B-Van Lithium Operation Manual

V5R 12.9.2022

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The B-Van is equipped with a 51.2V house battery, an alternator, voltage regulator, Renogy 3500W Inverter Solar Charger, and 200W of solar panels. The instructions will lay out the components and how to operate and maintain them.

Must Read Before Operating

- These instructions are for reference only, please refer to the individual product manuals for detailed instructions and data.
- Do not modify or alter the components in any way
- Do not connect an external charger to the Lithium Battery
- Do not alter the solar array in any way
- If issues exist please refer to the individual product instruction manuals for more detail.
- For technical assistance please call DEHCO Inc., 1-800-621-2278 or email renogy-oem@dehco.com
- To purchase the optional solar blanket please call DEHCO Inc., 1-800-621-2278
- For more information please visit https://www.renogy.com
- Do not connect anything other than the Renogy solar blanket (optional) to the external solar connection

Quick Startup

- If the Total Voltage of the Lithium System falls below 50V, the battery must be charged.
- The 12V Master Disconnect (Main Power) Switch must be in 'ON' for the unit to charge with the Alternator.
- The battery should be charged once it reaches 20% SOC or before to keep all charging options open.
- It is imperative to try to recharge the battery to 100% SOC, as this also recalibrates the BMS.
- When the unit is depleted below 10% SOC, this can cause the SOC% and voltage levels to be out of calibration. Recalibrate the BMS by changing the inverter parameter #9 to 54.8 and charge the unit to 100% SOC.

Renogy System YouTube Video

SCAN ME

Getting Started

1. Turning on the lithium battery: Turn battery on with the self-locking switch and self-resetting switch
   A. Press and release the self-locking switch (typically installed behind an access panel near the lithium battery)

NOTE: Self-locking switch should be 'ON' at all times except for long periods of storage

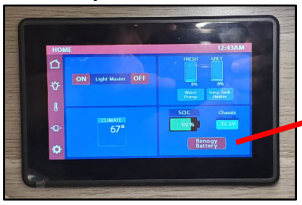
   B. Next press and hold the self-resetting switch (typically installed overhead cabinet near Firefly

touchscreen) for approximately 5-10 seconds to turn on the battery. There will be a series of clicks count to 5 after the last one.

2. Turn on Inverter by pushing button on Inverter remote switch. Green light will turn on the remote switch when inverter is on. Turn off inverter when not charging by shore power or using 120V outputs (outlets and Timberline Heater) for short storage to preserve battery SOC%. Leaving the inverter ON when the system is not in use can result in a 15-20% loss in SOC per day.

3. To turn on 12V power, press and release the momentary switch located near the rear of the sliding door. Note that the red light by switch is illuminated when the 12V power is active. To turn off the 12V power, press and release the switch again and the red light by switch will turn off.

4. Turn on the Firefly Touchscreen and select the Renogy Battery icon:
   A. Verify voltage
   B. State of Charge
   C. Current
   D. Faults



Powering Down – Long Storage

1. Verify all charging sources have been disconnected:
   A. Engine
   B. Shore Power
   C. Rooftop Solar – disconnect near battery in the 'OFF' position
   D. Side Solar

WARNING: When turning off battery for long storage, press Self-Locking Switch and release. See warning label "DO NOT turn off battery when charge is present…"
NOTE: "ALL CHARGERS" need to be off or disconnected including Engine, Shore Power, and both Rooftop and External Solar. Turn off the 12V disconnect switch and ensure that the "Total Current on the Renogy Monitor = 0A.

2. Turn off the 12V Master Disconnect (Main Power) located near the rear of the sliding door.

3. Turn off the Inverter by pushing button on Inverter remote switch.

4. Press and release the Self-Locking Battery Switch. The button will be flush in the 'OFF' position.

5. Review the Samkoon Battery Screen to ensure that there is not any voltage present.

System Flow Chart

120VAC 3500 Watt inverter powered from the 48V high voltage DC connection, and also charges the 51.2VDC 210 aH Lithium Ion battery with up to 40A when the unit is connected to 120VAC 30A shore connection.

120VAC 30A max shore connection

74.4VDC 200W Solar Array (roof mounted) There are 4 50W solar panels mounted on the roof, wired in series to create a 74.4VDC 200W solar array that is connected to the 3500W 48V MPPT inverter / charger, to recharge the 51.2VDC 210 aH Lithium Ion battery.

HIGH VOLTAGE DC (120v)
Converts 48VDC to 120AC
- Distribution Panel
  - Timberline Electric Heating Element
  - Outlets

LOW VOLTAGE DC (12V)
- Firefly Interface
- Refrigerator
- Lights (Interior/Exterior)
- Water Pump
- Awning
- Bed

HIGH VOLTAGE DC (48V)
- Air Conditioner

48VDC Engine driver alternator / generator which charges the 51.2VDC 210 aH Lithium Ion battery as the engine is running and the engine RPM's are greater than 1500.

39.5VDC 300W external solar blanket array (optional). There is a factory installed RCC10RVRB Rover Boost DC to DC charge controller connected to the factory installed external solar port to recharge the 51.2VDC 210 aH Lithium Ion battery.

51.2V 210Ah Lithium Battery

- DO NOT over-charge or over-discharge the battery.
- DO NOT discharge the battery at high temperatures above 140°F (60°C).
- **Battery Operational Parameters:**

Operation Parameter	
Charge Voltage	54.7V
Charge Cut-Off Voltage	58.4V
Discharge Cut-Off Voltage	41.6V
Maximum Continuous Charge Current	105A
Maximum Continuous Discharge Current	200A
Charge Temperature Range	32°F~131°F / 0°C~55°C
Discharge Temperature Range	-4°F~140°F / -20°C~60°C
Storage Temperature Range	-4°F~95°F / -20°C~35°C
Operation Relative Humidity	5%~95%

- **Switch Operation:**
  - The battery can be turned on or off with the Self-Locking Switch and Self-Resetting Switch. For the first time use, press down the Self-Locking Switch and long press the Self-Resetting Switch for approximately 5-10 seconds to turn on the battery. There will be a series of clicks which are completing self-checks on the battery. After the last click, wait about 5 seconds and release the Self-Resetting Switch.
  - Prior to long periods of storage, press the Self-Locking Switch again to turn off the battery. When the battery is off, it has a low self-discharge rate and can hold the charge for a longer period of time.
  - If the battery is in protection mode, it can be restarted by long pressing the Self-Resetting Switch for 3~5 seconds. After restarting, the battery will automatically run the self-check program and release the protection mode if the recovery conditions have been reached.
- **Self-Heating Function Operation**
  - The normal operation of the self-heating function requires a stable charge current greater than 8A. The self-heating function will start operating automatically once the battery temperature drops below 41°F (5°C) and stop operating automatically once the battery temperature rises above 50°F (10°C).

    NOTE: The self-heating function will not be able to operate normally if the unit is not connected to shore power, and the charger setting #28 is not greater than 5A. The solar array is not large enough to preheat the battery.
- **Charging Battery**

  During the standard charging process, the battery is first charged at a constant current via the 51.2V Input/Output Terminals until the battery voltage reaches between 54.0V and 54.8V. The standard charging process is considered complete when the charge current is less than 4.2A. However, leaving the battery on float will continue to balance the battery cells and will not damage the battery. The standard charging process normally takes 7 hours. The battery should be charged to 54.8V to recalibrate the BMS which adjusts the SOC meter, and keeps it close to specifications. This should be done periodically, or as needed. Setting number 9 on the inverter charger may be adjusted between 54.0V and 54.8V to accomplish your specific usage, and then to recalibrate the BMS when needed. Safe charging requires battery temperatures within normal operating temperatures. If the self-heating

function is unable to work normally, battery temperatures above 32°F (0°C) is also required for the safe charging.

