LinkBMS manual

LinkBMS is system that turns your electric vehicle battery into energy storage system that works with various hybrid inverters.

- managing max 400 lithium cells
- max 800V 50A
- 2 communication ports, each max 15 LinkSlave
- easy to access config and parameters monitoring using any mobile device or PC
- cloud parameters monitoring accesible from internet with 1 month history
- works with Sofar, Deye, Goodwe inverters using CAN communication

Warning!

Li-ion batteries can be extremely dangerous if not handled properly. Improper use or handling of these batteries can lead to serious risks, including electric shock, fire, or even explosion. LinkBMS is not liable for any damages arising directly or indirectly from the use or malfunction of the product.

List of supported inverters	
Make	Model
Sofar	HYD 5K~20KTL-3PH
Deye	SUN-25/30/40/50K-SG01HP3
Goodwe	gw(5-10)k-et plus hv
Others	All that support Pylontech H2 CAN protocol

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How to start

System consists of 3 elements:

- LinkMaster – controller of whole system
- LinkPDU – power distribution unit
- LinkSlave – cell measuring and balancing devices

This is step by step instruction described briefly whats necessary to build working HV ESS using LinkBMS.

For detailed instructions check the LinkSlave, LinkMaster and LinkPDU sections in this manual.

1. Connect LinkMaster, to USB cable and 5V powerbank/charger.
2. Connect ethernet or configure WiFi connection. You can find how to do it in the LinkMaster description.
3. (Optional) Connect to bms.local/config and configure Your 1 slave testing device. Power the LinkMaster with 5V.
4. Solder the LinkSlaves to create low voltage modules. You can find how to do it in the LinkSlave description below. Double-check cell sensing wires using voltmeter before connecting to LinkSlave.
5. (Optional) Check each LinkSlave if it is soldered correctly using configuration for 1 Slave, and corresponding number of cells. If You achieve communication the blue LED will blink.
6. Connect all previously prepared LinkSlave modules to LinkMaster using original connectors. Power the LinkMaster with 5V.
7. Open bms.local/config and configure the BMS1 and BMS2 with ammount of LinkSlaves per each string, type in cell number per module and total number of cells in series, type in all voltages using LFP, Li Ion preset or change it manually.
8. Connect to bms.local and check the Voltage/Temperature matrix for errors. If none - proceed to next step, otherwise check for errors and eliminate them.
9. Next go to and check if communication is okay - if BMS1 and BMS2 is "OK" (or "OFF" if using one communcation channel) - it may take few seconds to start talking. If you see "COM_ERR", check your slave wiring, slave count config or contact supplier.
10. Connect main +/- battery terminals to High Voltage DC PV Switch that meet current and voltage requirements of your batterypack using different color wires (black/red or black/orange).
11. Connect output of the HVPV Switch to LinkPDU V in-, V in+.
    Double check the polarity (!)
12. Disconnect LinkMaster from 5V. Connect :
    - CAN
    - Ethernet/WiFi
    - LinkMaster to LinkPDU using original connector
    - LinkSlave String 1 and String 2 to BMS1 and BMS2 slot.
    - Connect LinkPDU V out+ V out- to inverter (You can use MC-4 connectors rated for Your current requirements)

13. Next step You require electrical qualifications, proceed only when You have skills required to work with high voltage.
14. **!!! WARNING High Voltage !!!**
    Proceed to connecting modules in series.
    !!! WARNING High Voltage !!!
    - Pro Tip : Create modules that do not exceed 60VDC to work in extra low voltage region.
    - You can stack voltages exactly the same as PV panels using MC-4 connector that suits Your current needs.
    - Before connecting You can discharge the battery to achieve the lowest voltage possible to limit number of modules connected via MC-4 connectors.
15. Turn on the Voltage using PV Switch.
16. If no errors the contactors should switch on and the inverter will start charging/discharging the battery.

Congratulations! You have Your own HV Energy Storage Solution.

Thanks to this system you can convert any electric car lithium battery to photovoltaic energy storage system like below: 12x 8S batteries from Volkswagen, working with Deye SUN-50K-SG01HP3 inverter.

