are limited by the 500W (400W continuous) power rating of each CC-400 used and assume that the CC-400's are connected in "parallel" to bring the total current rating up to 300A (150A for each CC-400). If using two CC-400's connected in "series", the power rating is still 1000W (800W continuous), but the maximum available current is 150A.

Test Amps	CBA Amps	CC-400 Setting
10A	1A	9A
20A	2A	18A
30A	3A	27A
40A	4A	36A
50A	5A	45A
60A	6A	54A
70A	7A	63A
80A	8A	72A
90A	9A	81A
100A	10A	90A
110A	11A	99A
120A	12A	108A
130A	13A	117A
140A	14A	126A
150A	15A	135A
160A	16A	144A
170A	17A	153A*
180A	18A	162A*
190A	19A	171A*
200A	20A	180A*
210A	21A	189A*
220A	22A	198A*
230A	23A	207A*
240A	24A	216A*
250A	25A	225A*
260A	26A	234A*
270A	27A	243A*
280A	28A	252A*
290A	29A	261A*
300A	30A	270A*
310A	31A	279A*
320A	32a	288A*

\*You must use two CC-400's wired in "parallel" to be able to set the current above 150A.

For accurate data plotting, when setting up a new AmpHrs or WattHrs test in the CBA Software (with Pro upgrade), you must correctly set the Amplifier selection to one of the following:

- **No Amplifier** – No CC-400 is being used, just the CBA.
- **One Amplifier**- One CC-400 is connected to the battery and one of the wires from the battery is passed through the CC-400's current sensor. The maximum power rating for the discharge is 500W (400W continuous) at up to 150A.
- **Two Amplifiers**- Two CC-400's are connected to the battery and one of the wires from the battery is passed through both CC-400's current sensor. The maximum power rating for the discharge is 1000W (800W

continuous) at up to 150A if the CC-400's are wired in "series" and 300A if the CC-400's are wired in parallel.

NOTE: If you are doing a Volts vs. Minutes test, you should set the Amplifier selection to **No Amplifier**.

**CAUTION: Be sure to set the Amplifier selection correctly! If you do not, the discharge current level will be incorrect.**

**CAUTION: The CBA Software will allow a maximum of 500W for each Amplifier you say is being used. But, a CC-400 will only allow a 500W discharge for the first 15 seconds. If the power level has not dropped to below 400W by then, the CC-400 will turn off.**

Setting the CC-400's current level is critical when doing a AmpHrs or WattHrs test using one or two CC-400's with the CBA Software. The current setting for the CC-400 is not determined automatically, it must be manually set based on the table above.

- To determine the discharge current level for the CBA, the CBA Software takes the **Test Amps** value you enter and divides that by ten. For example, if you enter 100A, the CBA will discharge at 10A.
- The remainder of the discharge current must be drawn by the one or two CC-400's you're using. Using the chart above, determine the current setting needed for the CC-400(s) and either set the CC-400 to that level or divide it between the two CC-400's to keep the power level down to below the 500W (400W continuous) rating of each CC-400.

For example. If the Test Amps value is 100A, the CBA will be set to 10A. The CC-400 must then discharge at 90A for the CBA Software's graphs and data to be correct.

- If using two CC-400's, you can divide the current between them in any way as long as the max power ratings aren't exceeded.

If you are using the free CBA Software version (not the Pro upgrade), the Amplifier option is not available. Because of this, the WattHrs or AmpHrs display will not take into account the addition of the CC-400's discharge current. But, the time and voltage data is accurate. Data exported from the CBA can be easily managed with Microsoft Excel though to add the current discharged by the CC-400. However, you do not need to export the data to compare multiple discharges as the time and voltage data plots shown onscreen are accurate. Just the Watthr or Ah readings are off.

In order to obtain accurately scaled graphs using the CBA with the CC-400 it is recommended that the current be divided in the following manner:

- The CC-400 should be set to carry 9/10 of the desired current and the CBA should discharge 1/10. For example, if the requirement was a 30A discharge one should set the CC-400 to 27A ( $0.9 \times 30A = 27A$ ) and the CBA should be set to 3A ( $0.1 \times 30A = 3A$ ). This effectively multiplies the current setting of the CBA by ten, i.e. if the CBA is set to 3A, by setting the CC-400 to 27A you obtain a 30A discharge ( $3A \times 10 = 30A$ ).

