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## Warnings



### **WARNING!**

**Lithium-ion batteries are very dangerous! Improper use of this equipment may cause fire.**



### **WARNING!**

**Use of this equipment requires at least basic knowledge in electronics and electrical engineering.**



### **WARNING!**

**When installing this equipment, carefully read and follow the manufacturer's instructions.**

## Introduction

Here is the “Universal adapter for additional external battery hot-plug connecting” or, in short, Rita.

This device allows you to connect and disconnect an external battery at any time, regardless of its charge level and charge level of the internal battery. This is not necessary to align battery voltages before connecting an extra battery. The external battery voltage may even exceed the standard 36V value, which significantly increases the scooter speed and power.

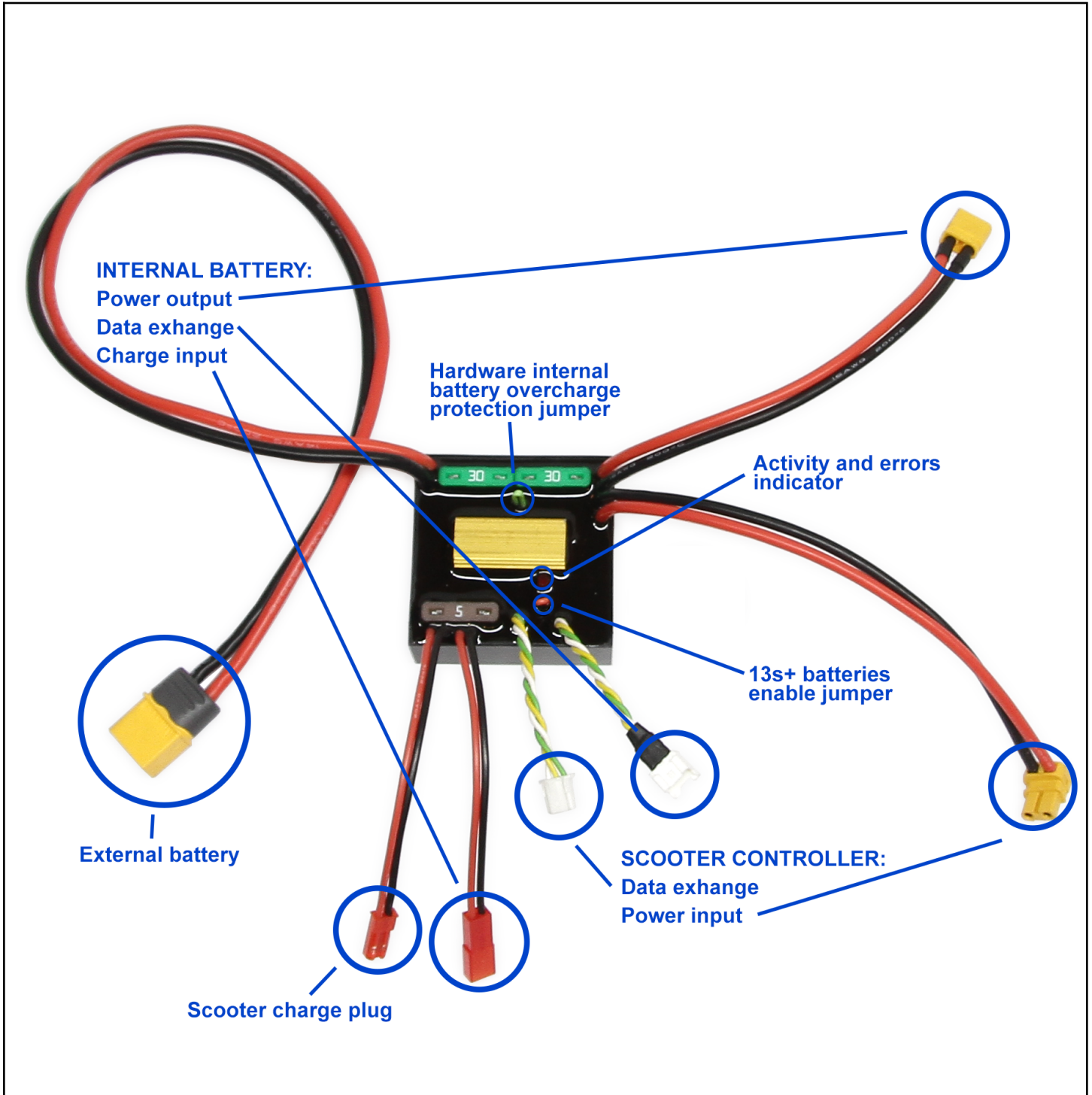


## **WARNING!**

**This document is related to the 5th generation of Rita adapter. Pay your attention, there are a lot of changes and improvements in the 5th generation compared to previous ones, so you must be very careful, avoiding using this manual if you own another generation Rita unit. You can identify your device by checking a sticker at the bottom side. More information is presented at the “[Rita generations overview](#)” section below.**