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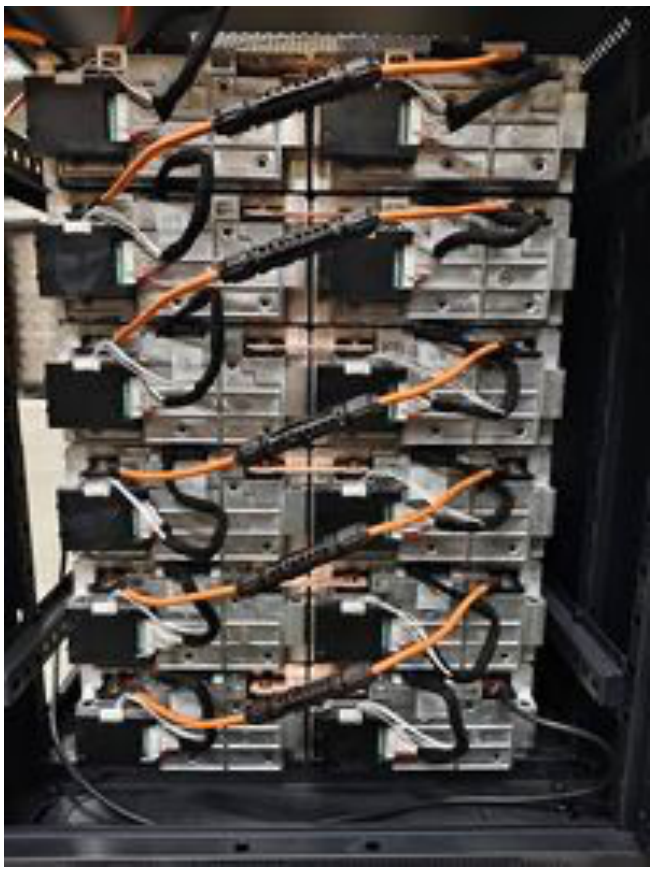

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LinkMaster

LinkBMS Master is the main controller of LinkBMS system. It can manage up to 400 cells using max 30 LinkSlave devices. Parameters:

- managing max 400 lithium cells
- 2 communication ports, each max 15 LinkSlave
- easy to access config and parameters monitoring using any mobile device or PC
- cloud parameters monitoring accesible from internet with 1 month history
- 4 inputs, 4 outputs (sinking)
- power voltage 7-24V
- 2 CAN bus, RS485 ports
- works with Sofar, Deye, Goodwe inverters using CAN communication

Warning!

Do not open LinkBMS Master case. It is equipped with anti-tamper measures and opening the case may brick your device.

Connecting to WiFi / Ethernet

If You want to connect LinkMaster using **Ethernet** cable just plug it in RJ45 connector.

If You want to connect LinkMaster using **WiFi** :

1. Using Android/iOS device connect to WiFi Access point that has been created by Master BMS called "LinkBMS-xxxx" (password is ppppppppp).
2. You should see an automatically popping up notification to LOG-IN.
3. Log in to network.
4. Set Your WiFi credentials.
5. Set your mDNS address. (Default = bms, it means that the access to LinkBMS will be through : bms.local, You can switch it to <yourname>.local)
6. If there will be no automatic push notification than open Your web browser and type in : 1.2.3.4/wifi
7. If You have more than 2 LinkMaster devices connected to one network, log into bms.local/wifi and change mDNS to BMS1, BMS2, BMS3 ect. in order to avoid IP conflict.

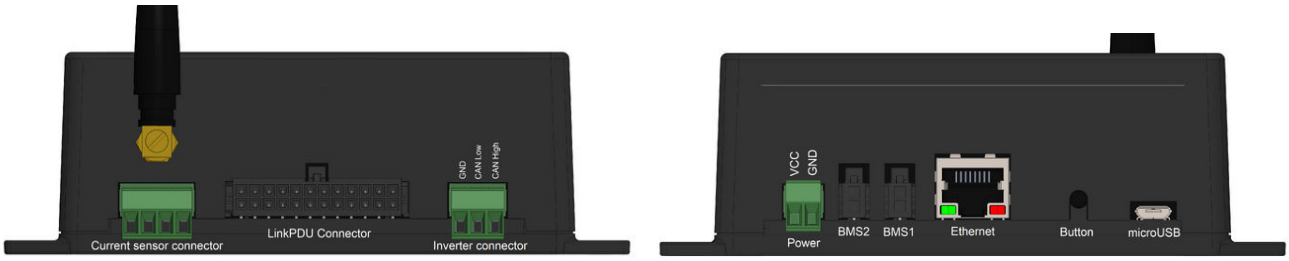
Attention!

If You will make any error during connection proces or You want to change WiFi Settings, you can always press RESET button for 5-6 seconds to reset BMS WiFi settings and start over again.

Useful links :
bms.local
bms.local/wifi
bms.local/config

LinkBMS Master connectors

LinkBMS have multiple connectors that allows to easily connect to other system components.