- **Quick Recharge Chart:** The chart below will display a quick reference that can be used to determine how much time it will take to recharge the battery to 100% SOC at a specific current value. Look at the display and if the status is displayed as "charging", note the current SOC%, as well as the current value. Then put a finger on the column with the closest matching SOC%, and move it across to the right, stopping at the cell, in the row with the closest matching current value. This corresponding cell will be the amount of time (in hours) it will take to charge to 100% SOC at that charge rate. See below:

SOC %	RECHARGE CHART GIVES TIME (IN HOURS) NEEDED TO GO FROM LISTED SOC TO 100% SOC AT THE SPECIFIC CHARGE CURRENT VALUES BELOW																								
0%	42.00	21.00	14.00	10.50	8.40	7.00	6.00	5.25	4.67	4.20	3.82	3.50	3.23	3.00	2.80	2.63	2.47	2.33	2.21	2.10	2.00	1.91	1.83	1.75	1.68
5%	39.90	19.95	13.30	9.98	7.98	6.65	5.70	4.99	4.43	3.99	3.63	3.33	3.07	2.85	2.66	2.49	2.35	2.22	2.10	2.00	1.90	1.81	1.73	1.66	1.60
10%	37.80	18.90	12.60	9.45	7.56	6.30	5.40	4.73	4.20	3.78	3.44	3.15	2.91	2.70	2.52	2.36	2.22	2.10	1.99	1.89	1.80	1.72	1.64	1.58	1.51
15%	35.70	17.85	11.90	8.93	7.14	5.95	5.10	4.46	3.97	3.57	3.25	2.98	2.75	2.55	2.38	2.23	2.10	1.98	1.88	1.79	1.70	1.62	1.55	1.49	1.43
20%	33.60	16.80	11.20	8.40	6.72	5.60	4.80	4.20	3.73	3.36	3.05	2.80	2.58	2.40	2.24	2.10	1.98	1.87	1.77	1.68	1.60	1.53	1.46	1.40	1.34
25%	31.50	15.75	10.50	7.88	6.30	5.25	4.50	3.94	3.50	3.15	2.86	2.63	2.42	2.25	2.10	1.97	1.85	1.75	1.66	1.58	1.50	1.43	1.37	1.31	1.26
30%	29.40	14.70	9.80	7.35	5.88	4.90	4.20	3.68	3.27	2.94	2.67	2.45	2.26	2.10	1.96	1.84	1.73	1.63	1.55	1.47	1.40	1.34	1.28	1.23	1.18
35%	27.30	13.65	9.10	6.83	5.46	4.55	3.90	3.41	3.03	2.73	2.48	2.28	2.10	1.95	1.82	1.71	1.61	1.52	1.44	1.37	1.30	1.24	1.19	1.14	1.09
40%	25.20	12.60	8.40	6.30	5.04	4.20	3.60	3.15	2.80	2.52	2.29	2.10	1.94	1.80	1.68	1.58	1.48	1.40	1.33	1.26	1.20	1.15	1.10	1.05	1.01
45%	23.10	11.55	7.70	5.78	4.62	3.85	3.30	2.89	2.57	2.31	2.10	1.93	1.78	1.65	1.54	1.44	1.36	1.28	1.22	1.16	1.10	1.05	1.00	0.96	0.92
50%	21.00	10.50	7.00	5.25	4.20	3.50	3.00	2.63	2.33	2.10	1.91	1.75	1.62	1.50	1.40	1.31	1.24	1.17	1.11	1.05	1.00	0.95	0.91	0.88	0.84
55%	18.90	9.45	6.30	4.73	3.78	3.15	2.70	2.36	2.10	1.89	1.72	1.58	1.45	1.35	1.26	1.18	1.11	1.05	0.99	0.95	0.90	0.86	0.82	0.79	0.76
60%	16.80	8.40	5.60	4.20	3.36	2.80	2.40	2.10	1.87	1.68	1.53	1.40	1.29	1.20	1.12	1.05	0.99	0.93	0.88	0.84	0.80	0.76	0.73	0.70	0.67
65%	14.70	7.35	4.90	3.68	2.94	2.45	2.10	1.84	1.63	1.47	1.34	1.23	1.13	1.05	0.98	0.92	0.86	0.82	0.77	0.74	0.70	0.67	0.64	0.61	0.59
70%	12.60	6.30	4.20	3.15	2.52	2.10	1.80	1.58	1.40	1.26	1.15	1.05	0.97	0.90	0.84	0.79	0.74	0.70	0.66	0.63	0.60	0.57	0.55	0.53	0.50
75%	10.50	5.25	3.50	2.63	2.10	1.75	1.50	1.31	1.17	1.05	0.95	0.88	0.81	0.75	0.70	0.66	0.62	0.58	0.55	0.53	0.50	0.48	0.46	0.44	0.42
80%	8.40	4.20	2.80	2.10	1.68	1.40	1.20	1.05	0.93	0.84	0.76	0.70	0.65	0.60	0.56	0.53	0.49	0.47	0.44	0.42	0.40	0.38	0.37	0.35	0.34
85%	6.30	3.15	2.10	1.58	1.26	1.05	0.90	0.79	0.70	0.63	0.57	0.53	0.48	0.45	0.42	0.39	0.37	0.35	0.33	0.32	0.30	0.29	0.27	0.26	0.25
90%	4.20	2.10	1.40	1.05	0.84	0.70	0.60	0.53	0.47	0.42	0.38	0.35	0.32	0.30	0.28	0.26	0.25	0.23	0.22	0.21	0.20	0.19	0.18	0.18	0.17
95%	2.10	1.05	0.70	0.53	0.42	0.35	0.30	0.26	0.23	0.21	0.19	0.18	0.16	0.15	0.14	0.13	0.12	0.12	0.11	0.11	0.10	0.10	0.09	0.09	0.08
100%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120	125
CURRENT (IN AMPS) SHOWN ON THE DISPLAY																									

- **Discharging Battery**
  During the standard discharging process, the battery is discharged via the 51.2V Input/Output Terminals until the battery voltage reaches 44.8V. Safe discharging requires battery temperatures between -4°F (-20°C) and 140°F (60°C). **The battery should be charged once it reaches 20% SOC or before to keep all charging options open.** Discharging the battery below 50.0VDC can lead to an under voltage fault, which will require the battery to be recovered, which limits the charging options to shore power only.
    - **Quick Discharge Chart:** The chart below will display a quick reference that can be used to determine how much time is left at the current usage value. Look at the display and if the status is displayed as "discharging", note the current SOC%, as well as the current value. Then put a finger on the column with the closest matching SOC%, and move it across to the right, stopping at the cell, in the row with the closest matching current value. This corresponding cell will be the amount of time (in hours) left at that discharge rate.

SOC %	DISCHARGE CHART GIVES TIME (IN HOURS) LEFT AT THE SPECIFIC CURRENT VALUES BELOW																														
100%	210.00	42.00	21.00	14.00	10.50	8.40	7.00	6.00	5.25	4.67	4.20	3.82	3.50	3.23	3.00	2.80	2.63	2.47	2.33	2.21	2.10	2.00	1.91	1.83	1.75	1.68	1.62	1.56	1.50	1.45	1.40
95%	199.50	39.90	19.95	13.30	9.98	7.98	6.65	5.70	4.99	4.43	3.99	3.63	3.33	3.07	2.85	2.66	2.49	2.35	2.22	2.10	2.00	1.90	1.81	1.73	1.66	1.60	1.53	1.48	1.43	1.38	1.33
90%	189.00	37.80	18.90	12.60	9.45	7.56	6.30	5.40	4.73	4.20	3.78	3.44	3.15	2.91	2.70	2.52	2.36	2.22	2.10	1.99	1.89	1.80	1.72	1.64	1.58	1.51	1.45	1.40	1.35	1.30	1.26
85%	178.50	35.70	17.85	11.90	8.93	7.14	5.95	5.10	4.46	3.97	3.57	3.25	2.98	2.75	2.55	2.38	2.23	2.10	1.98	1.88	1.79	1.70	1.62	1.55	1.49	1.43	1.37	1.32	1.28	1.23	1.19
80%	168.00	33.60	16.80	11.20	8.40	6.72	5.60	4.80	4.20	3.73	3.36	3.05	2.80	2.58	2.40	2.24	2.10	1.98	1.87	1.77	1.68	1.60	1.53	1.46	1.40	1.34	1.29	1.24	1.20	1.16	1.12
75%	157.50	31.50	15.75	10.50	7.88	6.30	5.25	4.50	3.94	3.50	3.15	2.86	2.63	2.42	2.25	2.10	1.97	1.85	1.75	1.66	1.58	1.50	1.43	1.37	1.31	1.26	1.21	1.17	1.13	1.09	1.05
70%	147.00	29.40	14.70	9.80	7.35	5.88	4.90	4.20	3.68	3.27	2.94	2.67	2.45	2.26	2.10	1.96	1.84	1.73	1.63	1.55	1.47	1.40	1.34	1.28	1.23	1.18	1.13	1.09	1.05	1.01	0.98
65%	136.50	27.30	13.65	9.10	6.83	5.46	4.55	3.90	3.41	3.03	2.73	2.48	2.28	2.10	1.95	1.82	1.71	1.61	1.52	1.44	1.37	1.30	1.24	1.19	1.14	1.09	1.05	1.01	0.98	0.94	0.91
60%	126.00	25.20	12.60	8.40	6.30	5.04	4.20	3.60	3.15	2.80	2.52	2.29	2.10	1.94	1.80	1.68	1.58	1.48	1.40	1.33	1.26	1.20	1.15	1.10	1.05	1.01	0.97	0.93	0.90	0.87	0.84
55%	115.50	23.10	11.55	7.70	5.78	4.62	3.85	3.30	2.89	2.57	2.31	2.10	1.93	1.78	1.65	1.54	1.44	1.36	1.28	1.22	1.16	1.10	1.05	1.00	0.96	0.92	0.89	0.86	0.83	0.80	0.77
50%	105.00	21.00	10.50	7.00	5.25	4.20	3.50	3.00	2.63	2.33	2.10	1.91	1.75	1.62	1.50	1.40	1.31	1.24	1.17	1.11	1.05	1.00	0.95	0.91	0.88	0.84	0.81	0.78	0.75	0.72	0.70
45%	94.50	18.90	9.45	6.30	4.73	3.78	3.15	2.70	2.36	2.10	1.89	1.72	1.58	1.45	1.35	1.26	1.18	1.11	1.05	0.99	0.95	0.90	0.86	0.82	0.79	0.76	0.73	0.70	0.68	0.65	0.63
40%	84.00	16.80	8.40	5.60	4.20	3.36	2.80	2.40	2.10	1.87	1.68	1.53	1.40	1.29	1.20	1.12	1.05	0.99	0.93	0.88	0.84	0.80	0.76	0.73	0.70	0.67	0.65	0.62	0.60	0.58	0.56
35%	73.50	14.70	7.35	4.90	3.67	2.94	2.45	2.10	1.84	1.63	1.47	1.34	1.23	1.13	1.05	0.98	0.92	0.86	0.82	0.77	0.73	0.70	0.67	0.64	0.61	0.59	0.57	0.54	0.52	0.51	0.49
30%	63.00	12.60	6.30	4.20	3.15	2.52	2.10	1.80	1.57	1.40	1.26	1.15	1.05	0.97	0.90	0.84	0.79	0.74	0.70	0.66	0.63	0.60	0.57	0.55	0.52	0.50	0.48	0.47	0.45	0.43	0.42
25%	52.50	10.50	5.25	3.50	2.62	2.10	1.75	1.50	1.31	1.17	1.05	0.95	0.87	0.81	0.75	0.70	0.66	0.62	0.58	0.55	0.52	0.50	0.48	0.46	0.44	0.42	0.40	0.39	0.37	0.36	0.35
20%	42.00	8.40	4.20	2.80	2.10	1.68	1.40	1.20	1.05	0.93	0.84	0.76	0.70	0.65	0.60	0.56	0.52	0.49	0.47	0.44	0.42	0.40	0.38	0.37	0.35	0.34	0.32	0.31	0.30	0.29	0.28
15%	31.50	6.30	3.15	2.10	1.57	1.26	1.05	0.90	0.79	0.70	0.63	0.57	0.52	0.48	0.45	0.42	0.39	0.37	0.35	0.33	0.31	0.30	0.29	0.27	0.26	0.25	0.24	0.23	0.22	0.22	0.21
10%	21.00	4.20	2.10	1.40	1.05	0.84	0.70	0.60	0.52	0.47	0.42	0.38	0.35	0.32	0.30	0.28	0.26	0.25	0.23	0.22	0.21	0.20	0.19	0.18	0.17	0.17	0.16	0.16	0.15	0.14	0.14
5%	10.50	2.10	1.05	0.70	0.52	0.42	0.35	0.30	0.26	0.23	0.21	0.19	0.17	0.16	0.15	0.14	0.13	0.12	0.12	0.11	0.10	0.10	0.10	0.09	0.09	0.08	0.08	0.08	0.07	0.07	0.07
0%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	1	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120	125	130	135	140	145	150
CURRENT (IN AMPS) SHOWN ON THE DISPLAY																															

