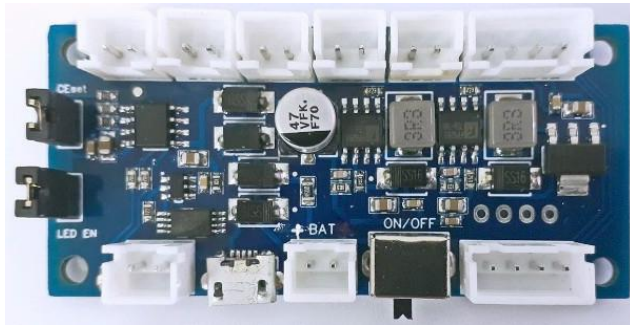


The PS4IoT Smart Power Module



Purpose and compatibility

PS4IoT is an uninterruptible power supply module with battery charging and protection, for building smart devices with power paths' redundancy, with 3.0 to 6 volts and 3V3, 5V or 12V output voltages, with a total power up to 5 watts.

The module is designed for use in electronic devices based on any microcontroller platform, such as ESP8266, ESP32, Arduino, STM32 and derivative boards (ESP12.OLED, NodeMCU, etc.) as an autonomous or software-controlled power supply unit.

Features

- Start from AC/DC adapter when the battery is deeply discharged;
- Start from AC/DC adapter when there is no battery;
- Automatic battery charging and simultaneous use of the device;
- Possibility to replace the battery without interrupting power from the AC/DC adapter;
- When powered by the AC/DC adapter, the battery is not connected to the load, which saves the number of charge-discharge cycles (prolongs battery life).

Capabilities of the module with basic settings

This tiny module may surprise you with many important and interesting functions. PS4IoT_V1 with basic settings provides:

- Automatic online switching "battery-mains" and vice versa, without interruption of output voltage generation (12V, 5V, 3V3) of loads;
- Automatically switches to AC/DC adapter 5V when the battery is disconnected without interrupting power to the loads;
- Automatic battery charge/discharge control; Default charge current is set to 0.5 A. The state of the battery charging process is displayed by two LED indicators.

Module application profiles

The module can provide the following profiles for autonomous and controlled use as part of a smart device:

- a battery-free device powered only by an AC/DC 5V adapter;
- a device powered by Li-Ion battery and AC/DC adapter 5V
- a device with rechargeable Li-Ion battery only;
- a device with fault-tolerant redundancy of 3 power supply paths.

The table of contents

The PS4IoT Smart Power Module	1
Purpose and compatibility	1
Features	1
Capabilities of the module with basic settings	1
Module application profiles	1
The table of contents	2
Smart power supply module formula	4
Module functions	4
Battery protection and safety functions	5
Module block diagram	6
Software monitoring of Li-Ion battery charging status	7
The interfaces are located on one side of the module	7
Cautions	7
Delivery sets	8
Set #1 - module only (Basic)	8
Set #2 - module with connectors and cables (Basic + Connectors (installed) and cables)	8
Option for Set #2 - interface cables AUX (Basic + Connectors (installed) and cables + AUX)	8
Technical information	9
Terms and abbreviations	9
Interface description (ports and pins)	9
USB Interface - power supply input 1 (PS1)	10
Connector type:	10
Pins:	10
Note:	11
X1 Solar Panel Interface - power supply input 1 (PS1)	11
Connector type:	11
Pins:	11
Note:	11
X8 Bat Interface - power supply input 3 (PS3)	11
Connector type:	11
Pins:	11
Note:	11
X6 & X7 Interface - aux spare interface	11
Connector type:	12
X1 Pins:	12
X8 Pins:	12
Note:	12
X5 Interface - battery voltage level output	12
Connector type:	12
Pins:	12
Note:	12
X4 Interface - 3V3 power output to the load	12

Connector type:	12
Pins:	12
Note:	13
X3 Interface - 5V power output to the load	13
Connector type:	13
Pins:	13
Note:	13
X2 Interface - 12V power output to the load	13
Connector type:	13
Pins:	13
Note:	13
X9 Interface - CP & CC status outputs	13
Connector type:	14
Pins:	14
Note:	14
J1 Interface - CEset charge enable control jumper or input	14
Connector type:	14
Pins:	14
Note:	14
J2 Interface - LED_EN control jumper	14
Connector type:	15
Pins:	15
Note:	15
Truth table	15
A high-level algorithm	17
Battery voltage levels	18
Mechanical characteristics	19
Module testing	20
PS4IoT module test bed	21
Connecting the PS4IoT module in ESP8266 / ESP32 managed mode to Home Assistant using the ESPHome plug-in	22
General guidelines for software module scripting	23
Links	24
Document version history	25
From the manufacturer	25

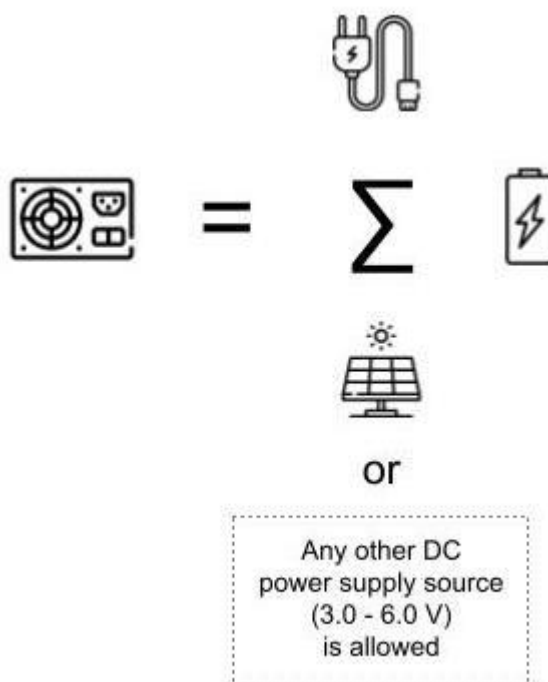
Smart power supply module formula

Online Uninterruptible Power Supply Unit module

- With automatic charger and selectable power source;
- Intelligent and connected;
- With power source redundancy layout;
- Fully autonomous or sufficiently managed;

- With or without a battery;
- For pockets or stationary;
- With simultaneous charging and power supply of load;
- Indoor or outdoor;
- In inexpensive and miniature design;

- Best suited for smart devices and IoT;



As you can see from our "formula", you can simultaneously power one or more payloads, connect a controller with any functionality to the module according to your design idea - in other words, you can create the most demanding portable and stationary devices using the PS4IoT_V1 module. This module is a versatile component that will provide reliable power, observability and controllability for your DIY or even commercial product.