Current sensor connector
This 4-pin connector is used to measure current from 5V analog current sensor. If you are using LinkPDU, don't connect anything to this.

LinkPDU connector
LinkPDU 24-pin connector is used to power LinkBMS master, to measure voltages, current and control contactors. If you don't want to use LinkPDU, contact us.

Inverter connector
This 3-pin connector is used to communicate with inverter. Usually you need to connect only CAN High and CAN Low. RJ45 to this connector cable is added to every LinkBMS, so in most inverters you only have to plug RJ45 connector (Deye: BMS1 or BMS2 port)

Power connector
Allows you to power LinkBMS Master with voltages ranging from 10 to 24V DC. Do not connect anything if using LinkPDU.

BMS1 and BMS2 connector
These connectors allows you to connect LinkSlaves. If your slave number is less than 15 you can occupy only one channel.

Ethernet
Connect Ethernet cable if you don't want to use WiFi. LinkBMS will automatically send data to LinkCloud.

microUSB
This connector allows you to easily power up the LinkBMS without need to power high voltage. You can use it to configure your device.

Parameter view

This is main parameter view site. You can monitor real time all of the BMS parameters. If you see "Disconnected" instead of "BMS Status" that means there is no connection with BMS. Make sure your connection is good, if your wifi signal is weak, connect Ethernet cable. If you see "Int conn error", contact your supplier.

Status	BMS 1	BMS 2	SOC	Vmin	Vmax	dV	Current	Power	Total Ah	Tmin	Tmax	RSSI	ETH	MQTT
RUNNING	OK	OFF	11.0	3.427	3.441	0.014	0.0	5	10.77	24.2	25.3	-76	false	true

Voltage	Vmeas in	Vmeas out	Charge Voltage	Discharge Voltage	Charge Current	Discharge Current	Capacity	Cell Count	Cycle Count	BMS voltage
327.6	328.3	328.3	384.0	297.6	25.0	50.0	100.0	96	0	14.6

BMS No	Pack No	Voltage	Cell 1	Cell 2	Cell 3	Cell 4	Cell 11	Cell 12	Cell 13	Cell 14	T1	T2	T3	T4	T5
1	1	27.32	3.428	3.439	3.440	3.441	3.441	3.439	3.440	3.439	-106.1	-106.1	-106.1	24.2	24.2
1	2	27.30	3.428	3.437	3.437	3.438	3.437	3.438	3.439	3.437	-106.1	-106.1	-106.1	24.4	24.3
1	3	27.30	3.431	3.439	3.439	3.438	3.438	3.437	3.437	3.437	-106.1	-106.1	-106.1	24.8	24.8
1	4	27.31	3.430	3.437	3.437	3.437	3.437	3.438	3.438	3.437	-106.1	-106.1	-106.1	25.0	25.0
1	5	27.29	3.432	3.440	3.440	3.440	3.440	3.440	3.438	3.438	-106.1	-106.1	-106.1	25.1	24.8
1	6	27.28	3.427	3.438	3.439	3.438	3.437	3.437	3.437	3.436	-106.1	-106.1	-106.1	25.3	25.3
1	7	27.32	3.430	3.439	3.439	3.440	3.439	3.437	3.438	3.438	-106.1	-106.1	-106.1	24.4	24.3
1	8	27.29	3.428	3.439	3.437	3.438	3.437	3.438	3.436	3.437	-106.1	-106.1	-106.1	24.7	24.7
1	9	27.36	3.426	3.438	3.438	3.439	3.439	3.438	3.437	3.434	-106.1	-106.1	-106.1	24.8	24.8
1	10	27.35	3.428	3.439	3.439	3.438	3.437	3.438	3.437	3.437	-106.1	-106.1	-106.1	24.7	25.0
1	11	27.33	3.430	3.441	3.439	3.440	3.439	3.440	3.439	3.438	-106.1	-106.1	-106.1	24.8	24.9
1	12	27.34	3.430	3.440	3.440	3.439	3.438	3.439	3.437	3.436	-98.0	-106.1	-88.1	25.2	25.1

`Status`

Status is the main state of device. It can get few states:

"RUNNING" - all parameters are ok and BMS is functioning normal, main relays are on.

"WARNING" - some of parameters are close to critical, and battery current is cut down.

"PROTECT" - some of parameters are beyond critical, main relays are off.

"CHECKING" - your system is starting and checking parameters.

"CONFIG ERR" - config is corrupted. Check your config parameters.