- **Battery 101**

How to quickly calculate power for consumption, and recharge. There is a physical limit to the amount of stored energy, so energy must be budgeted. You can determine what each activity, or load will "cost you" in watt-hours. This will help you understand energy usage, and how to make your reserve last when a charging source in not available.

To be able to manage energy, there needs to be a basic understanding of a few mathematic equations to convert energy from one source to the same source as the battery. The first step is a basic understanding of electrical terms.

The battery is rated at 51.2VDC at 210Ah. An "Ah" is amp-hour, or a rating for battery capacity (electric charge) which means that it will supply 210 amps of current for one hour. This means that to determine the capacity that a load will consume we will need to use a few calculations to move the loads of various power sources to one value.

To make calculations easy, we will use watt-hours or Wh. Watts is a measure of power, and it's the product of the current and voltage of a specific load or device, and to determine power, simply multiply the wattage (in watts) by the time it's used (in hours).

Example:
Coffee pot consumes 12.5A and it connects to the 120VAC outlet. (12.5A) x (120V) = 1500W

To determine the energy use (watt-hours) of the activity, first determine the load in watts and multiply by the time it's used (in hours).

Example:
Making coffee for breakfast and the coffee pot was on for 30 minutes:
Wh = (1500W) x (.5 Hours) = 750Wh

The battery has 210 Ampere Hours at 51.2VDC, or 10,752Wh of energy available at 100% SOC. Each 1% of SOC (state of charge) is equal to 2.1A at 51.2VDC, or 107.52Wh (51.2V x 2.1A). To determine current reserve capacity, in SOC% left after the usage, divide the Wh's of usage by 107.52Wh to determine the SOC % that the activity would cost. Then you can compare that SOC percentage from the current SOC percentage to determine if you want to perform that activity. Continuing our example from above:

Example:
Making coffee for breakfast and the coffee pot was on for 30 minutes:
Wh = (1500W) x (.5 Hours) = 750Wh
SOC% = 750Wh/107.52Wh = 6.98%
SOC% Cost for 30 minutes of coffee is approximately 7% SOC

The display will give you current SOC%, and the aforementioned calculations can be used to determine what loads will cost in SOC, to help determine how long the current capacity can last before recharging. Recharging uses the same calculations so you simply convert the amps of charging to watt hours, then SOC%. The only difference is you add from current SOC% instead of subtract. To simplify this, a chart was comprised of typical loads and charge values, with corresponding Wh and SOC percentage are.

- **SOC Quick Reference for discharge:** Use the chart below as a quick reference for typical load SOC percentages to subtract from current SOC percentage for discharge times, see below:

USAGE (LOADS)(IN Wh)					USAGE (LOADS)(SUBTRACT FROM SOC%			
LOAD NAME	WATT HOURS				AMP HOURS			
	FOR 15 MIN.	FOR 30 MIN.	FOR 45 MIN.	FOR 1 HOUR	FOR 15 MIN.	FOR 30 MIN.	FOR 45 MIN.	FOR 1 HOUR
INTERIOR LIGHTS	10	20	30	40	0.09%	0.19%	0.28%	0.37%
EXTERIOR LIGHTS	12.5	25	37.5	50	0.12%	0.23%	0.35%	0.47%
WATER PUMP	15.6	31.3	46.9	62.5	0.15%	0.29%	0.44%	0.58%
AIR PUMP	45	90	135	180	0.42%	0.84%	1.26%	1.67%
ELWELL HEATING	448	896	1344	1792	4.17%	8.33%	12.50%	16.67%
CABIN AIR CONDITIONER	384	768	1152	1536	3.57%	7.14%	10.71%	14.29%
COOKTOP	375	750	1125	1500	3.49%	6.98%	10.46%	13.95%
COFFE MAKER	375	750	1125	1500	3.49%	6.98%	10.46%	13.95%
KEURIG (HEATING)	375	750	1125	1500	3.49%	6.98%	10.46%	13.95%
KEURIG (ON AFTER WARM)	100	200	300	400	0.93%	1.86%	2.79%	3.72%
MR COFFEE COFFEE POT	375	750	1125	1500	3.49%	6.98%	10.46%	13.95%
AIR FRYER	425	850	1275	1700	3.95%	7.91%	11.86%	15.81%
ELECTRIC GRILL	400	800	1200	1600	3.72%	7.44%	11.16%	14.88%
WAFFLE IRON	375	750	1125	1500	3.49%	6.98%	10.46%	13.95%
SPACE HEATER	375	750	1125	1500	3.49%	6.98%	10.46%	13.95%
1 HP VACCUM CLEANER	186.5	373.1	559.6	746.2	1.73%	3.47%	5.20%	6.94%
1/2 HP VACCUM CLEANER	93.3	186.5	279.8	373.1	0.87%	1.73%	2.60%	3.47%
TRAVEL HAIR DRYER LOW	225	450	675	900	2.09%	4.19%	6.28%	8.37%
TRAVEL HAIR DRYER MED	300	600	900	1200	2.79%	5.58%	8.37%	11.16%
TRAVEL HAIR DRYER HIGH	375	750	1125	1500	3.49%	6.98%	10.46%	13.95%

- **SOC Quick Reference for re-charge:** Use the chart below as a quick reference for typical load SOC percentages to add to current SOC percentage for recharge times, see below:

CHARGING (REPLENSHMENT) (IN Wh)					CHARGING (REPLENSHMENT) (ADD TO SOC %)			
SOURCE NAME	WATT HOURS				WATT HOURS			
	FOR 15 MIN.	FOR 30 MIN.	FOR 45 MIN.	FOR 1 HOUR	FOR 15 MIN.	FOR 30 MIN.	FOR 45 MIN.	FOR 1 HOUR
ALTERNATOR 1000 RPM	408.8	817.5	1226.3	1635	3.80%	7.60%	11.40%	15.21%
ALTERNATOR 1250 RPM	885.6	1771.3	2656.9	3542.5	8.24%	16.47%	24.71%	32.95%
ALTERNATOR 1400 RPM	1090	2180	3270	4360	10.14%	20.28%	30.41%	40.55%

ALTERNATOR 1600 RPM	1226.3	2452.5	3678.8	4905	11.40%	22.81%	34.21%	45.62%
ALTERNATOR 1700 RPM	1294.4	2588.8	3883.1	5177.5	12.04%	24.08%	36.12%	48.15%
ALTERNATOR 1800 RPM	1362.5	2725	4087.5	5450	12.67%	25.34%	38.02%	50.69%
ALTERNATOR 2150 RPM	1430.6	2861.3	4291.9	5722.5	13.31%	26.61%	39.92%	53.22%
ALTERNATOR 2500 RPM	1498.8	2997.5	4496.3	5995	13.94%	27.88%	41.82%	55.76%
ALTERNATOR 3000 RPM	1566.9	3133.8	4700.6	6267.5	14.57%	29.15%	43.72%	58.29%
INVERTER CHARGER FULL	545	1090	1635	2180	5.07%	10.14%	15.21%	20.28%
INVERTER CHARGER 75%	408.8	817.5	1226.3	1635	3.80%	7.60%	11.40%	15.21%
INVERTER CHARGER 50%	272.5	545	817.5	1090	2.53%	5.07%	7.60%	10.14%
INVERTER CHARGER 25%	100	200	300	400	0.93%	1.86%	2.79%	3.72%
SOLAR BANK ROOF (FULL)	50	100.1	150.1	200.1	0.47%	0.93%	1.40%	1.86%
SOLAR BANK ROOF (50%)	25	50	75.1	100.1	0.23%	0.47%	0.70%	0.93%
SOLAR BLANKET EXT. (FULL)	75.1	150.1	225.2	300.2	0.70%	1.40%	2.09%	2.79%
SOLAR BLANKET EXT. (50%)	37.5	75.1	112.6	150.1	0.35%	0.70%	1.05%	1.40%

- **Battery Maintenance**
  - The battery needs to be maintained above 20% SOC. When the battery reaches 20% SOC, a recharge cycle needs to take place, and this can be completed by either connection to 120VAC 30A source or starting the engine and allowing the engine driven alternator/generator to recharge the battery.
    - If the battery is not recharged, under voltage disconnects will take place. The high voltage under voltage disconnects (inverter/charger, engine driven alternator, and cabin A/C) occurs at approximately 5%-6% SOC, the low voltage under voltage disconnect (Firefly, interior/exterior lighting, and water pump) occurs at approximately 2%-3% SOC.
    - If the high voltage is disconnected, then recharging with the engine driven alternator/generator cannot take place. It is vital to always keep the battery above 20% SOC to avoid the loss of functionality and recharging options. Once the SOC% is below the 5% to 6% point, the recovery process will need to take place.

- **Recovery Process**
  - To begin the recovery process, connect the RV to an external 120VAC (up to 30A) power source, and ensure that the inverter/charger power switch is in the "ON" position. The battery will begin "clicking". The SOC will slowly increase and once the proper SOC%'s are reached the under voltage disconnects will be reestablished. First the low voltage, then the high voltage sources will recover, and the battery will stop "clicking". ***It is imperative to try to recharge the battery to 100% SOC, as this also recalibrates the BMS. When the unit is depleted below 10% SOC, this can cause the SOC% and voltage levels to be out of calibration, the only way to recalibrate the BMS is to charge the unit to 100% SOC.***

- **Cold Weather Recovery**
  - Note that in cold weather, when the cell temperature drops below 10°C (50°F), ***the unit will need connected to shore power. The self-heat process may take 15-20 minutes to activate and begin warming the cell temperature enough to re-charge the battery bank. The warming process could take up to one hour or longer. The inverter/charger will charge at 8A to heat the battery, and once the minimum cell temperature reaches 5° the charging contactor will close, and full charging will begin.***

Battery Monitor

Typically, the battery monitor is mounted in the overhead cabinet.
Display features include:

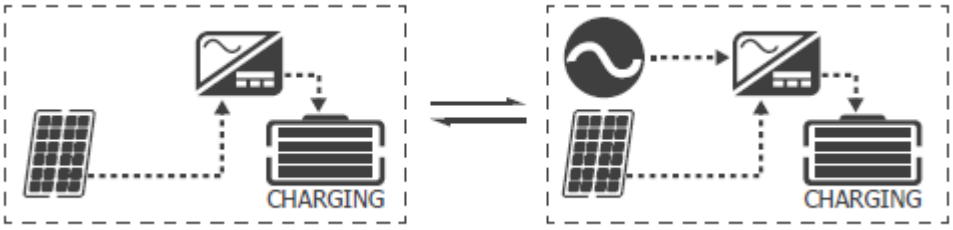
- Voltage = current 51.2VDC voltage
- Temperature = current cell temperatures
- Status = this refers to state, whether it is charging or discharging
- SOC Percentage = the current amount of capacity the battery has in SOC%
- Charger Operating Status = this is for the engine driven alternator/generator only, not the solar or inverter / charger
- Faults = this refers to any faults from the battery
- Lights: Power (PWR), Run and Communication (COM)

Status	PWR	RUN	COM
No Power	Off	Off	Off
Power Connected	On		
CPU Works Normally	On	On	
Communicates Normally	On	On	Flash

Inverter Charger

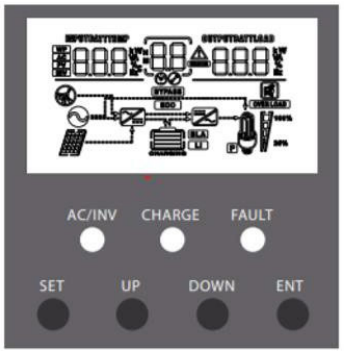
The Renogy Solar Inverter Charger is an advanced hybrid system combining the advanced charging algorithm of solar and industrial reliability and electrical energy of pure sine wave inverters to give you a complete power system. The unit features 4 charging modes and 3 output modes to meet an array of application needs. The recommended charging mode is:

- **Hybrid Charging:** In Hybrid Charging, PV and Utility will work together to charge the battery bank at the same time. Priority will be given to PV and utilize MPPT charging. Upon PV charging being insufficient, the power supply replenishes with Utility power. This method is the fastest to charge and suitable for unstable areas of the grid, ready to provide adequate backup power supply.



- **<u>Renogy BT-2 Bluetooth Module:</u>** The BT-2 Bluetooth module used to pair charge controllers with the Renogy BT App. After pairing is done you can monitor your system and change parameters directly from you cell phone or tablet. You can see performance in real time without the need of checking on the controller's LCD.

- **<u>Power Shore Settings:</u>** The only adjustment needed to the inverter is to change the AC Charging Current where the connection is less than 120VAC 30A. The inverter/charger rate may need to be reduced.
    A. Press SET button on Inverter to open parameter settings
    B. Press UP or DOWN and go to Parameter 28 and then press ENT button
    C. Parameter setting will begin to flash, then change the AC Charging Current from 0-40A by intervals of 5A to desired charging current
    D. Press ENT button to save setting
    E. Press SET button to exit setting menu



Rooftop Solar Array

There are two (2) DC disconnect switches installed in the rooftop solar array. One is located on top of the roof and one is located inside the unit near the inverter location. It is important that both switches are in the "ON" position when rooftop solar is needed.

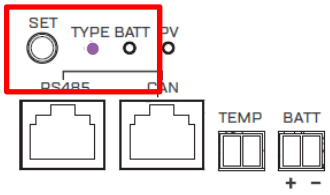
Rover Boost Charge Controller (Exterior Solar Blanket)

The Rover Boost controller is a 10Amp Maximum Power Point Tracking (MPPT) charge controller engineered to charge a 48V battery bank. Featuring 4-stage battery charging (Bulk, Boost, Float, and Equalization), the Rover Boost is pre-set to be compatible with Lithium batteries, and even includes custom battery settings. The Rover Boost is packed with numerous battery bank, controller, and solar electronic protections for an optimized system. Key features include:

- Self-adaptable to a wide solar panel input voltage for appropriate battery charging.
- Multi-Function LEDs displaying system information and identifying any errors.
- 4 Pre-set battery charge profiles includes Lithium batteries.
- Multiple battery bank, controller, and solar electronic protections including over-charge protection, reverse polarity protection, and more.
- RS485 communication port for monitoring using the Bluetooth module and Renogy DC Home App.

<u>Battery Setup:</u> Your unit should be pre-set with the correct battery type. The LED Indicators and SET button are found on the OUTPUT side of the Rover Boost.

- Programming: Set Battery Type to Purple LED - To change or set the battery type, long press the SET button for approximately 8 seconds. The Type Indicator will flash a color depending on the battery type indicated below. Tap the SET button to change between battery types until color PURPLE is showing.



<u>LED Indicators:</u> The Rover Boost LED indicators work to provide battery type information, battery status information, and solar charging information.

BATT LED	Color	Behavior	Charge State
●	Green	***Always on*** Bright, always on	Battery is fully charged
●	Yellow	***Always on*** Bright, always on	Battery voltage is normal
●	Red	***Always on*** Bright, always on	Battery undervoltage warning
●	Red	***Slow Flashing*** ON 1 second, OFF 1 second, cycle is 2 seconds	Battery over discharged disconnected
●	Red	***Quick Flashing*** ON 0.1 second, OFF 0.1 second, cycle is 0.2 seconds	Battery Overvoltage or Over temperature
○	---	***OFF***	Battery is not detected

PV LED	Color	Behavior	Charge State
●	Green	***Always on*** Bright, always on	MPPT Bulk Charging
●	Green	***Slow Flashing*** ON 1 second, OFF 1 second, cycle is 2 seconds	Boost Stage
●	Green	***Single Flash*** ON 0.1 second, OFF 1.9 seconds, cycle is 2 seconds	Float Stage
●	Green	***Quick Flashing*** ON 0.1 second, OFF 0.1 second, cycle is 0.2 seconds	Equalization Charge
●	Green	***Double Flashing*** ON 0.1 seconds, OFF 0.1 second, ON 0.1 seconds OFF 1.7 seconds	Lithium Activation or Power Limiting
○	---	***OFF***	PV is not charging or not detected

Renogy BT-2 Bluetooth Module: Pair the controller to the Renogy DC Home App to monitor your system using a smart device like a cell phone or tablet. Set custom charging parameters using User Mode and monitor your system in real time.

APS-500 Alternator Regulator

The APS-500 provides unexcelled control over alternator-based charging by utilizing system voltage, current monitoring and alternator and battery temperature to ensure the safest and most powerful charging possible. The APS-500 Alternator Regulator is equipped with a bright, multi-color LED which provides a range of operational and advisory codes. The LED is visible via a waterproof bezel located on near the lower left corner of the label on the regulator's cover.

WARNING: Turn off switches and disconnect your batteries prior to installing your APS-500 Alternator Regulator or other electrical system components. Failure to do so may cause damage or injury. Do not reconnect batteries until wiring is complete, and ensure wires are connected correctly.

There are three modes of information provided:

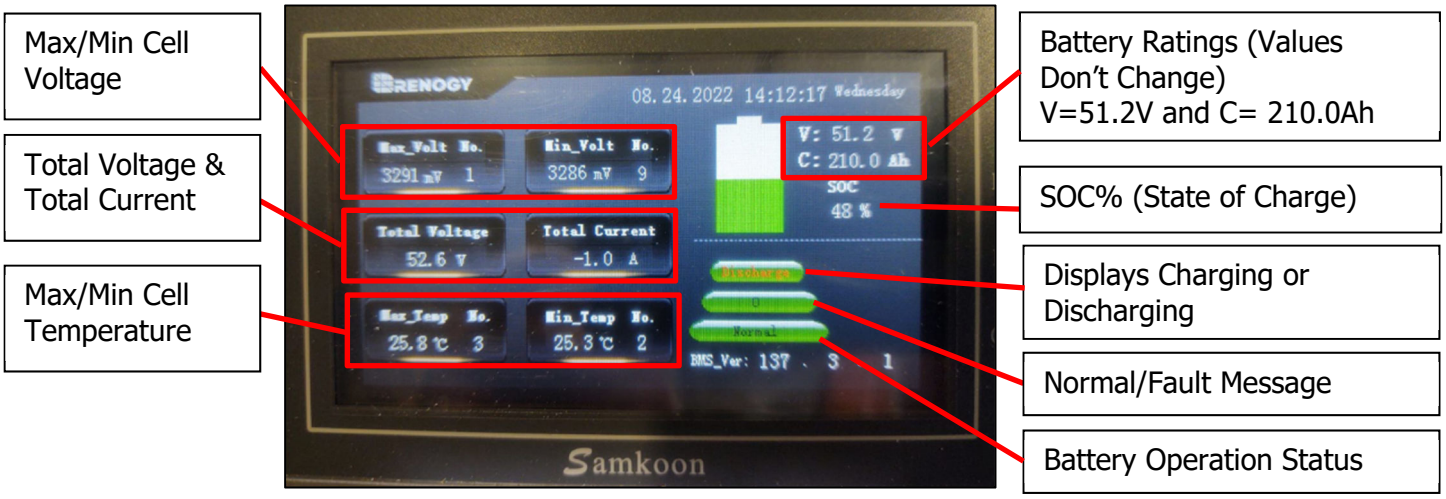
- Orange (Flashing) = Synced with the battery BMS
- Green = Lost communication with the battery BMS
- Red (Flashing) = Error/Advisory mode

Frequently Asked Questions Preface

It is important to note that when a battery fault occurs, multiple components will exhibit faults, and in most cases multiple faults. By first looking at the battery monitor screen (Renogy Samkoon) will help diagnose the root cause of the fault, and allow for the fault to be first corrected. Once the battery fault is corrected, then the other erroneous faults will clear out, once the corresponding proper operational parameters within the battery are reached. The most common faults are under or over voltage, and over or under temperature. It is important to know that the severity number of the fault, which is indicated in the second bubble below the battery is a 1 (warning), 2(alarm), 3(protection). Any condition with the fault level of 1 or warning is self-recoverable, and will correct itself once the level of the waring is reduced.

Lithium Battery FAQ

What is wrong with my lithium battery system? Battery Triage – Troubleshooting with the Renogy Battery Monitor aka Samkoon.



SOC% (State of Charge): It can fall out of calibration over time. There are times when you will see that this system's total voltage is either increasing or decreasing but the SOC% may appear to be locked on a certain percentage. The BMS (Battery Management System) can fall out of calibration over time. When this occurs, fully charging the battery with shore power will recalibrate the battery BMS.

Battery Operation Status: The battery contains a battery management system (BMS) that warns you and protects the battery from over-voltage, under-voltage, over-current, short circuit, high temperature, low temperature, uneven temperature, uneven voltage, and insulation fault. At the Battery Operation Status, you will find a number between 0-3.

0 = Normal (NO faults and all operating values are within normal range)
1 = Warning – message will clear when the system recovery value is reached
2 = Alarm – requires a battery restart when the system recovery value is reached
3 = Protection – requires a battery restart when the system recovery value is reached

If the battery operation status is anything but normal (1, 2, or 3), review the message icon to see what fault message is displayed. Look at battery fault message chart below to see the value that triggers a warning or protection and what value needs to be reached for recovery and clear the fault message.

Battery Faults: Please refer to the following table for the triggering and recovery condition of each warning and protection. Most common faults are Battery Under-Voltage, Battery Cell Over-Voltage and Charge Low Temperature.

Battery Under-Voltage: If the Total Voltage is below 50V, the battery needs to be charged.

Battery Cell Over-Voltage: The normal operating range is between 3000-3550mV.

- Warning will occur when the Maximum Cell Voltage is between 3550-3650mV. When the Maximum Cell Voltage reaches the 3500mV recovery, the warning will automatically disappear.
- Protection will occur when the Maximum Cell Voltage is above 3650mV. The protection mode will need to be cleared by allowing the cell voltage to reach the 3500mV recovery and restarting the battery.

Charge Low Temperature: The normal operating range is between 0°-55°C (32°-131°F).

- Warning will occur when the Minimum Cell Temperature is below 5°C (41°F). The battery will need to be warmed to the recovery temperature, charging will continue and warning with automatically disappear.
- Protection will occur when the Maximum Cell Temperature is below 0°C (32°F). The protection mode will need to be cleared by allowing the battery temperature to reach the 5°C (41°F) recovery and restarting the battery.

If it's a hard fault and not a warning, then the battery must be cycled on then off to reset the fault. This must be completed in a specific manor.

1. Turn off the vehicle ignition
2. Unplug the shore power connection
3. Turn off the solar disconnect switch located in the rear service panel
4. Turn off the 12V by pressing and releasing the momentary 12V disconnect switch located near the slider door
5. Turn off the inverter remote on/off button.
6. Make sure the BMS monitor does not show that the battery is in the charging state

7. Press Self-Locking Switch and release - the button is flush in the off position. This will shut the battery down
8. Wait 3-5 minutes
9. Turn the battery on again, by pressing and releasing the self-locking switch, next press and hold the self-resetting switch for approximately 5-10 seconds to turn on the battery. There will be a series of clicks which are completing self-checks on the battery. After the last click, wait about 5 seconds and release the Self-Resetting Switch.

Battery Fault Messages

Battery Operation Status		Condition	
Battery Over-Voltage	Warning	Triggering	Battery Voltage≥56.8V
		Recovery	Battery Voltage≤56V
	Protection (51.2V Circuit)	Triggering	Battery Voltage≥58.4V
		Recovery	Battery Voltage≤56V
			Battery Voltage≤57.6V Discharge Current≥2A
Battery Cell Over-Voltage	Warning	Triggering	Battery Cell Voltage≥3.55V
		Recovery	Battery Cell Voltage≤3.5V
	Protection (51.2V Circuit)	Triggering	Battery Cell Voltage≥3.65V
		Recovery	Battery Cell Voltage≤3.5V
			Battery Cell Voltage≤3.6V Discharge Current≥2A
Battery Under-Voltage	Warning	Triggering	Battery Voltage≤48V
		Recovery	Battery Voltage≥48.8V
	Protection (51.2V Circuit)	Triggering	Battery Voltage≤44.8V
		Recovery	Battery Voltage≥48.8V
			Battery Voltage≥46.4V Charge Current≥2A
	Protection (12V Circuit)	Triggering	Battery Voltage≤41.6V
		Recovery	Battery Voltage≥44.8V Restart Battery
Battery Cell Under-Voltage	Warning	Triggering	Battery Cell Voltage≤3.0V
		Recovery	Battery Cell Voltage≥3.05V
	Protection (51.2V Circuit)	Triggering	Battery Cell Voltage≤2.8V
		Recovery	Battery Cell Voltage≥3.05V
			Battery Voltage Cell≥2.9V Charge Current≥2A
	Protection (12V Circuit)	Triggering	Battery Cell Voltage≤2.6V
		Recovery	Battery Cell Voltage≥2.8V Restart Battery
Charge Over-Current	Warning	Triggering	Charge Current≥115A
		Recovery	Charge Current≤105A
	Protection (51.2V Circuit)	Triggering	Charge Current≥120A
		Recovery	Charge Current≤105A
Discharge Over-Current	Warning	Triggering	Discharge Current≥220A
		Recovery	Discharge Current≤200A
	Protection (51.2V Circuit)	Triggering	Discharge Current≥230A
		Recovery	Discharge Current≤200A
Charge High Temperature	Warning	Triggering	Battery Temperature≥122°F (50°C)
		Recovery	Battery Temperature≤113°F (45°C)
	Protection (51.2V Circuit)	Triggering	Battery Temperature≥131°F (55°C)
		Recovery	Battery Temperature≤122°F (50°C)
	Protection (12V Circuit)	Triggering	Battery Temperature≥134.6°F (57°C)
		Recovery	Battery Temperature≤122°F (50°C) Restart Battery
Discharge High Temperature	Warning	Triggering	Battery Temperature≥131°F (55°C)
		Recovery	Battery Temperature≤122°F (50°C)
	Protection (51.2V Circuit)	Triggering	Battery Temperature≥140°F (60°C)
		Recovery	Battery Temperature≤131°F (55°C)

	Protection (12V Circuit)	Triggering	Battery Temperature≥143.6°F (62°C)
		Recovery	Battery Temperature≤131°F (55°C) Restart Battery
Charge Low Temperature	Warning	Triggering	Battery Temperature≤41°F (5°C)
		Recovery	Battery Temperature≥50°F (10°C)
	Protection (51.2V Circuit)	Triggering	Battery Temperature≤32°F (0°C)
		Recovery	Battery Temperature≥41°F (5°C)
Discharge Low Temperature	Warning	Triggering	Battery Temperature≤14°F (-10°C)
		Recovery	Battery Temperature≥23°F (-5°C)
	Protection (51.2V Circuit)	Triggering	Battery Temperature≤-4°F (-20°C)
		Recovery	Battery Temperature≥5°F (-15°C)
	Protection (12V Circuit)	Triggering	Battery Temperature≤-4°F (-20°C)
		Recovery	Battery Temperature≥5°F (-15°C) Restart Battery
Short Circuit	Protection	Triggering	Discharge Current≥1920A
		Recovery	Remove Short Circuits Restart Battery
Battery Cell Uneven Temperature	Primary Warning	Triggering	Battery Cell Temperature Difference≥27°F (15°C)
		Recovery	Battery Cell Temperature Difference≤18°F (10°C)
Battery Cell Uneven Temperature	Secondary Warning	Triggering	Battery Cell Temperature Difference≥36°F (20°C)
		Recovery	Battery Cell Temperature Difference≤18°F (10°C)
Battery Cell Uneven Voltage	Primary Warning	Triggering	Battery Cell Voltage Difference≥0.5V
		Recovery	Battery Cell Voltage Difference≤0.3V
	Secondary Warning	Triggering	Battery Cell Voltage Difference≥0.8V
		Recovery	Battery Cell Voltage Difference≤0.3V
Insulation Fault	Warning	Triggering	Insulation Resistance≤500Ω/V
		Recovery	Insulation Resistance≥600Ω/V
	Protection (51.2V Circuit)	Triggering	Insulation Resistance≤100Ω/V
		Recovery	Insulation Resistance≥600Ω/V
	Protection (12V Circuit)	Triggering	Insulation Resistance≤100Ω/V

Storage and Cold Weather Recovery FAQ

When storing the unit during the winter months or an undetermined length of time, the BMS should be recalibrated before storage to ensure the SOC is correct and **the system should be shut down following the "Powering Down – Long Storage" section**. There are three different storage terms listed below, and each have their own unique specific criteria. The important part is to determine which storage method, or combination of methods suit the intended storage.

- **Short Term Storage** is defined as storage in which the battery is shut down, unused for up to one month, 30 continuous days. It is important to note that the temperature and humidity range for short term storage is greater than medium or long term storage. This is important to pay close attention to this detail because the aforementioned environmental criteria will define the maximum length of time the battery can be stored.
    - Short Term Storage: up to 1 month, 30 continuous days
    - Storage temperature and humidity range: -20°C to 35°C / -4°F to 95°F, 45% to 75% Relative Humidity
    - Charge the battery to 100% SOC before putting it in storage mode

  To prepare the battery for short term storage, you can charge the battery up to up to 100% SOC, and not lower than 50% before putting it in storage mode. If the storage temperature is less than 10°C or 51°F, then it important to charge the battery to, or as close to 100% SOC.
- **Medium Term Storage** is defined as storage in which the battery is shut down, unused for a length of time greater than one month, 30 continuous days, and up to three months, or 90 continuous days. This is important to pay close attention to this detail because the aforementioned environmental criteria will define the maximum length of time the battery can be stored.
    - Medium term storage: Greater than 1 month, 30 continuous days, and less than 3 months, 90 continuous days

- Storage temperature and humidity range: -10°C to 30°C / 14°F to 86°F, 45% to 75% Relative Humidity
- Charge the battery to 70% SOC before putting it in storage mode

To prepare the battery for medium term storage, you can charge the battery up to up to 70% before putting it in storage mode. It is important to note that the environmental criteria is more stringent than the short term storage, and if this criteria is not able to be met, then you cannot store the unit for the extended length of time.

- **Long Term Storage** is defined as storage in which the battery is shut down, unused for a length of time greater than three months, 90 continuous days, and no longer than six months, or 180 continuous days. The suggested SOC before storage is 50%. Storing battery at full charge will cause more capacity loss (permanent) overtime comparing to 40% to 50% SOC. This is important to pay close attention to this detail because the aforementioned environmental criteria will define the maximum length of time the battery can be stored.
  - Long term storage: Greater than 3 months, 90 continuous days, and less than 6 months, 180 continuous days
  - Storage temperature and humidity range: 0°C to 30°C / 32°F to 86°F, 45% to 75% Relative Humidity
  - Charge the battery to 50% SOC before putting it in storage mode

To prepare the battery for long term storage, you can charge the battery up to up to 50% before putting it in storage mode. It is important to note that the environmental criteria is more stringent than the short term storage, and if this criteria is not able to be met, then you cannot store the unit for the extended length of time.

When the battery is taken out of storage, it should be given a full charge prior to usage.

<table>
<tr><th>Storage Temperature @ 45-75% Relative Humidity</th><th>Short Term: 0-30 Days</th><th>Medium Term: 30-90 Days</th><th>Long Term: 90-180 Days</th></tr>
<tr><td rowspan="5">35°C / 95°F
30°C / 86°F

0°C / 32°F

-10°C / 14°F

-20°C / -4°F</td><td colspan="3">NOT RECOMMENDED FOR STORAGE</td></tr>
<tr><td rowspan="3">RECALIBRATE BMS & STORE BATTERY @ 50-100%</td><td rowspan="2">RECALIBRATE BMS & STORE BATTERY @ 70%</td><td>RECALIBRATE BMS & STORE BATTERY @ 50%</td></tr>
<tr><td rowspan="2"></td></tr>
<tr><td colspan="3">NOT RECOMMENDED FOR STORAGE</td></tr>
</table>

Important Notes:

1. In order to avoid a cold and dead battery, it is highly recommended to utilize the Short Term Storage method. Once a month, operate the battery system including discharging/charging the system and verifying the battery SOC is between 50 to 100%.
2. At the lowest allowed storage temperature -20°C/-4°F, the dischargeable capacity is about 70% of the rated capacity of the battery. Essentially, you are losing 30% of the amp hours. Instead of 210aH, it will be closer to 147aH.
3. With the battery shut down and below 0°C /32°F in storage mode, the self-consumption rate of the lithium cell is about 3% per month.
4. The maximum storage duration is 6 months.
5. Long Term storage is NOT RECOMMENDED when:
    a. Below freezing temperature. This will minimize the lithium battery voltage loss during storage and increase the recovery time caused by lower temperatures.
    b. Temperatures are extreme over 60°C /140°F.
6. Storing the battery outside of these environmental parameters: (-20°C to 35°C / -4°F to 95°F, 45% to 75% Relative Humidity) will trigger the low temperature cut off and the battery will be un-usable, and can cause permanent damage. If exposure to environmental criteria outside of the aforementioned parameters is needed please contact RENOGY at: renogy-oem@dehco.com

Troubleshooting includes:

1. "Getting Started" – Turning on the Operating System including the Lithium Battery, Inverter and 12V Power.
2. Determine Faults:
    A. Review the Samkoon Battery Screen to determine:
        i. What is the Normal/Fault Message?
            a. 0 = Normal – System should be operating correctly
            b. 1 = Warning – message will clear when the system recovery value is reached
            c. 2 = Alarm – requires a battery restart when the system recovery value is reached
            d. 3 = Protection – requires a battery restart when the system recovery value is reached
        ii. What is the Battery Operation Status? In lower temperatures, the Charge Low Temperature or Discharge Low Temperature are the common faults.
        iii. What is the Minimum Cell Temperature?

Charge Temperature Range	0°C~55°C /32°F~131°F
Discharge Temperature Range	-20°C~60°C /-4°F~140°F
Storage Temperature Range	-20°C~35°C /-4°F~95°F

    B. Review the Inverter Screen to determine if the inverter is out of operating temperature. With the inverter 'ON', a code 20 error may flash which indicates a protection mode for the operating temperature.

Operating Temperature	-15°C ~ 55°C /5°F ~ 131°F
Storage Temperature	-25°C ~ 60°C /-13°F ~ 140°F

3. Cold Weather Recovery
    A. Inverter Code 20 Flashing
        i. Remove the inverter access cover to provide additional exposure to the inverter.
        ii. Heat the interior cabin space – Bring the unit inside to allow the unit to warm or warm

the unit with the internal heaters

1. Chassis Dash Heat
2. Cabin Heat – When the burner icon is selected, the heater will run and keep the coolant hot and ready for heat.

iii. The goal is to heat the interior cabin space to a minimum of -15°C (5°F).

B. ***Lithium Battery Warning/Protection****:* With the system shut down for long periods of storage, it is not necessary to keep the unit connected to shore power. However, shore power will need to be connected if the temperature drops below 10°C (50°F) for charging. By connecting the shore power, it will provide a stable charge current greater than 8A required for the self-heating function to operate normally.

i. Connect shore power to the unit and turn on the inverter/charger.

ii. The self-heat process may take 15-20 minutes to activate and begin warming the cell temperature enough to re-charge the battery bank. The self-heating function will stop operating automatically once the battery temperature rises above 10°C (50°F)

NOTE: With the shore power connected, it is common to hear clicking and to see the shore power to connect and disconnect on the inverter. Leave the shore power connected and allow time to complete the warming process.

NOTE: Once the warming process is completed, it will take additional time to charge completely.

iii. Fault Status:

1. If the unit had a Warning (1) status, the battery will need to be warmed to the recovery temperature, charging will continue and warning with automatically disappear.
2. If the unit had a Protection (3) status, the protection mode will need to be cleared by allowing the battery temperature to reach the 5°C (41°F) recovery and restarting the battery.

Inverter FAQ

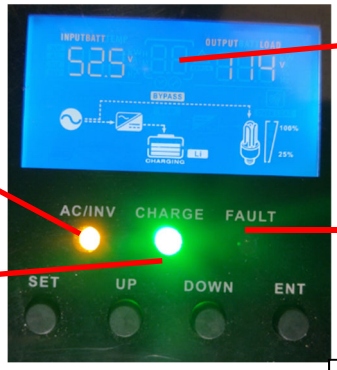
Why is the inverter not charging?

Inverter Charger Display

Orange light will flash while inverting.

Orange light will be solid when shore power is connected.

Green light will flash while charging.



Fault Code Display

Red light will be solid during a fault with a buzzing alarm

Inverter Charger On/Off Remote
Green Light = Inverter Powered

Inverter Charger On/Off Remote
Red Light = Inverter Fault

Step 1: Verify that the lithium battery and the inverter charger on/off remote are ON.
Step 2: Review the Inverter Charger Display to see if a fault code is present (see Inverter Fault Codes below). The most common faults is 03 (Battery not detected).

Inverter Fault Codes

Fault code	Fault name	Description
【01】	BatVoltLow	Battery under-voltage alert
【02】	BatOverCurrSw	Battery discharge current software protection
【03】	BatOpen	Battery not detected
【04】	BatLowEod	Battery under voltage stop discharge alarm
【05】	BatOverCurrHw	Battery overcurrent hardware protection
【06】	BatOverVolt	Charge overvoltage protection
【07】	BusOverVoltHw	Bus overvoltage hardware protection
【08】	BusOverVoltSw	Bus overvoltage software protection
【09】	PvVoltHigh	PV overvoltage protection
【10】	PvBuckOCSw	Buck Overcurrent Software Protection
【11】	PvBuckOCHw	Buck Overcurrent Hardware Protection
【12】	bLineLoss	utility power down
【13】	OverloadBypass	Side-by-side load protection
【14】	OverloadInverter	inverter overload protection
【15】	AcOverCurrHw	Inverted overcurrent hardware protection
【17】	InvShort	Inverter short-circuit protection
【19】	OverTemperMppt	Controller over-temperature protection
【20】	OverTemperInv	inverter over temperature protection
【21】	FanFail	Fan failure
【22】	EEPROM	Memory failure
【23】	ModelNumErr	Model settings are wrong
【26】	RlyShort	Error between AC output and bypass
【29】	BusVoltLow	Internal battery boost circuit failure

Fault	Solutions
Screen not displaying	Make sure the battery is properly connected and charged to be able to recognize the solar inverter. Or click any button on the screen to exit screen sleep mode.
Battery overvoltage protection	Measure whether the battery voltage exceeds 60Vand disconnect the photovoltaic array from and the power-on.
Battery undervoltage protection	Wait until the battery is charged to return to above the low voltage recovery voltage.
Fan failure	Check that the fan is not turning or is blocked by something else.
Over-temperature Protection	When the temperature of the equipment cools to, normal charge and discharge control is restored.
Overload Protection	(1) Reduce the use of electrical equipment (2) Restart the solar inverter charger and load recovery output.
Inverter short-circuit protection	Disconnect or reduce any loads from the unit. Shut down the solar inverter charger and turn on again to clear the error.
PV overvoltage	Check with the meter if the PV input voltage is above the maximum allowable input voltage of 145 V operating voltage.
Battery missed alert	Check that the battery is not connected or that the battery side circuit breaker is not closed.

Step 3: Verify the inverter settings to make sure they are set properly.

Recommended Inverter Settings

OPTION #	DESCRIPTION	SELECTION	DEFAULT OR CUSTOM
00	EXIT	N/A	
01	LOAD WORKING MODE	UTILITY	DEFAULT
02	OUTPUT FREQUENCY	60	DEFAULT
03	AC INPUT VOLTAGE RANGE	UPS	DEFAULT
04	BATTERY POWER UTILITY SETPOINT	44.0V	DEFAULT
05	UTILITY TO BATTERY POWER SETPOINT	58.8V	DEFAULT
06	BATTERY CHARGING MODE	SnU	DEFAULT
07	MAXIMUM CHARGING CURRENT	80A	DEFAULT
08	BATTERY TYPE	L16	CUSTOM SET POINT
09	BOOST CHARGE VOLTAGE	54.0V	CUSTOM SET POINT
10	BOOST CHARGE DURATION	VARIABLE UNTIL FULL	DEFAULT
11	FLOAT CHARGE VOLTAGE	N/A	DEFAULT
12	LOW VOLTAGE LOAD DISCONNECT	48V	DEFAULT
13	BATTERY OVER DISCHARGED DELAY TIME	30 s	DEFAULT
14	BATTERY UNDERVOLTAGE ALARM	48.8V	DEFAULT
15	BATTERY DISCHARGE LIMIT VOLTAGE	45.6V	DEFAULT
16	SET EQUALIZATION CHARGING	N/A	DEFAULT
17	BATTERY EQUALIZATION VOLTAGE	N/A	DEFAULT
18	BATTERY EQUALIZATION DURATION	N/A	DEFAULT
19	BATTERY EQUALIZATION TIME DELAY	N/A	DEFAULT
20	EQUALIZATION INTERVAL	N/A	DEFAULT
21	ENABLE EQUALIZATION IMMEDIATELY	N/A	DEFAULT
22	POWER SAVING MODE	DIS	DEFAULT
23	OVERLOAD AUTOSTART	ENA	DEFAULT
24	OVERTEMPERATURE AUTOSTART	ENA	DEFAULT
25	BUZZER ALARM	ENA	DEFAULT
26	ALARM	DIS	CUSTOM SET POINT
27	OVERLOAD BYPASS	ENA	DEFAULT
28	MAXIMUM A/C CHARGING CURRENT	40A	DEFAULT
29	SPLIT PHASE	DIS	DEFAULT
30	N/A	N/A	N/A
31	N/A	N/A	N/A
32	N/A	N/A	N/A
33	N/A	N/A	N/A
34	N/A	N/A	N/A
35	LOW VOLTAGE DISCONNECT RECOVER	50.8V	CUSTOM SET POINT
36	PV CHARGING CURRENT	80A	DEFAULT
37	BATTERY CHARGING BOOST RETURN SETPOINT	52V	DEFAULT
38	AC OUTPUT VOLTAGE SETTING	120	DEFAULT
39	MAX AC INPUT CURRENT	40A	DEFAULT