- Using this method the standard CBA software will produce a graph that is accurately scaled to other graphs produced at varying discharge rates. The mAh scale (x-axis) will be off by exactly one order of magnitude and will need to be multiplied by 10 to obtain the correct mAh.

### 100's Digit Current Switch Settings For Each Mode

Setting	Mode
0	Normal operation
1	Normal operation
2	For use by CamLight only
3	Burst Mode Step 1 duration, .1 - 99.9 secs.
4	Burst Mode Step 1 current level, 1A - 150A
5	Throttle Mode (to enter this mode)
6	Burst Mode Step 2 duration, .1 - 99.9 secs.
7	Burst Mode Step 2 current level, 1A - 150A
8	Burst Mode (to enter this mode)
9	Throttle Mode calibration

### Red LED error codes

Blinks	Reason
1	Battery voltage is < 0.5V
2	Battery voltage is > 60V
3	Current setting exceeds 150A
4	Power level exceeds the start-of-discharge limit of 500W.
5	Fan failure, contact CamLight Systems (see the end Specifications section below for contact info).
Continuous	Power level exceeded the continuous 400W limit for more than 15 seconds. You must reduce your power level and turn the CC-400 off for 1 second and then back on to reset it.

### Tips for using your CC-400:

- The guaranteed minimum current needed to turn on the CC-400 is 1.0A. But, it can often turn on with just 0.7A-0.8A.
- If desired, the minimum current needed to start the CC-400 can be reduced by looping the wire through the current sensor more than once. If you pass it through twice, you'll only need 0.5A. Pass it through three times and you only need 0.3A. Typically, the lowest you can go is 4 passes for an approximately 0.2A-0.25A starting current.



- If not using the new Version 2 software, a CBA can take several seconds after starting a discharge to reach its set current level. If the CBA is set to 1A, it might be a few seconds before the CC-400 turns on since it will take that long for the CBA's discharge current to reach the threshold of the CC-400's sensor. But, with most of the current flowing through the CC-400, that will only make a very small difference to the data you're recording.
- If the wiring coming out of the "front" terminal block of the CC-400 makes it too hard for you to use the current-setting switches, use the "rear" terminal block instead. It has the same current rating and allows you to route the cables away from the current-setting switches.
- The CC-400's two fans turn on at different discharge power levels and the top fan runs at two speeds. The bottom fan will only turn on for discharge current settings of 50A and above. The top fan will run at low speed up to approximately 250W (starting power level) during a discharge. Above that, it will run at high speed.
- After a discharge has finished, the top fan will continue to run for up to 20 seconds to cool the CC-400. If the starting power level for the previous discharge was less than 400W (approximately), you can start a new discharge without waiting for the fan to stop.
- If starting a discharge at a power level exceeding 400W (but less than 500W), a mandatory cooldown period is required when the discharge has ended. The fan will continue to run for up to 30 seconds before you can start another discharge. When it turns off, you're ready to go.

- The fan and heat sink **must** be kept free of dust. Regularly check both and use a can of compressed air to dislodge any accumulated dust. Make sure you do not just blow it deep into the CC-400's heat sink and have it become lodged. Having the fan running while blowing out the dust will help to remove the dust more effectively. This should only be required after running for several hundred hours. If it's required more often than that, pay especially close attention to any build-up of dust. Even a light coating can significantly reduce the CC-400's ability to shed the heat that is generated. This will shorten the CC-400's life expectancy.