"PRECHARGE_ERR" - there is error on system start - check if there is no short at output or check your voltage calibration.

"OCP" - overcurrent protection - check your inverter max current setting, OCP parameter in config or current calibration.

"COM ERR" - there is problem with communication with slave modules. Check your wiring or config.

"NO DATA" - contact support for help.

BMS1 and BMS2

Fields marked as BMS1 and BMS2 represents communication with slave modules. They can get these values:

"OK" - communication is established

"WARNING" - some of parameters are close to critical, and battery current is cut down.

"PROTECT" - some of parameters are beyond critical, main relays are off.

"OFF" - channel is disabled, because there is 0 value in this channel slave number.

"COM ERR" - there is communication error or no connection with slave module. Check communication wiring.

"NO DATA" - contact support.

SOC

SOC is a measure of the remaining charge in a battery relative to its full capacity. It is expressed as a percentage, where 100% indicates a fully charged battery and 0% indicates a fully discharged battery.

Vmin, Vmax, dV

Cell minimum voltage, cell maximum voltage and cell voltage difference.

Current and power

Indicates current and power, measured by current sensor inside of LinkPDU. Positive values are charging, negative values are discharging.

Total Ah

Estimated electric charge left in battery.

Tmin and Tmax

Minimum and maximum temperature measured by NTC temperature sensors.

RSSI

WiFi RSSI (Received Signal Strength Indicator) is a measurement that indicates the strength of the WiFi signal that a device is receiving from a wireless access point (router). RSSI is expressed in negative numbers, typically ranging from -30 dBm (excellent signal) to -90 dBm (weak signal). The closer the RSSI value is to 0, the stronger the signal. If it is 0, wifi is disconnected or in Access Point mode.

ETH
True if Ethernet cable is connected, false if disconnected.

MQTT
True when connected to LinkCloud, false if disconnected.

Voltage
Battery voltage measured by all slave modules.

Vmeas in
Battery voltage measured by LinkPDU on input connectors.

Vmeas out
Battery voltage measured by LinkPDU on output connectors.

Charge voltage
Maximum allowed voltage of battery.

Discharge voltage
Minimum allowed voltage of battery.

Charge current
Maximum allowed charge current of battery.

Discharge current
Maximum allowed discharge current of battery.

Capacity
Capacity of battery, set in config.

Cell count
Number of detected cells. If this value causes PROTECT state, check all voltages and connections.

Cycle count
Number of BMS cycles.

BMS Voltage
Voltage of system, this value should be around 12V.

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Device reset

If you want to hard-reset your device, you need to hold button for 20 seconds. You can also reset it using bms.local/config.

Detailed config

To change your config, go to bms.local/config. Don't forget to click 'Save' button at the bottom.

`No of slaves`
Determines how many slave modules are connected to each input.

`Cell count`
You need to input how many cells are in your system. If your cell count is red in parameters menu, make sure all measured cell voltages are good.

`Used cells`
Determines how many cells are shown in parameters menu.

`Temp sensor`
By clicking "Enable/disable temp sensors", there should pop-up a checkbox menu, where you can select which temperature sensors are connected.

To run system without any temperature sensor, disable all checkboxes.

`NTC parameters`
Parameters of temperature sensors: resistance and β(25/50). Check your temperature sensor datasheet for these values.

`Capacity`
Capacity of your battery in amp-hours.

`Protocol`
You can select your inverter CAN protocol.

- Sofar
  To connect LinkBMS to sofar inverter, you have to select Sofar protocol. In inverter you have to select battery "GENERAL" and set battery address. If you use only one battery with LinkBMS, you should set "Sofar battery 1" in config and set battery address in sofar to "00". If you want to use LinkBMS as second battery, you should select "Sofar battery 2" in 2nd battery config,

and battery 2 address "01" in sofar settings. LinkBMS can work as second battery only with batteries that uses "GENERAL" or "AMASS" protocol. Connect can-buses together.

- Deye
  To connect LinkBMS to Deye inverter, just connect RJ45 to BMS port in inverter and select "Deye" protocol in config. LinkBMS will work with Deye battery port 1 & 2, just need to connect it right. There are two BMS ports in Deye inverters, BMS1 for battery 1 and BMS2 for battery 2. You should see "CAN1 OK" or "CAN2 OK" on inverter main screen if communication is okay.

- Goodwe
  To connect LinkBMS to Goodwe inverter, connect CAN to Battery RJ45 inverter connector.