PS4IoT acts as an intelligent intermediary between the load and all available power sources.

This power supply automatically protects the device and the battery, providing consumers with the ease and simplicity of using the end device in a way that is only found in high-quality and high-tech smartphones.

Module functions

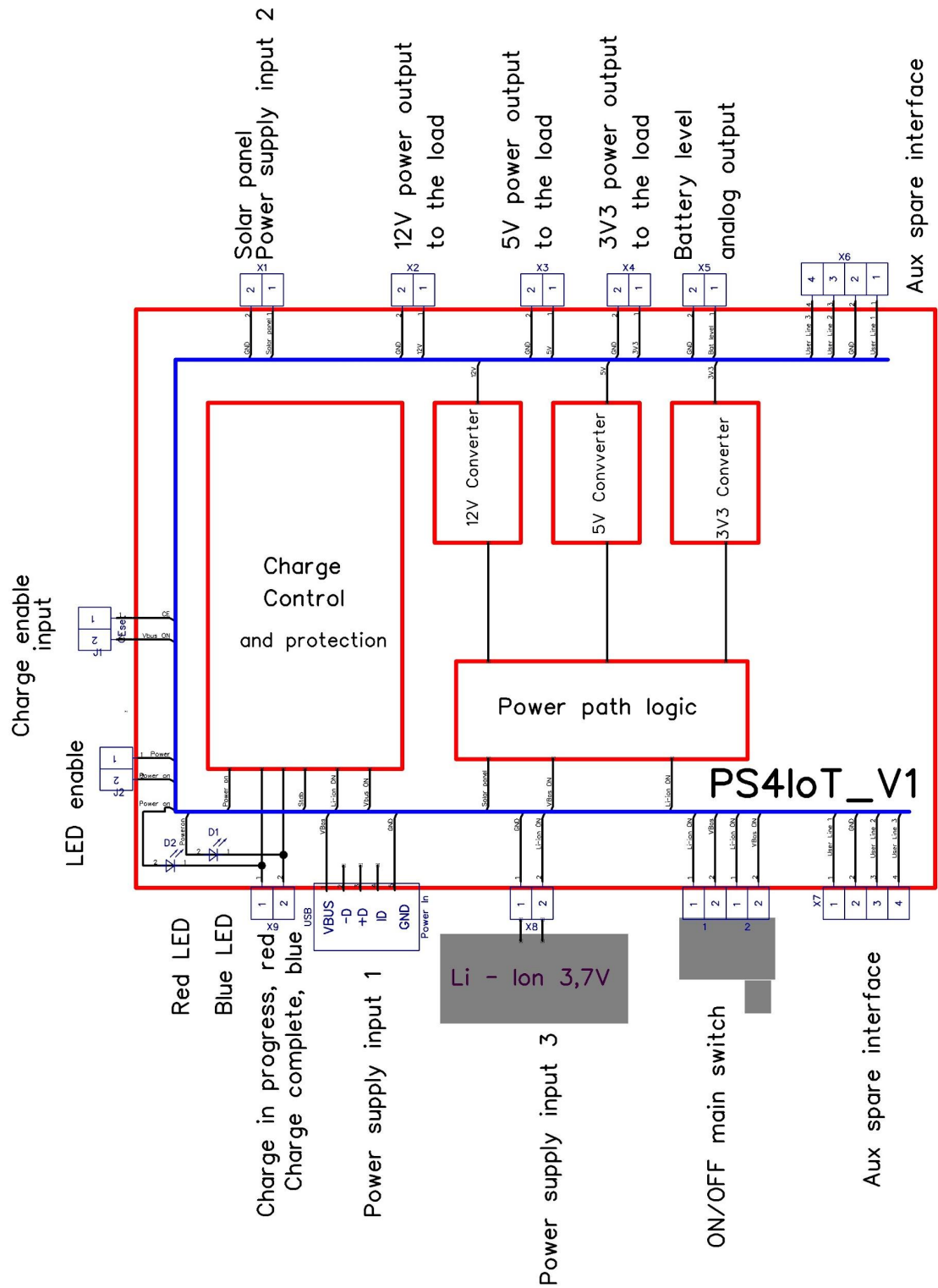
	Automatic mode	Managed by MCU mode
Battery-free operation	Yes, auto	Yes, auto
Starting with a deeply discharged battery	Yes, auto	Yes, auto
Simultaneous battery charging and power supply of loads	Yes, auto	Yes, auto
Automatic battery charging	Yes, auto	Yes, auto. Or by means of the controller via CEset

Choice of power supply paths	Yes, auto	Yes, auto
Battery charging enable and disable control	Yes, with a jumper	Yes, by means of the controller via CEset
Disabling the built-in status indicators	Yes, with a jumper	Caution! It is forbidden to switch on the status LEDs in managed by MCU mode
Electronic main switch	Mechanical, manual only	Mechanical, manual only
External power failure detection	Yes, with built-in indicators	Yes, by means of the controller using the status signals CC, CP, CEset.1

Battery protection and safety functions

	Automatic mode	Managed by MCU mode
Battery overheating protection	No	Possible by controller means via an optional I2C, NTC or 1-Wire battery thermometer using the 4-pin AUX pass-through interface.
Deep discharge protection	Yes, auto when below 2.3V	Yes, auto. Or by monitoring the battery voltage level via the ADC of the controller and switching to deep sleep mode.
Battery overcharge protection	Yes, auto when exceeding 4.2V	Yes, auto. Or controlled by the controller
Battery charge termination	Yes, auto	Yes, auto. Or controlled by the controller
Temperature compensation feedback of the charging current regulator	Yes, auto	Yes, auto

Module block diagram



Software monitoring of Li-Ion battery charging status

PS4IoT_V1 has a number of signal lines that allow the main controller to monitor the charging process status, temperature and battery voltage programmatically.