### **Specifications for the CC-400:**

- 400W maximum continuous discharge (at 86 °F. or 30 °C. ambient temperature, or lower).
- Up to 500W allowed for the first 15 seconds of a discharge (at 86 °F. or 30 °C. ambient temperature, or lower).
- Removing jumper allows continuous 500W discharges (at 86 °F. or 30 °C. ambient temperature, or lower).  
NOTE: CamLight Systems is not responsible for any damages to your CC-400 if the jumper is removed.
- 0.5V to 60V battery voltage range.
- Constant-Current Mode and Burst Mode: 1A-150A current (for 2V-60V cells/packs), selectable in 1A increments. Limited to 100A at 0.9V.
- Throttle Mode: 200mA-150A discharge current (for 2V-60V cells/packs), determined by maximum current setting and throttle, in as small as 50mA steps. Limited to 100A at 0.9V.
- In Throttle Mode, the CC-400 can be calibrated for different 0% - 100% throttle pulse width ranges.
- Accuracy is +/-35mA from 1A-20A and +/-1% from 21A to 150A (typically better than +/-0.6%).
- Uses two large terminal blocks so you can tailor your hookup to your needs, with up to 4AWG wire. The dual blocks allow you to have one set of wire leads for lower current levels (e.g., 12AWG) and another for higher current levels (up to 4AWG). The large terminal blocks also allow for the simple connection of multiple CC-400's together using short 4AWG wires, adding multiples of 400W to the maximum discharge power rating. For example, three CC-400's can be connected to provide a 1.2 kW discharge solution.
- Uses an international power supply, 100VAC-240VAC, 50/60Hz. It has a North American twin flat-blade configuration. For mains outlets with different configurations, like twin circular pins, use an adapter. You do not need a voltage converter, the CC-400's power supply can handle 100V-240V, 50/60Hz.

**If you have any questions, check our web site at [www.camlight.com](http://www.camlight.com) or contact us in New York City at (212) 579-1901, 9am-9pm EST, or via e-mail at [info@camlight.com](mailto:info@camlight.com).**

## **LEGAL DISCLAIMERS**

THIS PRODUCT IS PROVIDED "AS IS" WITHOUT WARRANTY OF ANY KIND, EXPRESS OR IMPLIED INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR PARTICULAR PURPOSE, OR NON-INFRINGEMENT.

JOHN MUCHOW, CAMLIGHT SYSTEMS AND ITS DISTRIBUTORS DO NOT WARRANT THE ACCURACY OR COMPLETENESS OF THE INFORMATION, SPECIFICATIONS, GRAPHICS, AND OTHER ITEMS CONTAINED IN THIS DOCUMENT OR THE CAMLIGHT SYSTEMS WEB SITE. YOUR RELIANCE ON ANY SUCH INFORMATION, SPECIFICATIONS, GRAPHICS, AND OTHER ITEMS SHALL BE AT YOUR SOLE RISK.

JOHN MUCHOW OR CAMLIGHT SYSTEMS MAY MAKE CHANGES TO THIS DOCUMENT OR THE CAMLIGHT SYSTEMS WEB SITE AT ANY TIME WITHOUT NOTICE.

## **LIMITATION OF DAMAGES**

IN NO EVENT SHALL JOHN MUCHOW, CAMLIGHT SYSTEMS AND ITS DISTRIBUTORS BE LIABLE FOR ANY DIRECT, SPECIAL, INDIRECT, CONSEQUENTIAL, PUNITIVE OR OTHER DAMAGES, RESULTING FROM ANY CAUSE WHATSOEVER, TO PERSONS OR PROPERTY, OF ANY KIND INCLUDING BUT NOT LIMITED TO LOSS OF PROFITS; LOSS OF SAVINGS OR REVENUE; BUSINESS INTERRUPTION; LOSS OF BUSINESS INFORMATION; WAGES AND SALARIES; LOSS OF USE OF THE PRODUCT OR ANY ASSOCIATED EQUIPMENT; COST OF CAPITAL; COST OF ANY SUBSTITUTE EQUIPMENT, FACILITIES, OR SERVICES; DOWNTIME; THE CLAIMS OF THIRD PARTIES INCLUDING CUSTOMERS; AND INJURY TO PROPERTY EVEN IF JOHN MUCHOW AND CAMLIGHT SYSTEMS HAVE BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCEPT AS PROHIBITED BY APPLICABLE LAW, THIS LIMITATION APPLIES TO CLAIMS FOR PERSONAL INJURY, LOSS OF LIFE, LOSS OF CONSORTIUM AND WRONGFUL DEATH. BECAUSE SOME STATES AND JURISDICTIONS DO NOT ALLOW THE EXCLUSION OR LIMITATION OF LIABILITY, THE ABOVE LIMITATION MAY NOT APPLY TO BUYER.