Cell voltage charge disable (SOC 100%)
If cell with highest voltage go above this value, BMS disables charging. This value corresponds do State of Charge 100%.

Cell voltage charge enable
If cell with highest voltage drops below this value, BMS enables charging.

Cell voltage discharge disable (SOC 0%)
If cell with lowest voltage drops below this value, BMS disables discharging. This value corresponds do State of Charge 0%.

Cell voltage discharge enable
If cell with highest voltage go above this value, BMS enables discharging.

Charge current
Maximum charge current in Amperes.

Discharge current
Maximum discharge current in Amperes.

Overcurrent protect
If current is higher than this value for more than 10 seconds, or current > 120% OCP value, BMS status changes "OCP" and disconnect contactor. Relase time is 30 seconds.

Cell overvoltage alarm
If cell with highest voltage go above this value, BMS status changes to "ALARM" and charge and discharge current is reduced.

Cell undervoltage alarm

If cell with lowest voltage drops below this value, BMS status changes to "ALARM" and charge and discharge current is reduced.

Cell overvoltage protect
If cell with highest voltage go above this value, BMS status changes to "PROTECT" and contactor is disconnected.

Cell undervoltage protect
If cell with lowest voltage drops below this value, BMS status changes to "PROTECT" and contactor is disconnected.

Cell voltage difference alarm
If cell highest voltage minus cell lowest voltage is above this value, BMS status changes to "ALARM" and charge and discharge current is reduced.

Cell voltage difference protect
If cell highest voltage minus cell lowest voltage is above this value, BMS status changes to "PROTECT" and contactor is disconnected.

Cell overtemperature alarm
If one of NTC temperature is above this value, BMS status changes to "ALARM" and charge and discharge current is reduced.

Cell undertemperature alarm
If one of NTC temperature is above this value, BMS status changes to "ALARM" and charge and discharge current is reduced.

Cell overtemperature protect
If one of NTC temperature is above this value, BMS status changes to "PROTECT" and contactor is disconnected.

Cell undertemperature protect
If one of NTC temperature is below this value, BMS status changes to "PROTECT" and contactor is disconnected.

Charge minimum temp
If one of NTC temperature is below this value, charging is disabled.

Charge maximum temp
If one of NTC temperature is above this value, charging is disabled.

Discharge minimum temp
If one of NTC temperature is below this value, discharging is disabled.

Discharge maximum temp
If one of NTC temperature is above this value, discharging is disabled.

Balance start cell voltage
If one of NTC temperature is above this value, discharging is disabled.

Balance cell voltage difference
If cell with highest voltage go above this value, balancing is enabled.

Current sensor
Lets you calibrate your current sensor. You have to calibrate it in two points, higher difference between low and high calibration is more precision. We reccomend to calibrate 'low' to 0 when no current is flowing and 'high' when high known current is flowing. All devices are pre-calibrated, but if your idle current is too high, calibrate only 'low' for 0A current. Positive current is charging, negative current is discharging.

Voltage sensor
Lets you calibrate voltage sensors. There are two voltage sensor in LinkPDU, on input and on output. There is only 'high' calibration, so if 'Vmeas in' and 'Vmeas out' is different than 'Voltage', check your config, measure your battery voltage using multimeter and calibrate it only when needed. This value is pre-calibrated.

Reset
Lets you reset device. "Reset BMS" will disconnect contactors, until communcation is established again.

Integration with smart home systems

You can easily integrate LinkBMS with various smart home systems like HomeAssistant. Data is live updated via JSON file, which you can access by address bms.local/data.json