# General view and pinout

Xiaomi edition(Rita Gen5X)



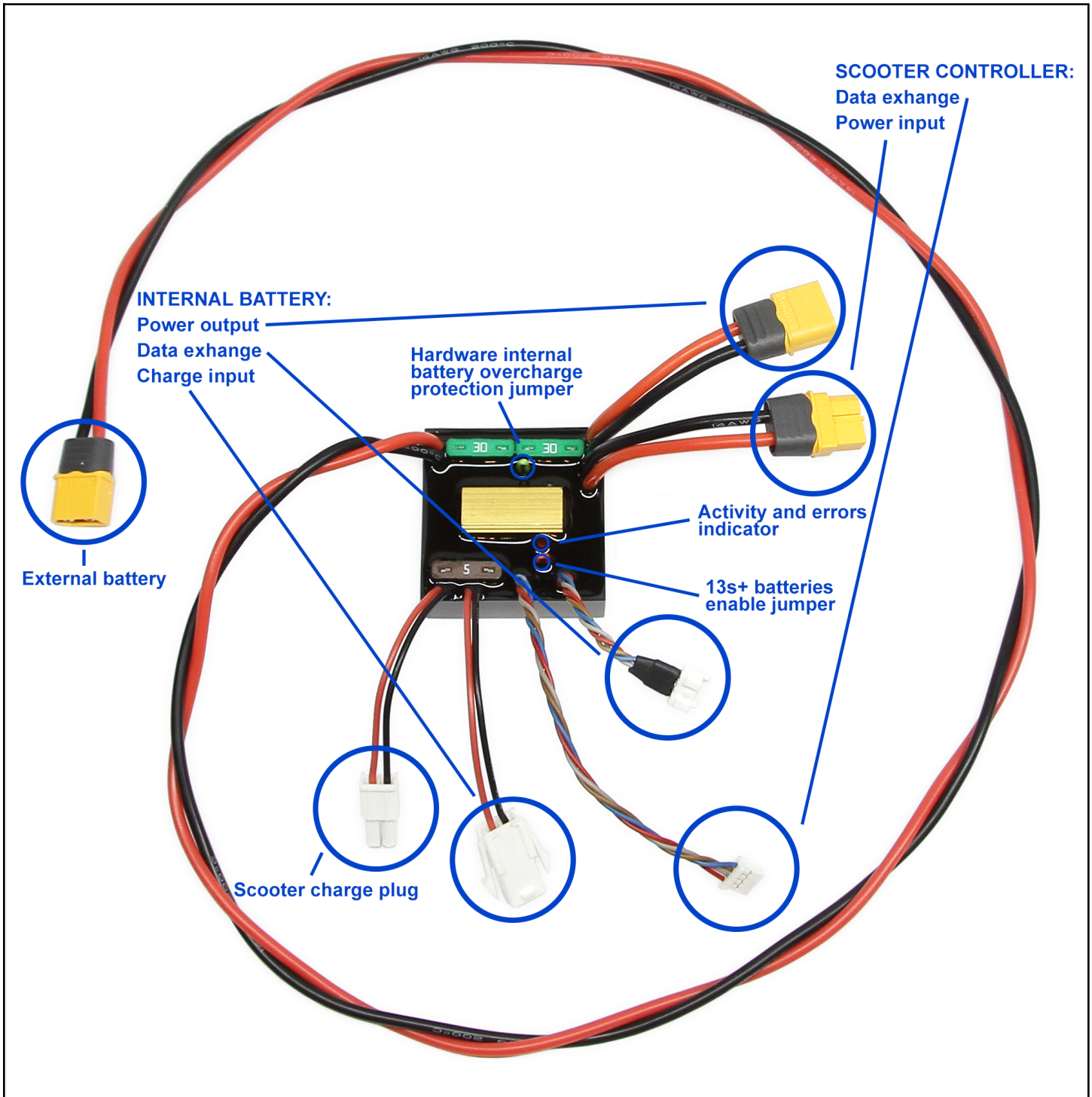


## General view and pinout

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External battery	Take it out of the scooter and connect an additional external battery to this plug.
Scooter charge port	Connect to the charging port of the scooter.
Internal battery: charge input	Connect to the charging port of the internal battery.
Internal battery: data exchange	Connect to the data exchange port of the internal battery.
Internal battery: power output	Connect to the power output of the internal battery.
Scooter controller: power input	Connect to the power input of the scooter controller.
Scooter controller: data exchange	Connect to the data exchange input of the scooter controller.
Activity and errors indicator	<p>Blinks a short flash once every 2 seconds when the scooter is turned off and the device is in power saving mode.</p> <p>Blinks a short flash twice a second when the scooter is turned on, and there is an active data exchange with the controller.</p> <p>Glows continuously if there was an emergency voltage surge during energy recovery, until the error will be automatically reset by timeout.</p>
13s+ batteries enable jumper	This jumper must be cut off in order to be able to use batteries with voltages more than 55V. DO NOT CUT THIS JUMPER OFF IF THE SCOOTER CONTROLLER IS NOT HARDWARE UPGRADED FOR INCREASED VOLTAGE!
Hardware internal battery overcharge protection jumper	This jumper must be cut off in order to be able to charge the internal battery over 43.7V

## Ninebot MAX edition(Rita Gen5N)



General view and pinout

External battery	Take it out of the scooter and connect an additional external battery to this plug.
Scooter charge port	Connect to the charging port of the scooter.
Internal battery: charge input	Connect to the charging port of the internal battery.
Internal battery: data exchange	Connect to the data exchange port of the internal battery.
Internal battery: power output	Connect to the power output of the internal battery.
Scooter controller: power input	Connect to the power input of the scooter controller.
Scooter controller: data exchange	Connect to the data exchange input of the scooter controller.
Activity and errors indicator	<p>Blinks a short flash once every 2 seconds when the scooter is turned off and the device is in power saving mode.</p> <p>Blinks a short flash twice a second when the scooter is turned on, and there is an active data exchange with the controller.</p> <p>Glows continuously if there was an emergency voltage surge during energy recovery, until the error will be automatically reset by timeout.</p>
13s+ batteries enable jumper	This jumper must be cut off in order to be able to use batteries with voltages more than 55V. DO NOT CUT THIS JUMPER OFF IF THE SCOOTER CONTROLLER IS NOT HARDWARE UPGRADED FOR INCREASED VOLTAGE!
Hardware internal battery overcharge protection jumper	This jumper must be cut off in order to be able to charge the internal battery over 43.7V