For example, if a mismatch is detected, such as exceeding the charging time or battery temperature, the controller can programmatically stop or restore the charging process.

In addition, these mechanisms in combination with the sleep mode are reasonable to use in the charge/discharge control software algorithm to extend battery life.

Note. The PS4IoT_V1 version of the module does not support connecting an NTC battery thermistor directly to the charging controller. Therefore, temperature monitoring can be implemented by connecting an additional temperature sensor to the main controller using I2C bus or other interface such as 1-Wire, SPI, NTC-thermistor, etc. Thus, through the Charge Enable signal (see CEset.2) the controller can prohibit or allow charging depending on the battery temperature.

The interfaces are located on one side of the module

It is recommended to design the case of the device where you plan to install PS4IoT_V1 so that the bottom edge of the PS4IoT module board touches one of the outer sides of the case, as shown in the pictures.

In that case

- Charge control LED;
- Power supply input 1 (μUSB);
- ON/OFF main switch;
- Aux spare interface - the connector for external devices;

can be used to organize a convenient interface to control the entire device through the user-provided mounting holes in the housing.

Cautions

Attention! Use quality batteries to obtain the declared technical characteristics of the product.

Attention! Use quality AC/DC adapters with appropriate cables capable of withstanding 5 volts with a load of up to 2 amps.

Attention! Maximum permissible load current:

- to the output 12V - 150 mA;
- to the output 5V - 1A;
- to the output 3.3V - 1A.

! The maximum total load on the charger and outputs is up to 5 Watts.

Delivery sets

Set #1 - module only (Basic)

1. PS4IoT_V1 module - 1 pc;
2. Jumper on the board - 2 pcs;
3. Pin connector 2.54 2P M, straight, included - 7 pcs;
4. Pin connector 2.54 4P M, straight, included - 3 pcs;

Set #2 - module with connectors and cables (Basic + Connectors (installed) and cables)

1. PS4IoT_V1 module - 1 pc;
 2. Jumper on the board - 2 pcs;
 3. Battery cable, flat, 15 cm, 2 wires, with connectors - 1 pc:
 - a. 2P JST XH2.54 F - Dupont 2x1P F.
 4. Power output cable, flat, 20 cm, 2 wires, with connectors - 2 pcs:
 - a. 2P JST XH2.54 F - Dupont 2x1P F.
 5. Charging status output cable CP&CC, flat, 20 cm, 2 wires, with connectors - 1 pc:
 - a. 2P JST XH2.54 F - Dupont 2x1P F.
 6. Battery level output cable, flat, 20 cm, 2 wires, with connectors - 1 pc.
 - a. 2P JST XH2.54 F - Dupont 2x1P F.
 7. JST XH 2.54 2P M connector, straight, on the board - 7 pcs;
 8. Pin connector 2.54 mm 4P M, straight, on the board - 1 pc;
 9. JST XH 2.54 4P M connector, angled, on the board - 1 pc;
 10. JST XH 2.54 4P M connector, straight, on the board - 1 pc;
- Note: In this version, these connectors are soldered to the board and are ready to use with the appropriate cables.

Option for Set #2 - interface cables AUX (Basic + Connectors (installed) and cables + AUX)

11. Internal interface cable, flat, 15 cm, 4 wires, with connectors - 1 pc.
 - a. 4P JST XH2.54 - Dupont 4x1P.
12. External interface cable, flat, 30 cm, 4 wires, with connectors - 1 pc.
 - a. 4P JST XH2.54 - Dupont 4x1P.

Attention. AC/DC adapter(s), battery pack, solar panel and temperature sensor are not included.

Technical information

Terms and abbreviations

- CP - Charge in Progress
- CC - Charge Complete
- CE - Charge Enable
- PS - Power Supply
- AUX - Auxiliary
- MCU - Main Computing Unit
- LED - Light Emitting Diode
- I2C - Inter-Integrated Circuit Bus
- BAT - Li-Ion Rechargeable Battery
- EN - Enable
- AC - Alternating Current
- DC - Direct Current

Interface description (ports and pins)