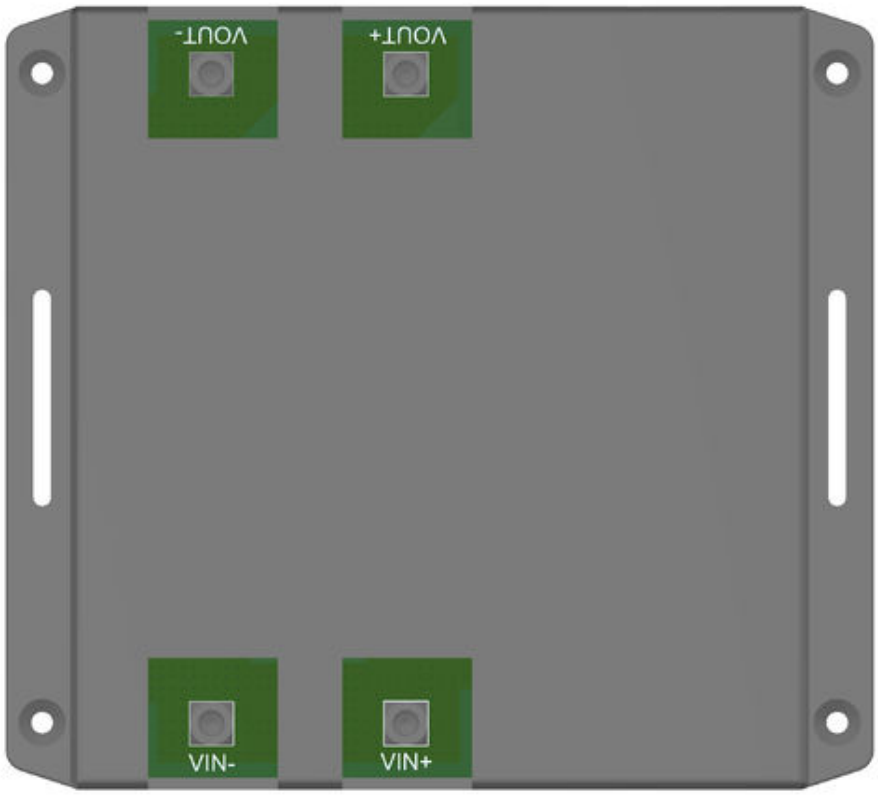
Paste this in HomeAssistant configuration.yaml. If you changed your mDNS address, you have to change 'resource' field. Reset your HomeAssistant after pasting.

```
sensor:
  - platform: rest
    resource: http://bms.local/data.json
    name: LinkBMS
    timeout: 15
    scan_interval: 10
    force_update: true
    verify_ssl: false
    value_template: 'OK'
    json_attributes:
      - CAc
      - PTV
      - PAc
      - CMn
      - CMx
      - DV
      - CTm
      - CTx
      - CCn
      - SOC

  - platform: template
    sensors:
      battery_current:
        value_template: "{{ state_attr('sensor.LinkBMS', 'CAc') }}"
        unit_of_measurement: "A"
      battery_voltage:
        value_template: "{{ state_attr('sensor.LinkBMS', 'PTV') }}"
        unit_of_measurement: 'V'
      battery_power:
        value_template: "{{ state_attr('sensor.LinkBMS', 'PAc') }}"
        unit_of_measurement: 'W'
      battery_cell_min:
        value_template: "{{ state_attr('sensor.LinkBMS', 'CMn') }}"
        unit_of_measurement: 'V'
      battery_cell_max:
        value_template: "{{ state_attr('sensor.LinkBMS', 'CMx') }}"
```

```
  unit_of_measurement: 'V'
battery_cell_diff:
  value_template: "{{ state_attr('sensor.LinkBMS', 'DV') }}"
  unit_of_measurement: 'V'
battery_temp_min:
  value_template: "{{ state_attr('sensor.LinkBMS', 'CTm') }}"
  unit_of_measurement: 'C'
battery_temp_max:
  value_template: "{{ state_attr('sensor.LinkBMS', 'CTx') }}"
  unit_of_measurement: 'C'
battery_cycle_count:
  value_template: "{{ state_attr('sensor.LinkBMS', 'CCn') }}"
battery_soc:
  value_template: "{{ state_attr('sensor.LinkBMS', 'SOC') }}"
  unit_of_measurement: '%'
```

LinkPDU



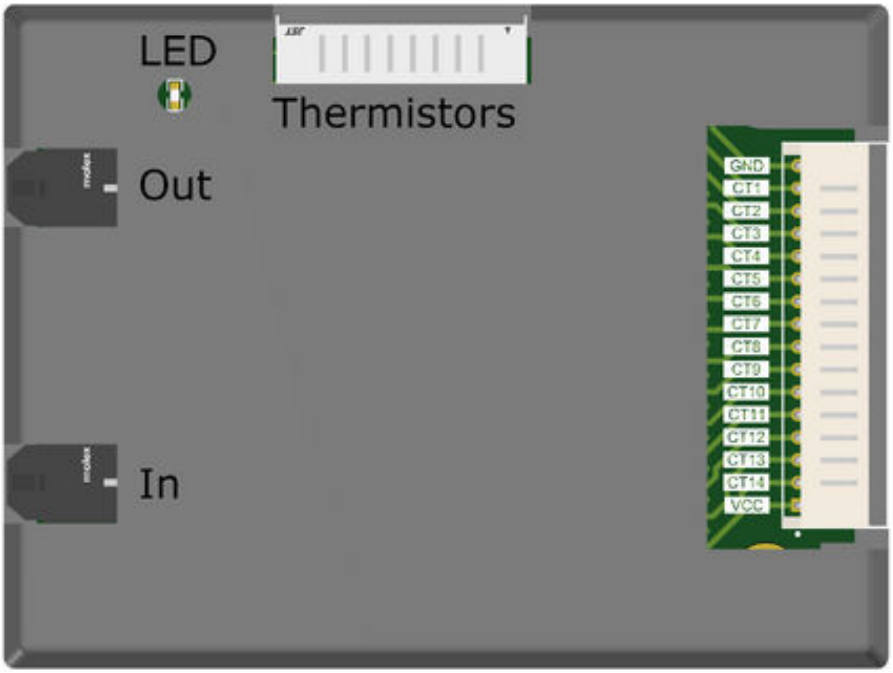
LinkPDU is the power distribution unit of LinkBMS. Basic parameters:

- supports 250-800V battery
- safety disconnecting contactors on positive and negative terminal with precharge
- 50A max (fuse 80A)
- integrated isolated power supply for LinkBMS Master
- isolated current and voltage measurement

Connecting LinkPDU

LinkPDU have two pairs of M6 screw terminals; input (VIN+ and VIN-) and output (VOUT+ and VOUT-). Connect your battery main to input and output to inverter. Don't forget to install breaker switch between battery and PDU to disconnect device from high voltage. It also has 24-pin connector, which connected to LinkMaster that allows to measure current, voltages and control contactors.

LinkSlave



LinkSlave is device that allows BMS Master to manage lithium cells. It measures voltages, temperatures and allows balancing. It communicates with LinkMaster and other slave modules using isolated chain communication. Basic parameters:

- 7 to 14 cells
- daisy-chain communication, max 15 modules in one chain
- measuring cell voltages 0-5V
- balancing current < 120mA
- up to 5 NTC temperature sensors

Connecting LinkSlave communication

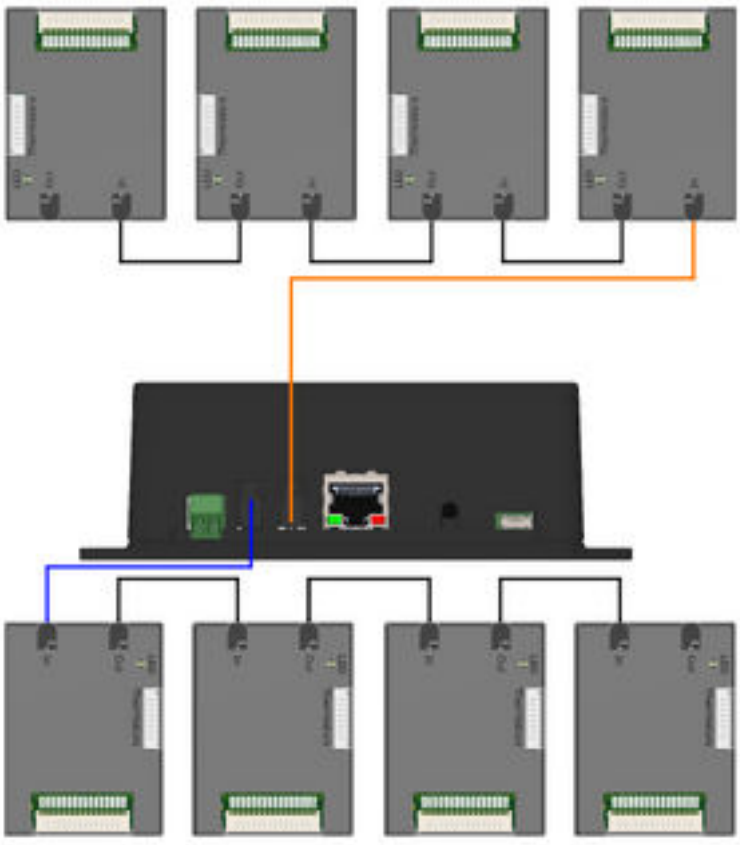
LinkSlave utilizes two wire daisy-chain communication, which means you can connect up to 15 slave modules in one chain (max 30 modules in both). It have two communication ports, which are described as input and output. First module input need to be connected to LinkBMS Master.

Chain communication can be wired in any order. You don't have to connect communication by increasing voltage but we highly suggest doing it in order to make maintenance easier.

Attention!

Do not extend communication wires between slave modules, because too long cable can cause communcation problems.