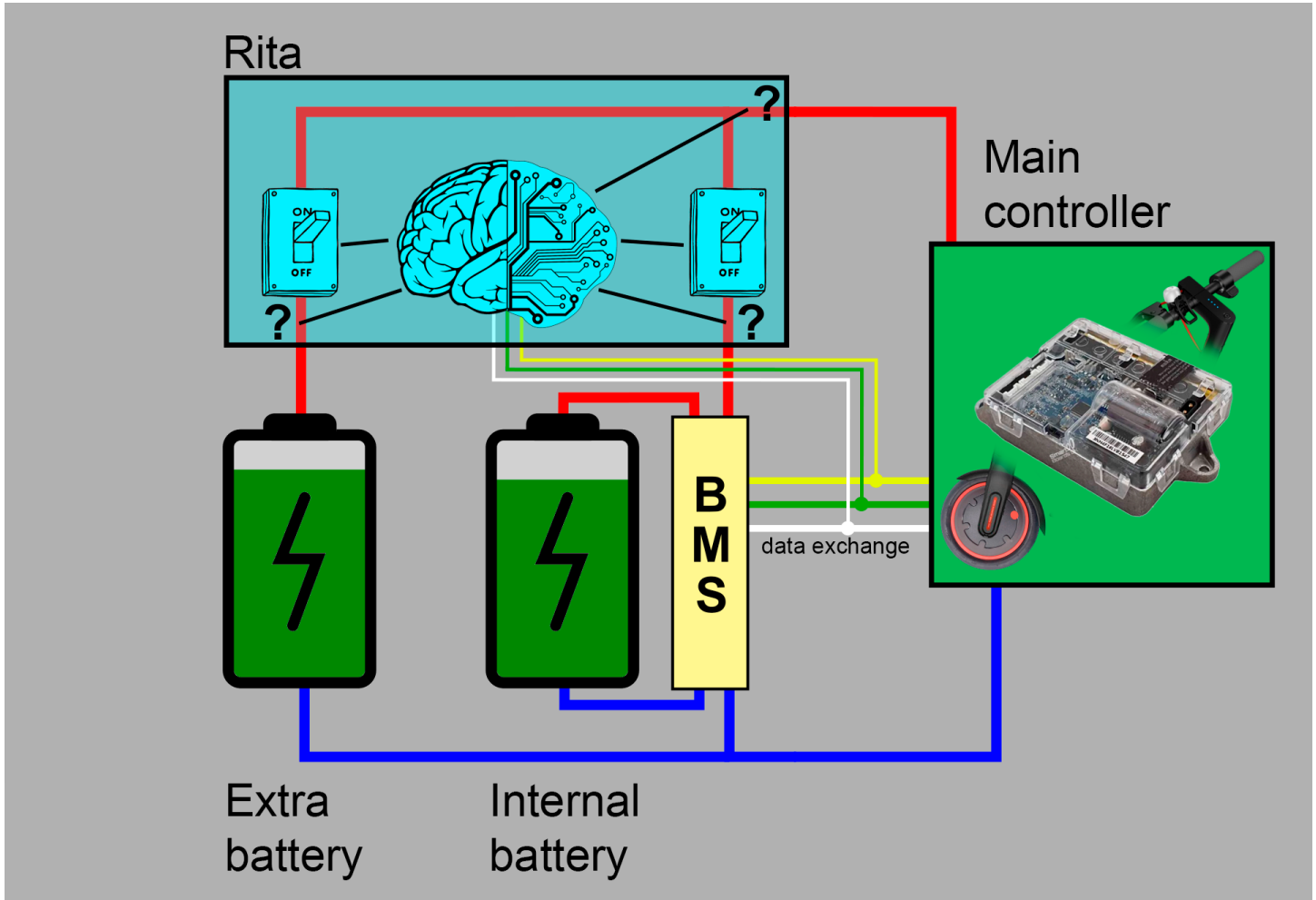
## Basic specifications

Supported Battery Types	Li-ion with 3.6 - 3.7V nominal cell voltage
Supported Battery Configurations	10 - 15s*
Supported scooter models	Xiaomi M365, PRO, PRO2, Essential, M187 Ninebot MAX G30, G30P, G30D, G30LP
Maximum possible capacity of an additional battery	No limits
Maximum continuous total discharge current of internal and external batteries, A	30
Maximum continuous total charge current of internal and external batteries, A	5
Self-consumption of battery current, mA	2

\*Installation of above 55V(13s) voltage batteries requires modification of the main scooter controller, as well as the special connection of this adapter. 13s batteries may be used without controller modification and with regular connection of the adapter.

# Functionality

## Operating principle



Rita analyzes voltages of the internal and external batteries, switching their positive power leads so that the charge does not flow from one battery to another, keeping the ability for the controller to consume current from both batteries and recover energy back when braking.

## Available use cases

Due to the fact that Rita has full control over power lines and data exchange lines, it provides a wide choice of use cases:

### 1. Original internal battery + additional external battery

The main case the device was created for. The scooter gets an increase in range, as well as an increase in maximum speed, if the additional battery has a higher voltage. Due to the hot plug feature, there is an opportunity to leave the scooter outside, taking only an external battery for charging.

### 2. Single original internal battery

In this case the external additional battery is not connected, and the scooter is powered by the original internal battery only. This option is useful to go somewhere nearby. Of course, the range and maximum speed are like a scooter out of the box

### 3. Single external battery

This case is suitable, for example, if the original battery is broken. Another feature is that the battery can be taken off to carry the scooter by plane.

### 4. Custom internal battery + additional external battery

This option is very similar to the first one. The difference is that inside is not the original battery, but the custom one, which was installed there to change the broken one, or to increase the capacity / voltage. The thing is there is no need to use a specialized smart bms for this custom battery - in fact, the device performs as a smart bms emulator, in addition to its main function of connecting an extra battery. As in the first case, due to the hot plug feature, there is an opportunity to leave the scooter outside, taking only an external battery for recharging.

### 5. Single custom internal battery

The same as the previous option, but without an external additional battery. Rita operates as a smart bms emulator.

## External battery connection

The additional external battery is connected by only two power wires, without any data lines.

On the one hand, this is convenient because the additional battery may be equipped with the cheapest common port bms.

On the other hand, we don't have information about its current state, for example, the temperature or voltage of each cell group. Therefore just approximate values are displayed instead of this data: cell groups voltage is calculated by simply dividing the total battery voltage by its configuration.

## Current consumption distribution

If the internal and external batteries have different voltage levels, the current will be consumed from the higher voltage battery first, and then, when the voltages are aligned, the current will be consumed from both batteries simultaneously.

## Charge level displaying

When calculating the level of the remaining charge, Rita generally does not consider the capacity and configuration of the extra battery, assuming that only the internal battery is connected. Example:

Additional voltage 12s batteries (and its charge level)	Main Battery Voltage 10s (and its charge level)	Displayed charge
50V(100%)	38V(60%)	100%
45V(70%)	38V(60%)	100%
42V(50%)	38V(60%)	100%
40V(30%)	38V(60%)	80%
38V(10%)	38V(60%)	60%
36V(0%)	36V(50%)	50%
0V(0%)	33V(20%)	20%
0V(0%)	30V(0%)	0%

A very notable moment is highlighted in red: in fact, just over 50% of the total charge of both batteries remains, but the scooter displays 100%. It's not convenient, but you can get used to it. This simplification of functionality is also made to reduce the cost of the device.

## Batteries charging

Rita allows you to charge the external and internal batteries simultaneously through the standard scooter charge port. That is, you don't need a special charging port at the external battery, or take it off for charging. Just plug the charger into the standard port of the scooter and both batteries will be charged.

If the extra battery with increased voltage is used, a new charger with increased voltage is needed. Use the new charger as usual - just plug it into the scooter charge port and the BMS of the internal battery will stop charging when it reaches 42V, while the additional battery will charge to its own voltage.



## WARNING!

**This feature is acceptable for common port BMS equipped external batteries only. “Common port BMS” means just one couple of wires sticking out of the battery, which are used for both charging and discharging, while another type, “Separate port BMS” has a dedicated charging input. If your battery has a dedicated charging input, there is a 90% chance it is a separate port BMS equipped. There also is a little 10% chance that the battery BMS is a common port type and charging and discharging plugs are just paralleled, like we do.**

Separate port BMS equipped batteries can also be charged via Rita and the scooter charging plug, but there is a risk of overcharge, because this separate charge port BMS is not able to interrupt charging on its discharge output. You can leave it as is, and be very careful, understanding that there is a real risk of fire if the battery is disbalanced and some cells groups get overcharged during charging process

Nevertheless it is possible to charge a separate port BMS equipped external battery via it's charging port, not using Rita for distribution charging current from a scooter charge port. In that case you don't use Rita charge plugs at all. You should connect the scooter charging port directly to the original internal battery(as it was connected from a factory), and if you connect it like this the charging current from the scooter charging port will not go to the external battery via its discharge port.

## External battery management during charging

Rita does not measure the external battery voltage and shows its voltage as 0V until the charger is plugged in. So, don't be surprised if you check voltages during charging and see the external battery is “not connected”.

## Recovery current protection

When connecting any battery to a Xiaomi or Ninebot scooter, you have to remember that the scooter not only consumes current from the battery during acceleration, but also recovers energy back when braking. For the correct operation of the recovery system, the battery must provide the following features:

1. Receive the recovery current, which flows from the controller to the battery.
2. If the battery is already fully charged and not able to receive the recovery current, inform the controller to stop the recovery in advance, using the data lines.

If the battery suddenly stops receiving the recovery current without notifying the controller in advance, a strong surge of voltage happens, frying the scooter controller. The problem is the external battery is connected



with only two power wires, and it does not have any data lines to notify the controller in advance that it no longer receives the recovery current. Rita uses 2 subsystems to solve this problem: primary and emergency.

The primary subsystem continuously measures the voltage of the external battery, then divides it by the serial configuration of the battery, calculating the average voltage of cell groups. For example, if the voltage of the external battery is 48 V, and its serial configuration is 12s, then the calculated cell group voltage is approximately  $48/12 = 4$  V. This approximate calculation is quite accurate when using a high-quality balanced battery. After calculating the average parallel voltage, Rita compares it with the BMS charge disable voltage (4.18V). If the calculated average cell group voltage exceeds the BMS charge disable voltage, Rita requires the controller to stop the energy recovery. Therefore the recovery system works correctly and the battery never closes unexpectedly for the controller.

But the main subsystem may fail in case of the battery failure: if cell groups are quite unbalanced. Consider an example: all battery groups have a voltage of 3.6 V, except the one of them, which is 4.2 V. Of course the BMS prohibits charging, but Rita, as usual, measures the battery voltage:  $3.6 * 11 + 4.2 = 43.8$  V, then divides it by 12, calculating the average cell group voltage of  $43.8 / 12 = 3.65$  V, and informs the controller that everything is fine and there is no need to disable the energy recovery. As a result, since the recovery current flows having no path, the voltage of the controller jumps up. Fortunately, this failure is handled by the emergency subsystem.

The emergency subsystem analyzes the voltage at the output of the device, and it detects the main subsystem failure if the voltage exceeds a critical level. First of all the emergency subsystem immediately sends a command to the controller to stop the recovery, but this is not enough: it takes about 100 milliseconds to execute the command, during which the recovery currents have enough time to fry everything. Therefore, all the time, until the command is executed, the emergency subsystem drains excess voltage to a powerful 25-watt resistor, keeping the voltage within safe limits.

When the emergency subsystem is triggered, Rita sets the temperature sensor to -10 degrees, which causes the scooter to start beeping error 39, drawing the attention of the owner to the malfunction.



## ATTENTION!

**Be careful since the electric brake is disabled while the batteries are fully charged. You usually have to ride 500-1000 meters before the electric brake and energy recovery are enabled again, after batteries get discharged a little bit and ready to sink the energy recovery current.**

## Overcurrent protection

Rita maximum allowed continuous discharge current is 30A. If the scooter exceeds the limit, Rita emulates 100°C battery temperature and a low battery level, so the scooter beeps error 39 and loses power for 30 seconds. If you are faced with such behaviour, you should reduce the controller power, setting less amps in the controller firmware.

## Rita overheat protection

If Rita temperature exceeds 90°C, the overheat protection is triggered. It disables charging, disconnects the external battery, and emulates 99°C battery temperature and a low battery level, so the scooter beeps error 39 and loses power. The protection system turns off when the temperature drops to 70°C.

Rita allows watching its temperature by replacing the internal battery temperature by Rita internal temperature divided by 2. But this feature is active when the external battery is presented only. If the scooter is supplied by a single original battery, then true internal battery values will be displayed, and it's impossible to watch the Rita internal temperature.

Don't worry if Rita's temperature rises to 80-85 degrees during a hard climb or charging, this temperature is absolutely comfortable for the semiconductors that Rita is made of.

## Internal battery overvoltage protection during charging

Rita interrupts the internal battery charging if its voltage divided on its serial configuration exceeds 4.2V.

## Emergency internal battery overvoltage protection during charging

In addition to the previous feature, Rita is equipped with another independent charging disabling subsystem, which stops both batteries' charging process if the internal battery voltage divided on its serial configuration exceeds 43V. Rita emulates the internal battery overheating if the protection is triggered, so the scooter beeps error 39.

## Emergency hardware internal battery overvoltage protection

Rita is equipped with another independent hardware subsystem, which disconnects the external battery and disables charging, if the internal battery voltage exceeds 43.7V. The subsystem can be disabled by the green jumper cutting.

## External battery overvoltage protection

Rita does not provide any external battery protection features. Rita distributes charging current directly to the external battery discharge plug, so the charger must have proper voltage and the external battery must be equipped with a proper BMS which is able to protect it from overcharge. Generally it must be a "common port BMS", which means just one couple of wires sticking out of the battery, which are used for both charging and discharging. See more information in the ["Batteries charging"](#) section.

## Anti-error 24 feature

The scooter controller beeps the error 24 if it detects voltage over 43V - this is a factory feature of Xiaomi/Ninebot scooters. So usually you have to flash the scooter with a custom firmware to disable this error when using a higher voltage battery.

Rita provides a workaround of this problem, allowing users to avoid scooter flashing. The workaround is based on the fact that the controller checks the voltage just once during its switching on, so Rita keeps an

external battery disconnected until the scooter is switched on, and connects it only when the scooter is switched on.

Of course this feature does not work if you use a single external battery.

## Using 10s+ internal batteries

You must cut the green Rita jumper to use a custom 10s+ internal battery. Otherwise the emergency hardware internal battery overvoltage protection will get triggered and you will not be able to charge the battery over 43.7V.

## Using 13s+ internal or external batteries

The main controller withstands a continuous supply voltage up to 55 V, as well as short voltage surges up to 60 V.

Therefore, the recovery current protection subsystem mentioned above is configured by default to a threshold of 57 V. This guarantees that if the recovery system fails, the voltage on the controller does not exceed the critical level and it will not be damaged.

However, fully charged 15s batteries have a voltage of 63 V, so if you connect such a battery, Rita decides that the recovery has failed, and tries to reduce the voltage to 57 V. It leads to almost instantaneous overheating and explosion, because the built-in resistor is designed only for short-time absorption of recovery currents that last no longer than 100 milliseconds.

Especially for those users who have modified their controller for higher voltages, Rita allows you to raise the emergency protection threshold from 57 V to 67 V. To do this, cut off the red wire-jumper located next to the LED indicator. After this, the use of 15s batteries becomes available, but it is forbidden to use a controller that is not modified for increased voltage, because in case of a failure during the recovery, the protection will be activated too late for it.

Changing the emergency protection threshold is specially made as an inconvenient cutting of the wire so that the user thinks carefully before doing this, and not thoughtlessly changes the settings on the smartphone screen.

Do not forget this:



## ATTENTION!

**Installation of more than 55V(13s) batteries requires modification of the main scooter controller, as well as the special connection of Rita adapter. 13s batteries may be used without controller modification and with regular connection of the adapter.**

# Installation

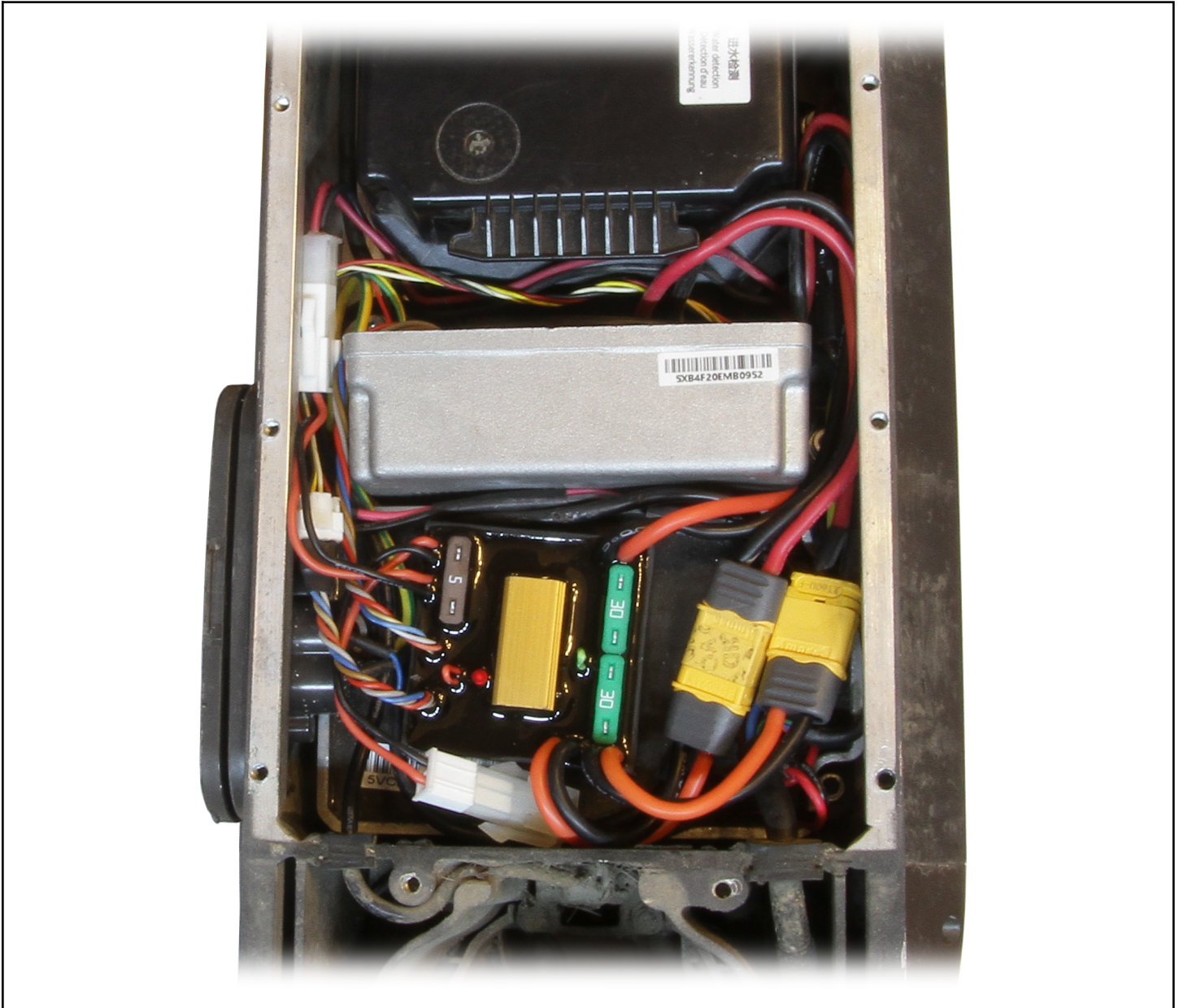
## Xiaomi



1. Disconnect the internal battery: power output, charging input, data line.
2. Take out the external battery plug.
3. Connect the charging port of the scooter to the adapter.
4. Connect the power output of the internal battery to the adapter.
5. Connect the charging input of the internal battery to the adapter.
6. Connect the internal battery communication connector to the adapter.
7. Connect the adapter data connector to the scooter controller.
8. Connect the power output of the adapter to the scooter controller.



## Ninebot MAX



### Wiring sequence

1. Disconnect the internal battery: power output, charging input, data line.
2. Take out the external battery plug.
3. Connect the charging port of the scooter to the adapter.
4. Connect the power output of the internal battery to the adapter.
5. Connect the charging input of the internal battery to the adapter.
6. Connect the internal battery communication connector to the adapter.
7. Connect the adapter data connector to the scooter controller.
8. Connect the power output of the adapter to the scooter controller.

## Installation process video tutorial

[Xiaomi M365/PRO/1S extra battery  
installation tutorial](#)

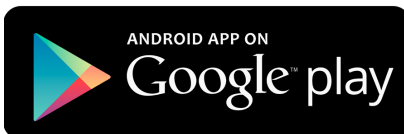


## Setting up the device

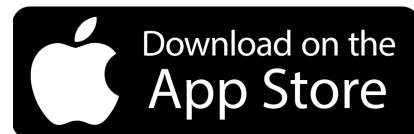
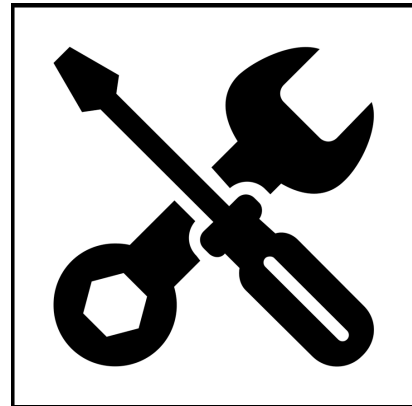
Please, use the “M365 BMS Tool” application to configure the device:



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[Download for iPhone](#)





## Parameters description

<b><i>Parameter</i></b>	<b><i>Description</i></b>
Internal battery capacity, mAh	Internal battery capacity. This value is really does not affect anything and just displayed in applications
External battery capacity, mAh	External battery capacity. This value is really does not affect anything and just displayed in applications
Internal battery configuration	Additional battery configuration. Very important parameter, used for charging level calculation and by the recovery current protection subsystem.
External battery configuration	Additional battery configuration. Very important parameter, used for charging level calculation and by the recovery current protection subsystem.

## Default parameter values

<b><i>Parameter</i></b>	<b><i>Default value</i></b>
Internal battery capacity, mAh	29000
External battery capacity, mAh	29000
Internal battery configuration	10
External battery configuration	10

## Troubleshooting

**Problem:**

I see the temperature icon at the scooter dashboard. The electronic brake does not work. The scooter beeps when I press the brake lever.

**Solution:**

Don't worry, this is a normal behaviour. Rita emulates low battery temperature when your batteries are fully charged to let the controller stop energy recovery, because fully charged batteries are not able to receive the recovery current. The problem will disappear after you ride the first 500-1000 meters and the battery' voltages drop a little bit. If the problem does not disappear, please check if parameters "Internal battery configuration" and "External battery configuration" are set correctly.

**Problem:**

The scooter beeps the error 39, loses power and displays a low charge level when I try to accelerate

**Solution:**

It looks like you exceed the 30A power limit and the overcurrent protection system is triggered. Please set less power in your scooter controller firmware.

## Rita generations overview

	Gen 1	Gen 2	Gen 3*	Gen 4	Gen 5
Manufacture dates	Jun 20 - Feb 21	Mar 21 - May 21	Jun 21 - Jul 21	Aug 21 - Nov 21	Dec 21 - ...
How to recognize	Internal fuses. There is no visual difference between gen 1 and gen 2. A smartphone app connection is required.	Internal fuses. There is no visual difference between gen 1 and gen 2. A smartphone app connection is required.	External 40A fuses	External 30A fuse without a sticker at the bottom side, or a sticker with the information at the bottom side	Sticker with the information at the bottom side
Supported scooters	Xiaomi	Xiaomi		Xiaomi	Xiaomi/Ninebot
Current measurement**	No	Yes		Yes	Yes
Charge control***	No	No		Yes	Yes
Rita overheat protection	No	No		No	Yes
Rita overcurrent protection	No	No		Yes	Yes
External battery wire	16AWG	16AWG		14AWG	14AWG
External battery plug	XT30	XT30		XT60	XT60

\*All 3rd generation devices are defective. They were recalled and replaced under warranty. Do not use a 3rd generation device, because it may damage your scooter.

\*\*All 2nd generation devices measure current with an error of about 30%. Some 4th generation devices measure current with an error when current exceeds 20A: for example it shows 25A instead of 30A.

\*\*\*1st and 2nd Rita generations are not able to interrupt batteries' charging process. They fully rely on the batteries' BMS for that purpose. The 4th Rita generation is equipped with a software internal battery overcharge protection subsystem, which analyzes the internal battery voltage and can disable its charging or even disable both batteries charging at all. In addition to that, the 5th Rita generation is also equipped with an independent hardware internal battery overcharge protection.

## Warranty and technical support

The warranty period is valid for 1 year from the date of the original purchase.

If you did not find the answer to your question after reading this manual, please, feel free to ask your questions in the special telegram group:

[Xiaomi M365/PRO/1S custom electronics](#)  
[by Denis Yurev](#)