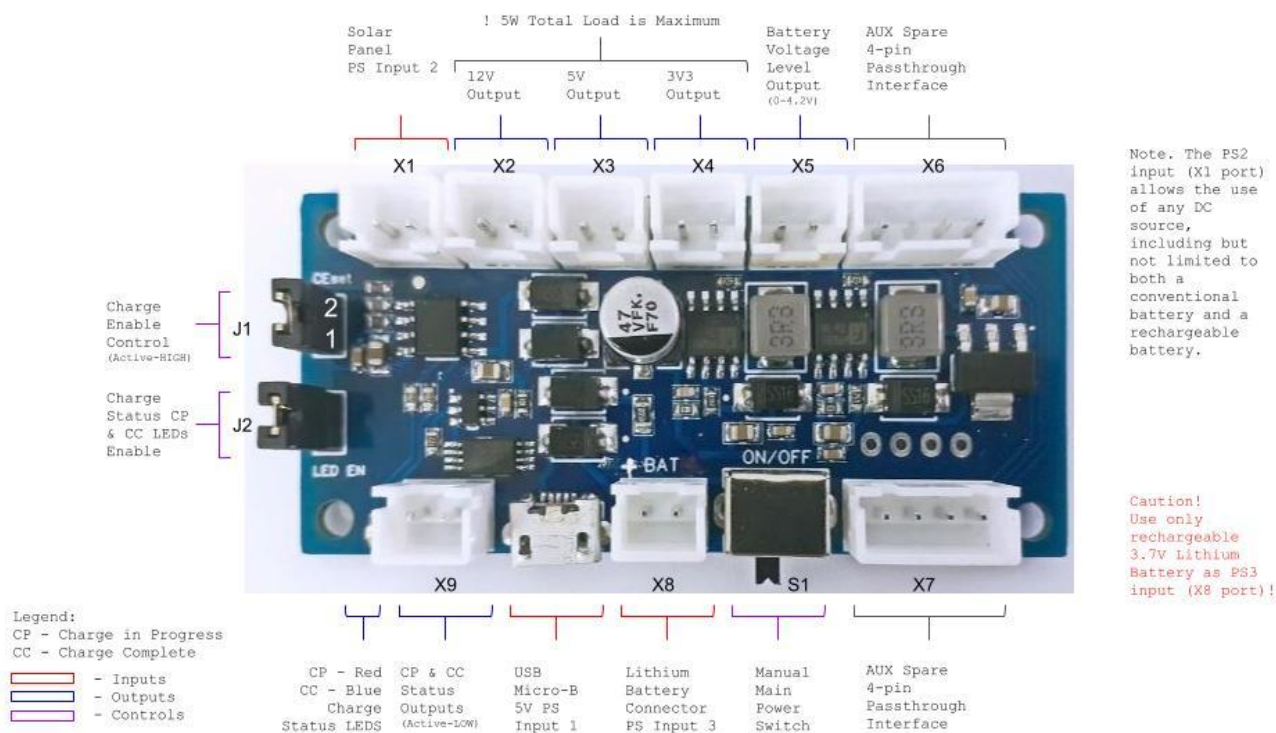


Fig. Description of interfaces

Type	Symbol	Alias	Logic	Name	Comment
Input	-	PS1	-	USB Micro-B 5V PS Input 1	PS1 and PS2 are also known as an external power sources
Input	X1	PS2	-	Solar Panel PS Input 2	Note. The PS2 input (X1 port) allows the use of any DC source, including but not limited to both a conventional battery and a rechargeable battery.
Input	X8	BAT / PS3	-	Battery PS Input 3	Caution! Use rechargeable 3.7V Lithium Battery as PS3 input (X8 port) Only PS3 is considered as an internal power source
Control	S1	-	Mechanical	Manual Main Power Switch	Completely turns on/off the entire device
Control input	J1.2	CEset.2	Active-HIGH	Charge Enable Control Input	Set J1.[2-1] jumper in automatic mode. Or use only J1.2 pin as CE input in managed by MCU mode
Output	J1.1	CEset.1	Active-HIGH	External Power Supply Blackout Detector - 5V output.	Caution! 5V logic. In managed mode, use the right logic level converter on the MCU side. In automatic mode, set jumper J1.[2-1].
Control	J2	LED_EN	-	CP & CC LEDs Enable Jumper.	Caution! Must be switched off in managed by MCU mode. Can be set in automatic mode. Use only as a jumper
Outputs	X4	3V3	-	3V3 Load Output	Caution! The total maximum load is 5 watts, including the load on the lithium-ion battery charger
Outputs	X3	5V	-	5V Load Output	
Outputs	X2	12V	-	12V Load Output	
Outputs	X9.1	CP	Active-LOW	Charge in Progress status output	Use 10K Ohm Pull-Up externally to 3V3 at the MCU side when in managed mode
Outputs	X9.2	CC	Active-LOW	Charge Complete status output	Use 10K Ohm Pull-Up externally to 3V3 at the MCU side when in managed mode
Indicator	-	CP Red LED	Active-LOW	Charge in Progress status Red LED	Usefull when in automatic (autonomous) mode
Indicator	-	CC Blue LED	Active-LOW	Charge Complete status Blue LED	Usefull when in automatic (autonomous) mode
Outputs	X5.1		-	Battery Voltage Level Output (0-4.2V)	Always detect a battery presence with CEset=disabled
Spare	X6	AUX	-	AUX Spare 4-pin Passthrough Interface	May be used for I2C or other tasks
Spare	X7	AUX	-	AUX Spare 4-pin Passthrough Interface	May be used for I2C or other tasks

Fig. Detailed interface table

USB Interface - power supply input 1 (PS1)

Used to connect the AC/DC adapter while charging and/or powering the device.

Connector type:

µUSB (USB Micro-B), factory-made

Pins:

- 1 +5V input
- 2 NC
- 3 NC
- 4 NC
- 5 GND

Note:

AC/DC adapter is not included.

X1 Solar Panel Interface - power supply input 1 (PS1)

Used to connect an external DC backup source (solar panel, DC adapter, non-rechargeable battery).

Connector type:

holes in the module with a pitch of 2.54 mm

Pins:

1 PS1 input

2 GND

Note:

At the customer's options, the kit can include:

- The JST XH 2P 2.5 Male connector, soldered to the module board.

By default:

- 2.54 mm pin-type connectors for board mounting, included;
- DC adapter or solar panel is not included.

X8 Bat Interface - power supply input 3 (PS3)

Used to connect the Li-Ion battery when using a rechargeable battery as part of the device.

Connector type:

holes in the module with a pitch of 2.54 mm

Pins:

1 GND Bat-

2 Bat+

Note:

At the customer's option, the kit can include:

- A 15 cm long cable with JST XH 2P 2.54mm Female connectors;
- JST XH 2P 2.54mm Male connectors soldered to the module board.

By default:

- 2.54 mm pin-type connectors for board mounting, included;
- The rechargeable Li-Ion battery **is not included**.

X6 & X7 Interface - aux spare interface

The X6 and X7 connectors are useful when you want to connect an external device (for example, an I2C digital thermometer, etc.).

X6 and X7 have a through joint, which is useful for organizing a bus type topology (e.g. I2C bus). It is convenient to connect the internal communication interface with the controller module inside the device housing to X6 and an external device or expansion module/sensor to X7.

Connector type:

holes in the module with a pitch of 2.54 mm

X1 Pins:

- 1 Line 1
- 2 GND
- 3 Line 2
- 4 Line 3

X8 Pins:

- 1 Line 1
- 2 GND
- 3 Line 2
- 4 Line 3

Note:

-

X5 Interface - battery voltage level output

Battery output after the On/Off switch. It is recommended to use as analog output for battery voltage level measurement by means of the main controller.

Connector type:

holes in the module with a pitch of 2.54 mm

Pins:

- 1 Bat level
- 2 GND

Note:

-

X4 Interface - 3V3 power output to the load

Power supply load output.

Connector type:

holes in the module with a pitch of 2.54 mm

Pins:

1 3V3 output
2 GND

Note:

-

X3 Interface - 5V power output to the load

Power supply load output.

Connector type:

holes in the module with a pitch of 2.54 mm

Pins:

1 5V output
2 GND

Note:

-

X2 Interface - 12V power output to the load

Power supply load output.

Connector type:

holes in the module with a pitch of 2.54 mm

Pins:

1 12V output
2 GND

Note:

-

X9 Interface - CP & CC status outputs

It makes sense to mount the X9 interface connector in cases when it is necessary to monitor the charge/discharge process programmatically.

CP Signal - Charge in progress, active-low output.

When the battery is discharged, charging begins. A low level is generated until charging is complete. During the charging process the red LED lights up and goes out when it stops.

CC Signal - Charge complete, active-low output.

If the output level is low - the battery is charged successfully, the blue LED indicator turns on.

When charging is prohibited, the LED signals go off immediately, the CC and CP outputs reproduce the charging status and transmit to the controller.

Note that when connecting the CP and CC charging status outputs to the controller, jumper J2 MUST be removed.

Connector type:

holes in the module with a pitch of 2.54 mm

Pins:

1 CP (Charge) - Charge in progress

2 CC (Stdb) - Charge complete

Note:

Details: <https://datasheetspdf.com/pdf/1309136/FUMANELECTRONICS/TC4056A/1>

J1 Interface - CEset charge enable control jumper or input

Jumper or connector to enable/disable battery charging.

For automatic program control, remove the jumper and supply a low logic level to CEset.2 pin from the controller to stop charging forcibly or a high level (3.3 or 5 volts) to allow charging.

Connector type:

holes in the module with a pitch of 2.54 mm, factory-made

Pins:

1 Vbus on, 5V Logic. Can be used as a detector of power presence/absence of external sources PS1 or PS2. If there is at least one external source, J1.1 will be high.

Caution! Pin J1.1 Vbus has 5V logic, so use an appropriate voltage level converter if you need to connect this pin to the GPIO controller input with a different logic level.

2 CEset (Charge enable)

Note:

The module comes with a jumper installed (charging enabled) that supplies a high level to pin J1.2 CEset from pin J1.1 Vbus.

J2 Interface - LED_EN control jumper

Jumper for enabling / disabling the operation of LED indicators on the module board.

To disable the LEDs, remove the jumper.

In stand-alone mode (i.e. without being controller managed) the jumper can be removed or set as desired.

Caution!

PS4IoT_V1

Do not set jumper J2 in controller managed mode (when outputs X9.1 and X9.2 are connected to the controller)!

Use pins of J2 only as a jumper.

Connector type:

holes in the module with a pitch of 2.54 mm, factory-made

Pins:

1 5V

2 LED

Note:

The module comes with a jumper installed (LEDs are enabled)

Truth table

PS4IoT_V1 Module Side	Main Power Switch	External Power Supplied	Battery Power Supplied	Charge Enable	Charge in Progress	Charge Complete	External Power Supply Detector	Battery Voltage Level	3V3 Load Output	5V Load Output	12V Load Output
	Control	Input	Input	Control	Output	Output	Output ! 5V Logic	Output	Output	Output	Output
Switched OFF	OFF	TRUE	TRUE	TRUE	FALSE	FALSE		0-4.2V +-1.5%	0V	0V	0V
Powering from PS1 or PS2; Battery is disconnected; CEset disabled at startup;	ON	TRUE	FALSE	FALSE	FALSE	FALSE	FALSE	0V	3V3	5V	12V
Powering from PS3 (battery); Battery is discharging; CEset disabled at startup; PS1 and PS2 disconnected;	ON	FALSE	TRUE	FALSE	FALSE	FALSE	FALSE	2.3-4.2V +-1.5%	3V3	5V	12V
Powering from PS1 or PS2; CEset enabled; Battery is charging;	ON	TRUE	TRUE	TRUE	TRUE	FALSE	TRUE	2.3-4.2V +-1.5%	3V3	5V	12V
Powering from PS1 or PS2; CEset enabled; Battery charge is completed;	ON	TRUE	TRUE	TRUE	FALSE	TRUE	TRUE	4.2V +-1.5%	3V3	5V	12V
Powering from PS1 or PS2; CEset disabled; Battery is floating;	ON	TRUE	TRUE	FALSE	FALSE	FALSE	TRUE	2.3-4.2V +-1.5%	3V3	5V	12V
Powering from PS1 or PS2; Battery is disconnected; CEset is enabled;	ON	TRUE	FALSE	TRUE	BLINKING <small>Bat Preconditioning</small>	BLINKING <small>Bat Preconditioning</small>	TRUE	near 4.1V	3V3	5V	12V
Managing MCU Side	-	-	-	Output Active-HIGH	Input Active-LOW use 10K Ohm Pull-Up	Input Active-LOW use 10K Ohm Pull-Up	Input Active-HIGH use right level convertor	Input, Voltage use right divider	-	Power Input	-
	-	-	-	GPIO	GPIO	GPIO	GPIO	ADC	-	Vin	-

Fig. PS4IoT_V1 module truth table

A high-level algorithm

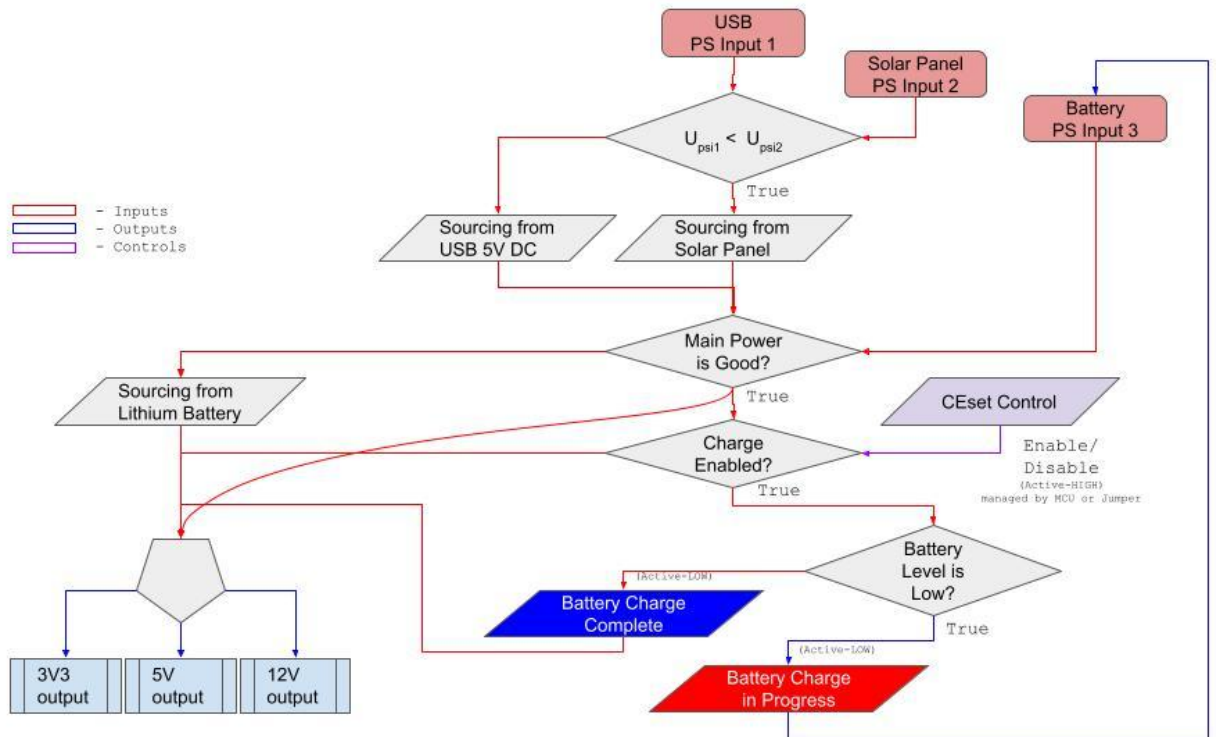


Fig.High-level algorithm of the PS4IoT_V1 module

Battery voltage levels

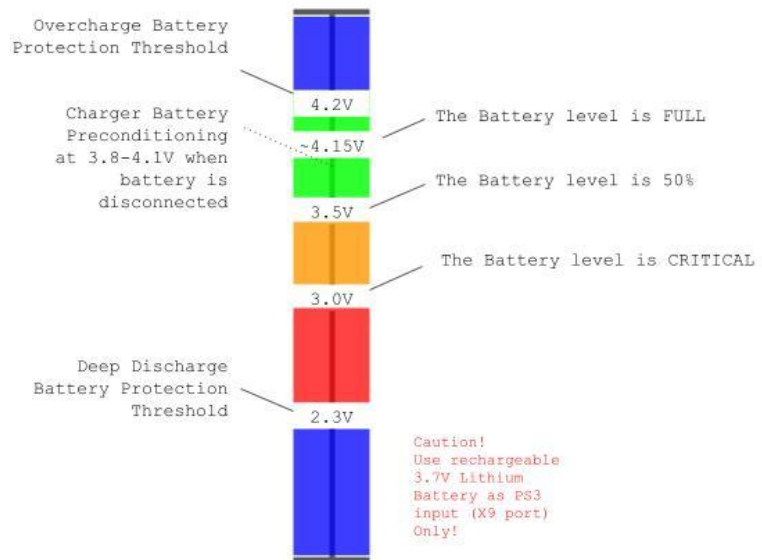


Fig. PS3 Input Battery Voltage Levels

Mechanical characteristics

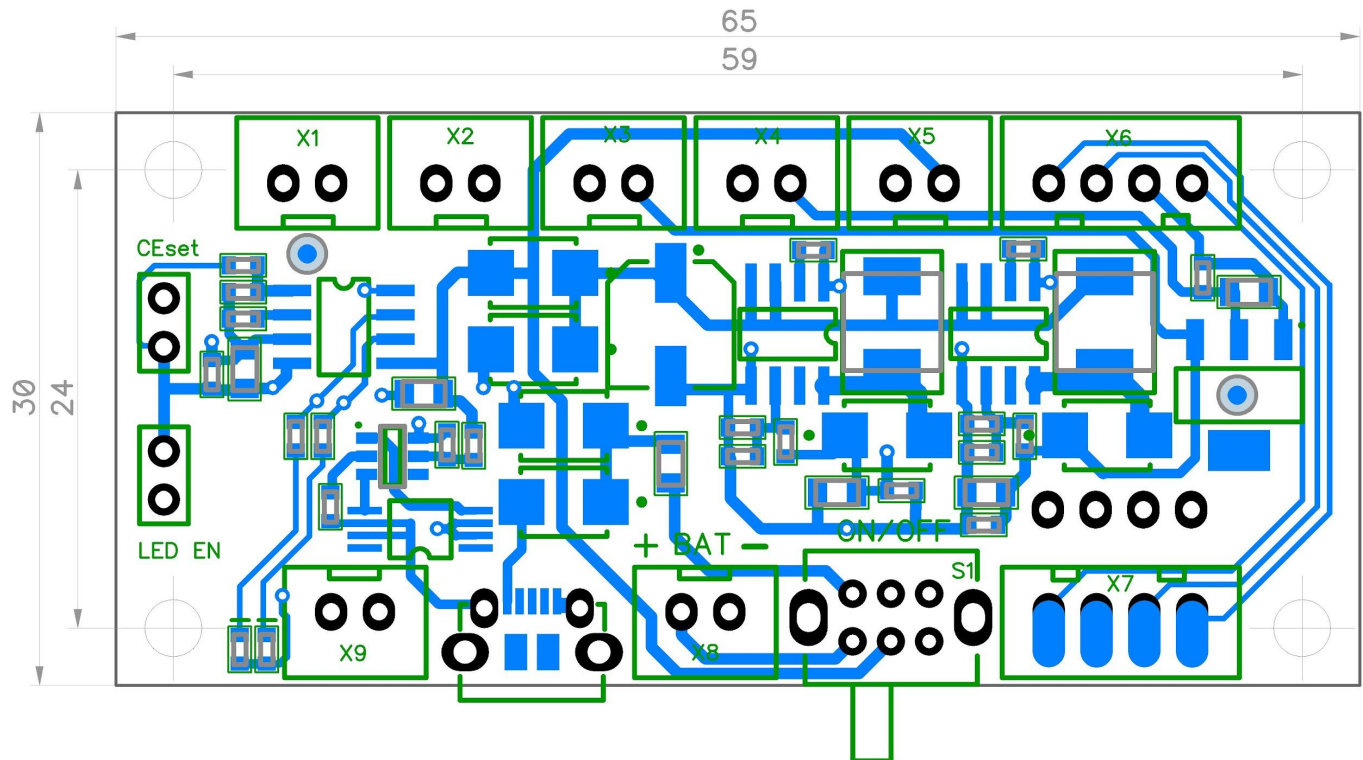
Module linear dimensions:

X: 65mm

Y: 30mm

Z: 13mm (with jumper installed)

Distance between the centers of the mounting holes: 59 mm x 24 mm



Module testing

The module has been tested for/to:

- power consumption at different voltage inputs without output loads;
- power consumption at different voltage inputs;
- automatic back-up power input between three sources S1, S, S3;
- Пуск пристрою із забороненою зарядкою, без батареї від зовнішніх джерел PS1, PS2;
- start the device with charger disabled, without a battery, from PS1, PS2 external sources;
- battery overcharge protection;
- battery deep discharge protection;
- start without a battery;
- start with an over-discharged battery;
- replacement the battery without interrupting power to the loads;
- load connection to 3V3, 5V, 12V outputs;
- control on/off charging with CEset;
- Довготривале знаходження пристрою у станах CC, CP, Discharge;
- a long time (continuous tests) in CC, CP, Discharge logic states;
- PS1 and PS2 power supply loss detection;
- measure the logic levels of CP (Charge) and CC (Stdb) output signals;

and others

Also see additional slides about testing the module in the EN-PS4IoT_V1 Quick Facts Sheet document.

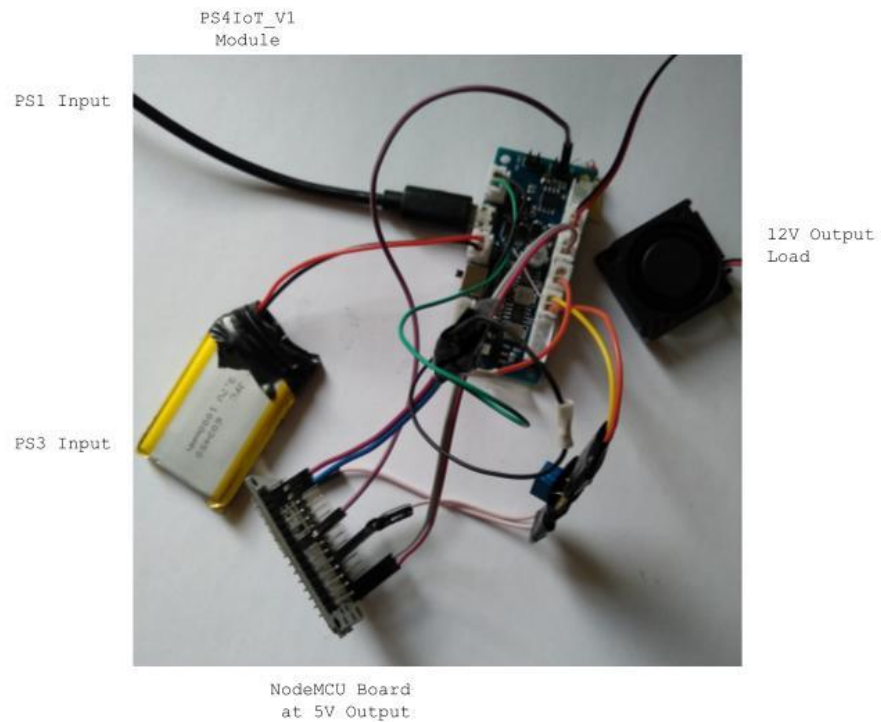


Fig. Hardware of the test bed

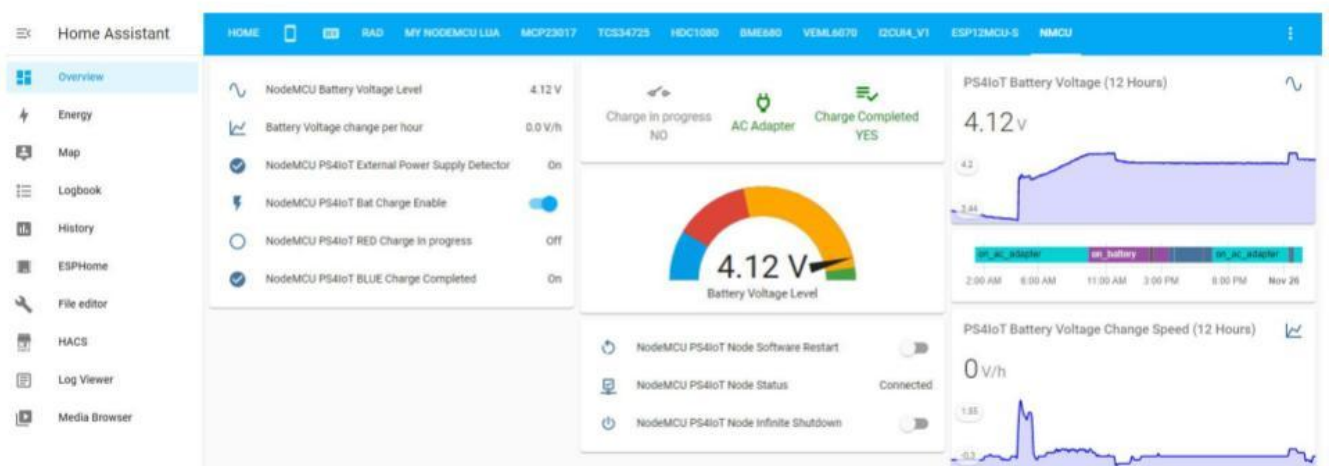


Fig. Software of the test bed

Connecting the PS4IoT module in ESP8266 / ESP32 managed mode to Home Assistant using the ESPHome plug-in

To enable the module in its full capacity, you need to create a yaml configuration script in ESPHome. The configuration must include the following entities:

```
sensor.nodemcu_battery_voltage_level
sensor.battery_voltage_change_per_hour
binary_sensor.nodemcu_ps4iot_external_power_supply_detector
switch.nodemcu_ps4iot_bat_charge_enable
binary_sensor.nodemcu_ps4iot_red_charge_in_progress
binary_sensor.nodemcu_ps4iot_blue_charge_completed
```

To properly add them to the configuration, the following inserts must be made in the yaml script of the ESP8266/ESP32 device:

switch:

- platform: gpio
pin: D5
name: "NodeMCU PS4IoT Bat Charge Enable"
restore_mode: RESTORE_DEFAULT_ON

- platform: shutdown
name: "NodeMCU PS4IoT Node Infinite Shutdown"
- platform: restart
name: "NodeMCU PS4IoT Node Software Restart"

binary_sensor:

- platform: gpio
name: "NodeMCU PS4IoT RED Charge In progress"
pin:
number: D1
inverted: true

- platform: gpio
name: "NodeMCU PS4IoT BLUE Charge Completed"
pin:
number: D2
inverted: true

- platform: gpio
name: "NodeMCU PS4IoT External Power Supply Detector"
pin:
number: D6

- platform: status
name: "NodeMCU PS4IoT Node Status"

sensor:

```

- platform: adc
  pin: A0
  name: "NodeMCU Battery Voltage Level"
  icon: "mdi:sine-wave"
  unit_of_measurement: "V"
  update_interval: 30s
  filters:
    - multiply: 5.0

```

In addition, you must add a synthetic battery voltage rate sensor to the Home Assistant server's general 'configuration.yaml' configuration file:

```

- platform: derivative
  source: sensor.nodemcu_battery_voltage_level
  name: Battery Voltage change per hour
  round: 1
  unit_time: h
  time_window: "00:30:00"

```

The settings will allow you to create the following basic dashboard widget:

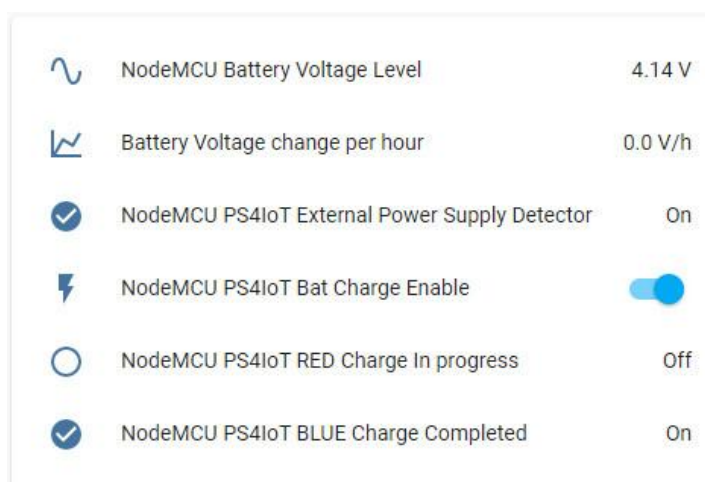


Fig. Basic widget with entities for monitoring and managing the status of the PS4IoT module

General guidelines for software module scripting

	Managed by MCU mode
Step 1 Disable the charger	Set CEset to "disabled" on boot by default
Step 2 Check the battery	Check the ADC readings to see if there is a battery. Note. If you detect the presence of a battery while the charge enable function is on, you will receive false data from the ADC.
Step 3 Manage the charger	If there is a battery, you can:

	<ul style="list-style-type: none">- allow charging at once (via the CEset pin);- allow charging only when the battery charge level has dropped to a critical level (Note. This saves charging cycles and extends battery life.); <p>If the battery is not connected, you do not need to enable the charging permission.</p> <p>Note. In this case you avoid a large number of changes of CC and CP pin states (when the charger is trying to charge the battery) and thus save local or cloud database resources of your server.</p> <p>Also note that when the battery is present, charging is enabled and is fully automatic. Therefore, in most cases you do not need to control charging at all.</p>
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Links

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The charging chip referenced in the document:

FUMAN ELECTRONICS TC4056A 1A Linear lithium ion battery charger	https://datasheetspdf.com/pdf/1309136/FUMANELECTRONICS/TC4056A/1
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From the manufacturer

Dear reader! Thank you for your interest in our products. We hope you enjoy this device as well. "IoT-devices" has been made possible thanks to the support of our Customers, as well as our experience and love for Electronics.

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