Example of 8 LinkSlave connected to LinkMaster in 2 strings.

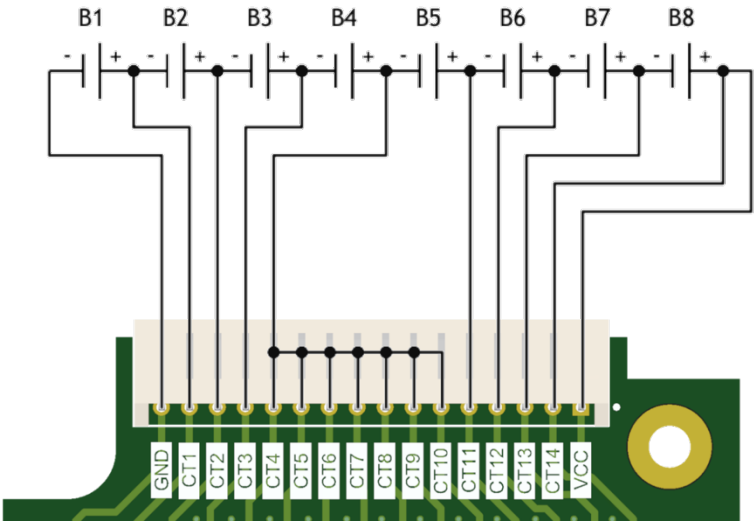


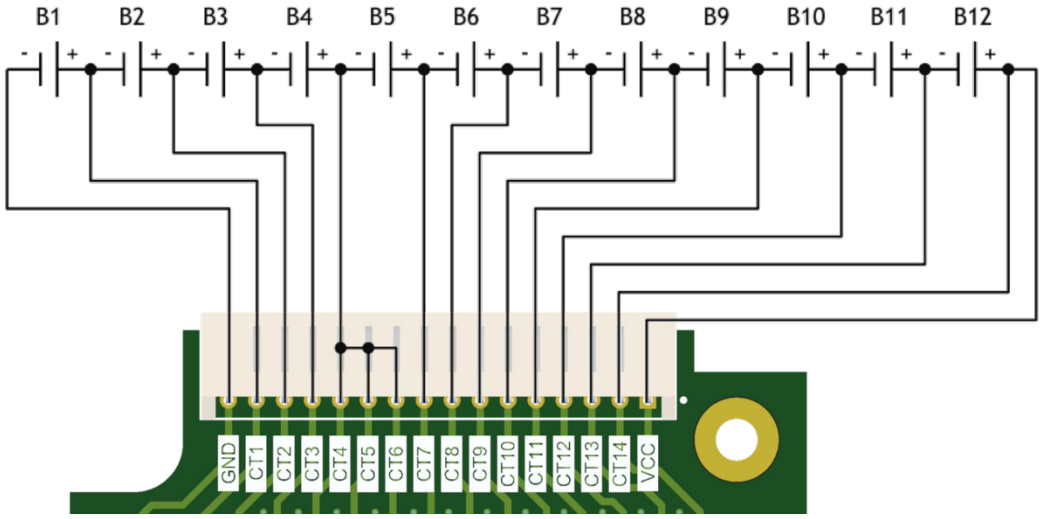
If communcation is good, LinkSlave diode is blinking.

Connecting cells to LinkSlave

You can connect from 7 to 14 cells to single LinkSlave. A minimum of seven cells must be used. At least cell 1 through cell 4 and cell 12 through cell 14 must be used. Unused cells must start with CT5. As a general rule, unused CTx have to be terminated to the positive terminal of cell 4. Pin VCC is the module power, so to avoid voltage drop while balancing, its best to connect VCC and CT14 directly to last cell terminal.

Here are connecting diagrams for 8s and 12s:





Attention!

Before plugging balance connector, double check your wiring and measure voltage on every pin. Bad wiring will burn your LinkSlave.

Connecting temperature sensors

LinkSlave is designed to work with NTC temperature sensors, most commonly used in all batteries. There are two parameters that describe NTC sensor: resistance in 25°C and β(25/50) that you need to insert in LinkBMS Master configuration. If you don't know know these parameters its best to harvest one sensor to check its marking and search for datasheet, or measure it using "NTC Beta Calculator". You can use from 0 to 5 NTC sensors each slave module.

If you are not using temperature sensors integrated in battery, use any 10k NTC sensors. Check Beta parameter in its datasheet and put it in Link Master config.

You can run system without any temperature sensor.

Diagram of connecting NTC's: