



SIRIUS CAPACITOR MODULE

User Manual

Model number: 7100-48-B-2C-M-SD-L-G

Version: 1.0; Release Date: April 2018

Introduction

The Sirius Capacitor Module (“Sirius”) is supercapacitor-based storage that uses supercapacitors as storage cells instead of chemical cells. Kilowatt Labs’ proprietary balancing, control and charge retention algorithms control the operation of the supercapacitor-based modules, making Sirius a safe, efficient and effective alternative to chemical batteries wherever chemical batteries are deployed.

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Safety

This Manual contains instructions for unpacking, mounting, installation and operation of a Sirius module. Please read this manual carefully before operating the system and follow all warnings and safety instructions. Please follow the instructions in this Manual carefully to prevent accidents. The Sirius module must be installed by trained personnel.

Warning

Selling and installation of this product is only through the Company’s Resellers who are trained on installation, operation and maintenance of the Sirius modules.

Table of Contents

Unpacking and Handling	4
Installation	4
Parallel Connection	4
Product Overview	5
Panel Description	6
LCD Description	6
COMM LED	8
COMM Connector	8
Power Switch	8
Safety Features	8
Operation Procedures	9
Trouble Shooting: Faults and Solutions	10
Maintenance	11
Safety	11
Storage	12
Disposal	12
Technical Specifications	13

Unpacking and Handling

Unpacking

Inspect the shipping carton for damage prior to unpacking the module. Document (photograph) all damage and report this to your reseller and to the shipping agent immediately. Remove the module from the shipping carton and retain the shipping materials until the unit has been inspected and is determined to be operational. The module must be removed by lifting the module body. Do not lift the module by the terminal posts.



**The module must be removed from the carton by lifting the module body.
Do not remove the module by the terminal posts.**

The following items are included in the package:

- Sirius Capacitor Module: 7.1kWh48VDC
- Compact Disc with the monitoring software Manual and application software.

NOTE: The original shipping materials are approved for both air and ground shipment.

Handling

The Sirius Capacitor modules are designed to provide years of trouble-free operation. Proper handling is required to avoid damage to the module. In particular, the following handling precautions should be observed:

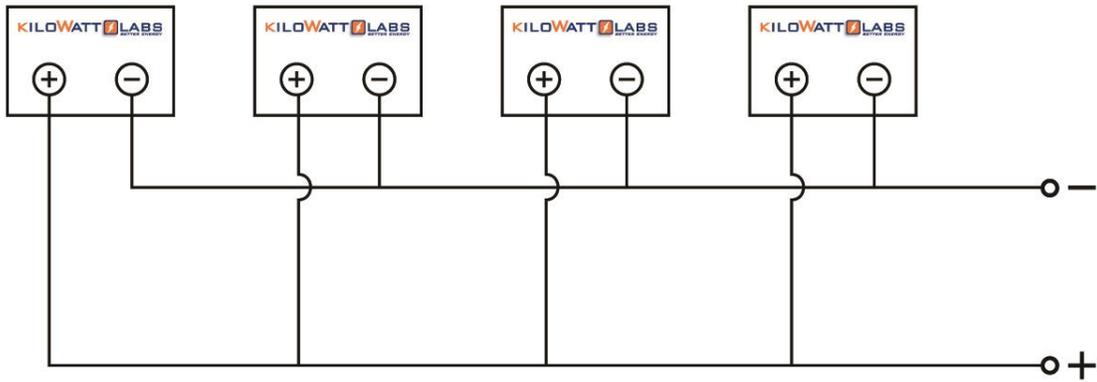
- Do not lift the module by the terminal posts.
- Do not stack modules once they have been removed from the shipping containers.
- Do not drop the module. Internal damage may occur that will not be visible from the exterior.
- Do not step on the module.
- Protect the module from impact

Installation

Installation must strictly follow the national safety regulations in compliance with the enclosure, installation, creep age, clearance, casualty, markings, and segregation requirements of the end-use application. Installation must be performed by professional installers only. Switch off the system and check for hazardous voltages before altering any connection! Sirius modules must be handled only by qualified and trained personnel. Installation should not exert bending or twisting torque to the module enclosure.

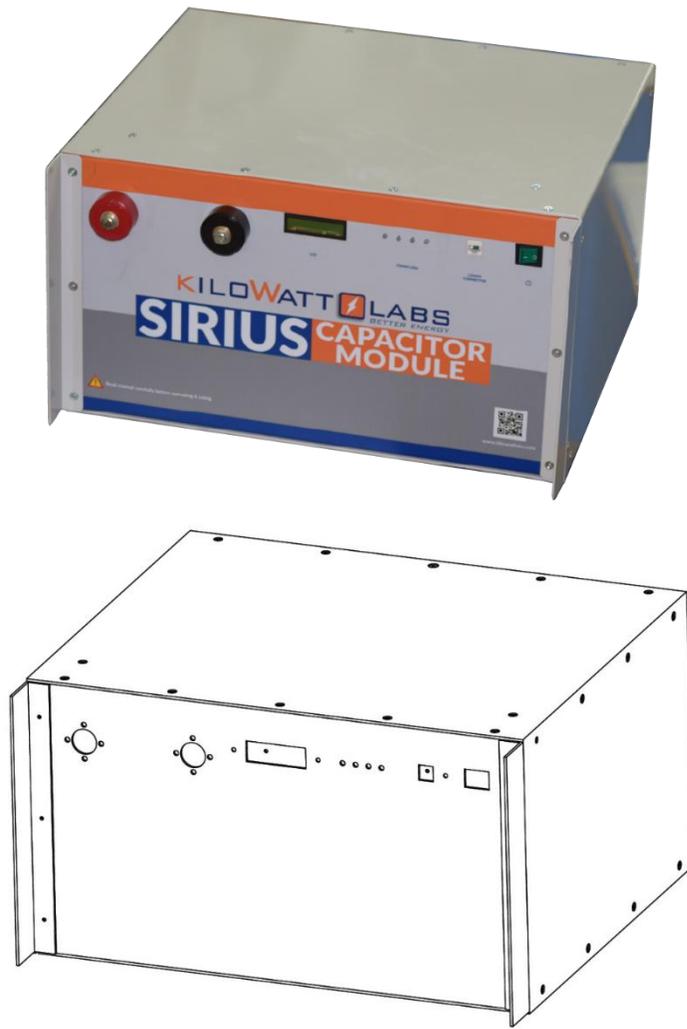
Parallel Connection of Sirius Modules

The parallel combination of the Sirius modules is as shown below. Any number of modules can be connected in parallel.



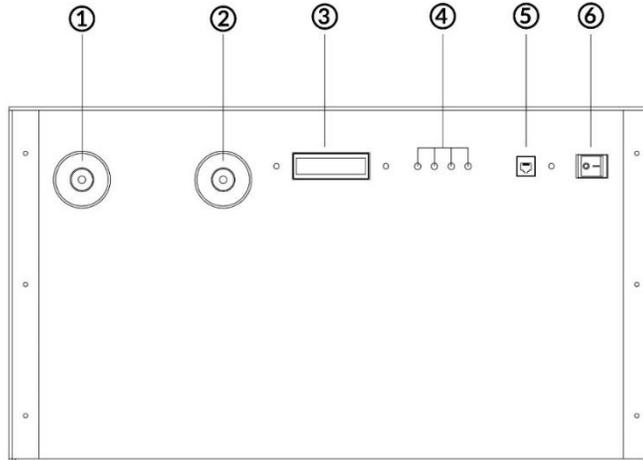
Product Overview

The appearance of the Sirius Capacitor Module is shown in the figure below:



Panel Description

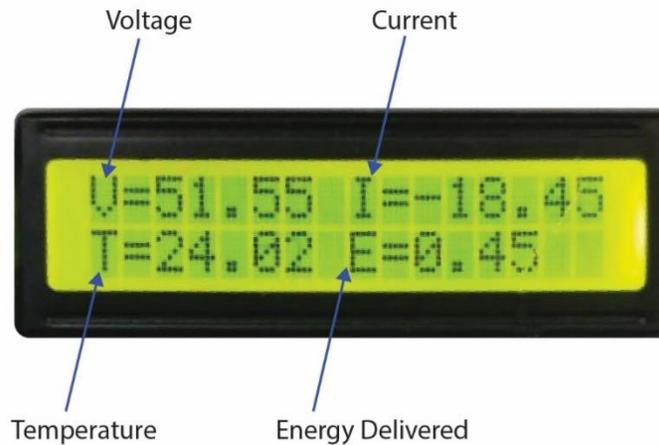
The figure below describes the front panel components of the module:



1	Positive Terminal	4	COMM LEDs
2	Negative Terminal	5	COMM Connector
3	LCD	6	Power Switch

LCD Description

Once the power is switched ON from the Power Switch, the module gets power and the LCD shows the following message:



LCD Messages

This section describes the messages that appear on the LCD.

Overcurrent (OCD)

When the module has an **overcurrent** fault (OCD), the LCD shows the following warning message:



This means the current has increased beyond the cut off current of 296A (in the illustration, the LCD shows that the module current has increased above 296A).

Overvoltage (OV)

When the module has an **overvoltage** fault (OV), the LCD shows the following warning message:



This means the module voltage has increased beyond the cut off limit of 54.5V. The LCD shows the voltage at that time as well (in the illustration, the LCD shows that the module voltage has increased to 56.1V).

Undervoltage (UV)

When the module has an **undervoltage** fault (UV), the LCD shows the following warning message:



This means the module voltage has decreased below the cut off value of 44V. The LCD shows the voltage at that time as well (in the illustration, the LCD shows that the module voltage has decreased to 43.9V).

Overtemperature (OT)

When the module has an **overtemperature** fault (OT), the LCD shows the following warning message:



This means that the temperature of the module has increased beyond the cut off value of 75°C. The LCD shows the temperature at that time as well (in the illustration, the LCD shows that the module temperature has increased to 75.1°C).

COMM LEDs

COMM LEDs are the LEDs which show the status of communication of the control module with the application software. There are 4 LEDs for the four control modules in the Sirius Capacitor Module.

Each LED has the following status:

- **OFF:** The control module is not powered and hence not communicating with the application software.
- **ON (Green):** The control module is powered ON but no communication with the application software.
- **Blinking Red:** The control module is communicating with the application software.

COMM Connector

This is a RJ45 connector to monitor the module using the application software.

Power Switch

When the power is switched ON using the ON/OFF switch on the front panel, the module electronics are powered up. The module is now functional and can be operated.

Safety Features

This Sirius Capacitor Module has the following safety features:

Anti-theft

The module is password protected and can only be operated by authorized personnel with a valid password at the time of connecting the module. The password is loaded to the module via a PC. If the module is disconnected from the DC power source, the anti-theft feature requires the password to be loaded to restart the module. In the event of disconnection from the DC power source, to restart the module, connect a PC to the module and enter the password.

If the module disconnects due to a safety event (described below), it automatically reconnects once the safety event is over.

Shut-down due to Safety Events:

- **Over-voltage cut off:** This feature will be activated when the module voltage goes beyond the high voltage threshold of 54.5V.
- **Under-voltage cut off:** This feature will be activated when the module voltage goes below the low voltage threshold of 44V.
- **Over-current cut off:** This feature will be activated when the module current exceeds the maximum load capacity of 296A.
- **Over temperature cut off:** This feature will be activated when the module temperature exceeds the maximum temperature limit of 75°C.

These features work as follows:

Disconnect Event	Disconnect Value	Reconnect Feature
Over voltage	54.5V	Module senses system voltage and reconnects automatically when system voltage is $\leq 53.0V$
Under voltage	44.0V	Module senses system voltage and reconnects automatically when system voltage is $\geq 46.0V$
Over Current	296A	Module senses system voltage and reconnects if V-system $\lt \gt +1V$ from Vbat@ rest
Disconnected from DC power source	Poles removed	Enter password through PC to reconnect

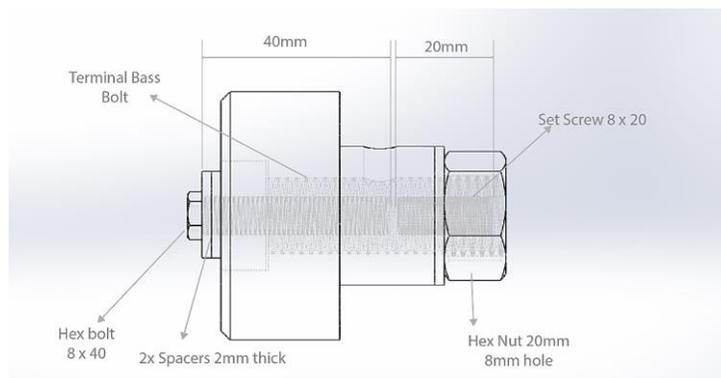
Operation Procedures



The module should only be operated within the specified voltage and temperature ratings.
Observe polarity indicated on module.
Do not reverse polarity.

Follow the steps below while operating the module.

- Connect the cables to the module terminals and ensure that the bolt enters 40mm into the terminals. The LCD will give an error message if the terminals and bolts are not connected as specified here.



- Configure the PC IP in the network and internet settings of the monitoring device.
- Connect the RJ45 cables to the COMM connector slot to start communication and monitoring.
- Now turn on the power switch which lights up the LCD.
- Open the monitoring software application in the monitoring device from the CD provided.
- The module has the anti-theft feature. So an authorized password should be entered to start operating the module.

NOTE: Please refer to the monitoring software manual in the CD provided with the module for the details.

- Now the module stays functional even when the RJ45 connector is removed (monitoring OFF).

NOTE: Authorization is required again when the module is either powered OFF or the cables are removed.

- The module can be shutdown either by the ON/OFF switch or by removing the output cables from the module terminals.

NOTE: Switch OFF the module when not in use as the module is self-powered or else, it can result in the self-discharge of the super-capacitors.

Trouble shooting: Faults and Solutions

This section explains how to correct faults:

Over-voltage (OV)

The OV cut-off is at 54.5V. Set the charger's limit below 54.5V to prevent an OV event. If the voltage exceeds 54.5V, the module shuts down and locks.

The module unlocks when the module's surface charge is cleared, and the voltage drops below 54V. The event can be repeated if the charger is still ON and operating in the same condition.

Troubleshooting: Check the charger's upper cut off limit and ensure it is set below 54.5V.

Under-voltage (UV)

The UV cut-off is 44V. If the voltage goes below 44V, the module shuts down and locks. The module unlocks when the voltage goes above 44V. The event can be repeated if the load is still ON and operating in the same condition.

Troubleshooting: Check for the operating load lower cut off limit and ensure it is above the lower threshold limit of 44V.

Over-Current (OC)

OC occurs when the current goes above 296A or when the module is short-circuited. In this event the module shuts down and locks.

Troubleshooting: Switch off the module and check the voltage across the module terminals to find whether it is a short circuit. In case of short circuit, check the operating circuitry and clear the short circuit. The module can be unlocked in 30 seconds after the current goes below 296A.

Over-Temperature (OT)

OT occurs when the module temperature goes above 75°C. In this event, the module shuts down and locks.

Troubleshooting: Shut down the module and check the room temperature and ensure the cooling units are operating properly. Leave the module to cool till the module temperature comes below 75°C. Now, turn ON the module.

Multiple Errors

The above-mentioned errors can occur simultaneously and will be shown on the LCD. To clear these, follow the steps explained in the above sections.

Maintenance

The Sirius Capacitor Module does not require periodic maintenance.

Safety
Strictly observe the safety instructions listed below to ensure safe handling, injury prevention and trouble-free operation of the module.
<ul style="list-style-type: none"> • Never touch the positive (+) or negative (–) terminals as the module can be charged and cause fatal electrical shocks. Always verify that the module is fully discharged before handling the module. • Ensure precautions to prevent short-circuit under all circumstances. • Do not operate the module above the specified voltage. • Do not operate the module above the specified temperature rating. • Do not touch the terminals with conductors while the module is charged. Serious burns, shock, or material fusing may occur. • Wear protective equipment when handling the modules including gloves, eyewear and hardhat. • Protect surrounding electrical components from incidental contact. • Do not use the module in an open environment, in rain or in a place exposed to water and other liquids. • In case the module is physically damaged due to any event, do not install and energize the module under any circumstances and contact your Reseller. • When connecting to external devices ensure that galvanic isolation does not exceed 1500V.