Step 4: Plug in shore power and look at the Samkoon battery monitor screen and check the Total Voltage and Total Current. Total current shows the differential current. If charger is providing 40A and loads are consuming at 80A, then the Total Current will show -40A and battery is discharging. If no loads are on and still not charging and voltage is below 49V, then follow the recovery process.

To begin the recovery process, turn off house battery disconnect and solar disconnect. Connect the RV to an external 120VAC (up to 30A) power source and ensure that the inverter/charger power switch is in the "on" position. The battery will begin "clicking". Once the contactor latches then the charger will start charging the battery. This might take a half hour to an hour depending on how low the voltage is on the battery. The SOC will slowly increase and once the proper SOC% is reached the under voltage disconnects will be reestablished. First the low voltage (12V), then the high voltage (48V) sources will recover. If battery voltage is 30V or below, then change setting 15 on inverter charger to 36.0V to help with the recovery process. This could take several hours to a couple days to recover if voltage is extremely low. DO NOT HAVE ANY TECHNICIAN OR CUSTOMER OPEN BATTERY!

It is imperative to try to recharge the battery to 100% SOC. To calibrate BMS, change setting 09 on inverter charger to 54.8V and when battery reaches 54.8V, then the BMS will recalibrate. It's good to do this periodically to recalibrate as SOC% as it can fall out of calibration over time. After recalibrating BMS, then the setting 09 can be changed back to 54.4V. If customer is getting Battery Cell Over-Voltage when charging, then change 09 setting to 54.0V.

Solar Power FAQ

How do I see if the solar is working?

Step 1: Have the customer check the inverter LCD screen and press the down button to cycle through the screens until they get to the one that shows PV Input Voltage on the left side of the screen and PV Output Current on the right side of the screen. The PV Input Voltage must be over 60V for solar to charge from the 200W solar array on the roof. The PV Output Amps (A) charge output displays how many Amps the solar is charging. Solar will produce about 3-5A on sunny day.

Inverter Display Screen

Press the DOWN button twice to get to the PV Screen from Main Screen

Step 2: If the voltage is showing 0V, verify that both of the solar disconnect switches are 'ON'. One will be located on the roof and a second near the inverter. If both are 'ON', check the wiring or fuses.

Step 3: If the inverter shows more than 60V and has a charge current (Amps) displayed on the inverter, then turn off inverter and 12V disconnect switch. Review the Samkoon battery monitor screen to see what is being displayed for the Total Current. If you are showing current on the Inverter PV screen and 0A on Samkoon screen, loads are using the current and/or the charge is too low for battery to detect.

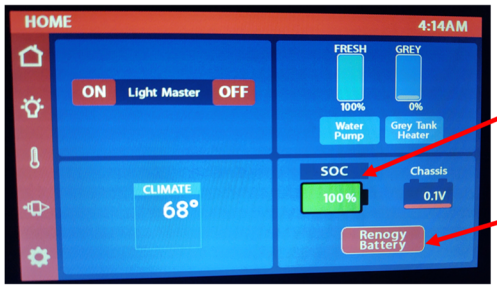
Alternator FAQ

Why is my Alternator not charging the battery?

Step 1: Are there any faults on the Samkoon battery screen? If yes, see the Lithium Battery FAQ section for diagnosis.

Step 2: If the Firefly shows 0% SOC, the Samkoon battery screen does show a percentage on the SOC% and there are no faults on the Firefly display screen or the Samkoon battery screen, complete a battery restart to see if the SOC% is displayed on the Firefly screen.

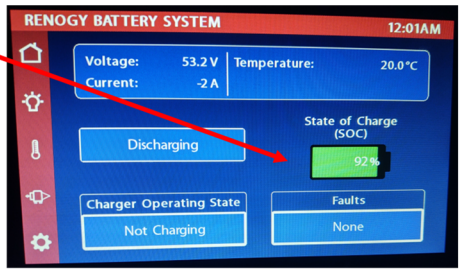
Home Page of Firefly Display



Battery SOC%

Click Renogy Battery for more battery information

Renogy Battery System



Step 3: If Firefly shows no faults and the SOC percentage is displayed, start the engine. After about 20 seconds with the engine at about 1500RPM, the Firefly display screen should show Constant Volt/Current and start charging. If it doesn't say this, then it might be incorrectly wired and will need additional troubleshooting.

The APS-500 Voltage Regulator is the component that regulates the alternator charging by getting messages from the battery BMS. There is a light on the voltage regulator:

- Orange (Flashing) = Synced with the battery BMS
- Green = Lost communication with the battery BMS
- Red (Flashing) = Error/Advisory mode
    - Should the APS-500 determine that a condition is outside of normal limits, it will display a red flashing LED pattern, followed by a series of flashes indicating the type of fault occurring. Most errors are hard-faults, indicating a condition which the APS-500 Alternator Regulator is unable to decipher and as such will shut down until corrected, in order to prevent any potential systems or battery damage. A few errors will attempt to auto-restart to see if the failing condition clears (example, error low battery voltage). When a fault is detected, the APS-500 will flash the "Error" code twice, followed by a series of flashes indicating the fault/error number. Note: the LED will only indicate the most recent fault detected.
        - Ignore the fast flashes.

        - Start counting the number of flashes to provide you the first digit of the error code.
        - There will be a short pause.
        - Start counting the number of flashes to provide you the second digit of the error code.
    - In some models, the APS-500 is not easily accessible via an access panel. In these vehicles, a secondary light has been added.
    - Error Code 51 is the most common (see below for full list of APS-500 Voltage Regulator Codes).

APS-500 Voltage Regulator Codes

Error Code	Description
12	Battery temperature exceeded limit
13	Battery voltage exceeded upper limit
14	Battery voltage below lower limit
21	Alternator temperature exceeded limit
22	Alternator rpms above expected value
23	Alternator #2 temperature exceeded limit
24	Alternator temperature exceeded limit during ramp
31	Global Variable charging state has some unsupported value in check for faults
32	Global Variable charging state has some unsupported value in manage alt
33	Global Variable cpIndex has some unsupported value in calculate alt targets
34	Global Variable cpIndex has some unsupported value in check for faults
35	Global Variable SystemAmpMult has some unsupported value in check for faults
41	Internal Field FET temperature exceed limit.
42	A 'Required' sensor is missing, and WS500 is configured to FAULT out
51	A CAN message was received that the battery charging bus has been disconnected
52	We have noted that a command has been sent asking for the battery bus to be disconnected
53	Battery Instance number is out of range (needs to be from 1..100)
54	Too many different BMS's are asking to be aggregated
57	A CAN command has been received asking for the battery but to be disconnected due to Low Voltage
58	A CAN command has been received asking for the battery but to be disconnected due to High Current
59	A CAN command has been received asking for the battery but to be disconnected due to High Battery Temperature
61	A CAN command has been received asking for the battery but to be disconnected due to Low Battery Temperature
62	A CAN command has been received that the battery has reached its upper limit, but not yet disconnecting. Charging should stop.

Additional possible alternator charging issues include: A fault from the battery BMS

1. Some units are built with two inline fuses at the lithium battery. Verify:
    a. Red wire has a 15A fuse
    b. Brown wire has a 3A fuse.
    c. Are the fuses seated properly or blown?
2. Communication cables disconnected or improper termination
    a. Check the black 4 position tap connector for 60 ohms. Use the ohms setting on the multimeter; measure the 2 middle pins that the white and blue CAN wires are connected to. You want to see 60 ohms for proper communication.
    120 ohms = under terminated
    60 ohms = properly terminated
    40 or under = over terminated