- Under no circumstances must the charge / discharge current exceed 296A.
- Under no circumstances must the charging voltage exceed 54VDC for more than 60 seconds.
- During charge cycle ensure never to exceed constant voltage of 54VDC and constant current of 296A.
- All modules must be at 100% SOC before connecting in series or parallel.
- The maximum number of modules that can be connected in series is 8 with a Module Combiner. Under no circumstances should you connect more than 3 modules in series.
- If you want to connect more than 8 modules in series, please contact your Reseller.
- Modules cannot be connected in a series – parallel combination under any circumstances.

Storage

The Sirius modules can be stored at any SOC (State of Charge) without affecting the projected cell cycle life of 1,000,000 cycles.

Projected Calendar Life (the projected life of the module (in years) from the date it is first operated) is 45 years for the supercapacitor cells.

Shelf Life (the life of the module (in years) from the date it is manufactured to the time it is first operated) is 10 years.

Disposal

Do not dispose of the module in trash. Dispose of according to local regulations.

Technical Specifications

Nominal Voltage	48VDC
Voltage Range	44VDC – 54VDC
Capacity	7100Wh
Maximum Charge Rate (0% -100% SOC)	296A
Maximum Discharge Rate (100% - 0% SOC)	296A
Maximum Charging Voltage	54VDC
Internal Resistance	≤3mΩ
Supercap cell DC to DC Roundtrip efficiency (@296A)	99.1%
Supercap cell Operating Temperature	-30°C to 85°C
Galvanic Isolation	1500V
Projected Cycle Life ^{1,2}	1,000,000
Projected Calendar Life ^{2,3}	45 years
Shelf Life ⁴	10 years
Warehousing	Can be stored at any SOC without affecting cycle life
Communication Port	TCP/IP RJ45 Ethernet
Monitoring Data	Temperature, Voltage, Current, Energy, Supercap Balancing
Remote Control Input	Battery Self-Check
Safety	Shutdown on Over-Charge, Over-Discharge, Over-Current, Over-Temperature, Reverse Polarity, Cell Imbalance
Terminal Type	F12
Module Casing Material	Aluminium
Dimensions (w x d x h)	600mm x 490mm x 330mm
Weight	Approx.127kg
Self-discharge ⁵	5% after 25 days
CE Certification ⁶	EN55032:2015, EN55024:2010, EN61000-4-2:2009, EN61000-4-3:2006+A1:2008+A2:2010
Precautions	
Physical Damage	In case the module is physically damaged due to any event, do not install and energize the module under any circumstances and contact an authorized technician
Short Circuit	Ensure precautions to prevent short-circuit under all circumstances
Galvanic isolation	When connecting to external devices ensure that galvanic isolation does not exceed 1500V
Charge / Discharge Current	Under no circumstances must the charge / discharge current exceed 296A
Charging Voltage	Under no circumstances must the charging voltage exceed 54VDC for more than 60 seconds.
Charge Cycle	During charge cycle ensure never to exceed constant voltage of 54VDC and constant current of 296A
Series Connection	To connect modules in series, ensure all modules are at 100% SOC before connecting. Do not connect otherwise
Maximum number of modules that can be connected in series ⁷	8 with Module Combiner

	Please consult with Kilowatt Labs or its Reseller when connecting the modules in series. Under no circumstances should more than 3 modules be connected in series without the Module Combiner
Maximum number of modules that can be connected in parallel	No limit
Series – Parallel Connection	Modules cannot be connected in a series – parallel combination under any circumstances
SiriusVIEW – Monitoring Software	
Individual Cell	Monitoring of voltage
Module	Monitoring of current, max. & min. voltage, temperature, DOD, SOC, rate of charge, rate of discharge, time to discharge, balance energy, total energy delivered over lifetime, graphs
System	Monitoring of all modules connected together

¹ Projected Cycle life of supercap cells.

² Additional terms and conditions, including a limited warranty, will apply at the time of purchase.

³ Projected Calendar life of supercap cells from the date of first operation

⁴ Shelf life is the life of the module (in years) from the date it is manufactured to the time it is first operated

⁵ Self-discharge: (1) 30% after 30 days; (2) 80% after 60 days; Self-discharge only when not charging or discharging; No memory effect; .Module can be recharged to 100% at any time.

⁶ CE certification is completed for supercap cells

⁷ Consult Kilowatt labs Reseller for information on connecting modules in series.

Product dimensions are for reference only unless otherwise identified and may change without notice.

For critical applications, please contact Kilowatt Labs, Inc., or its Reseller.