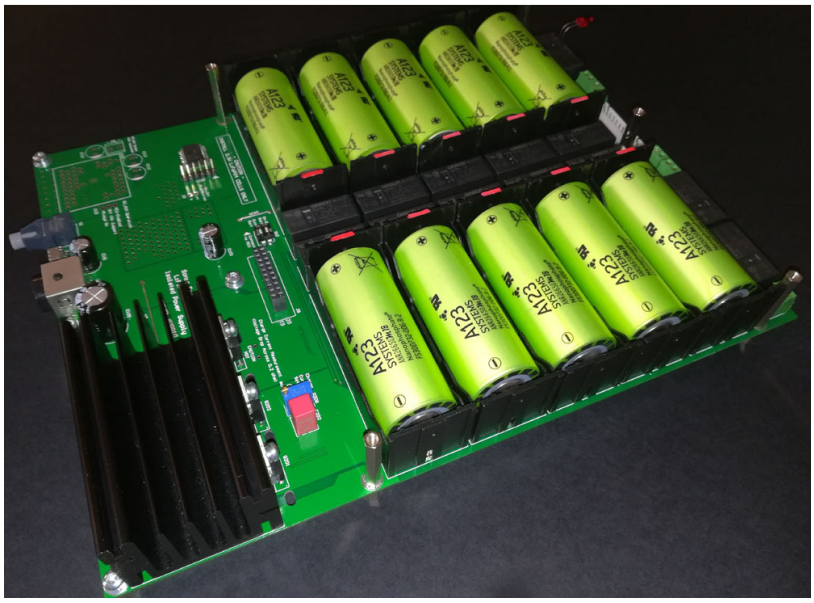
TWRPS-LBS-M LiFePo4 batteries power supply main board



This board is part of the new LiFePo4 batteries power supply system. This is the main board intended to supply oscillators, frequency doublers, FIFO buffer and so on. It provides the control for the whole system.

Features:

Input: PSU and battery charger TWRPS-LBS-P

Output voltage:

- 3V3 to 16V5, typically for oscillators

- 2 x 3V3 to 6V6, typically for DAC

- 3V3, auxiliary devices (for example the clock section of the FIFO)

- 5VDC 500mA linear regulator to supply other devices like USB to I2S and so on

Board size: 260mm x 195mm

Board options: finished and semi-finished

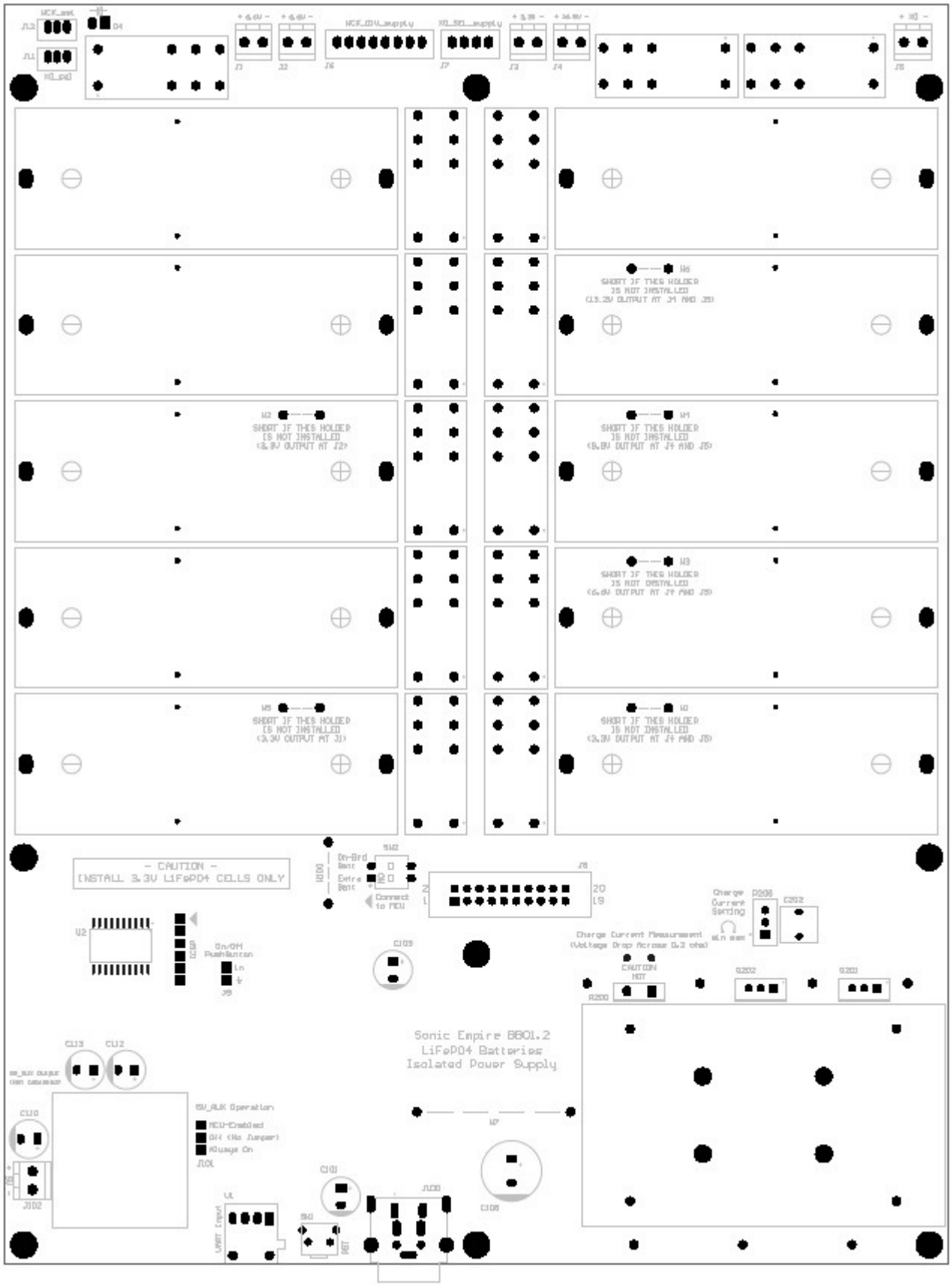
Note: supplied without batteries and battery holders

Remote power off

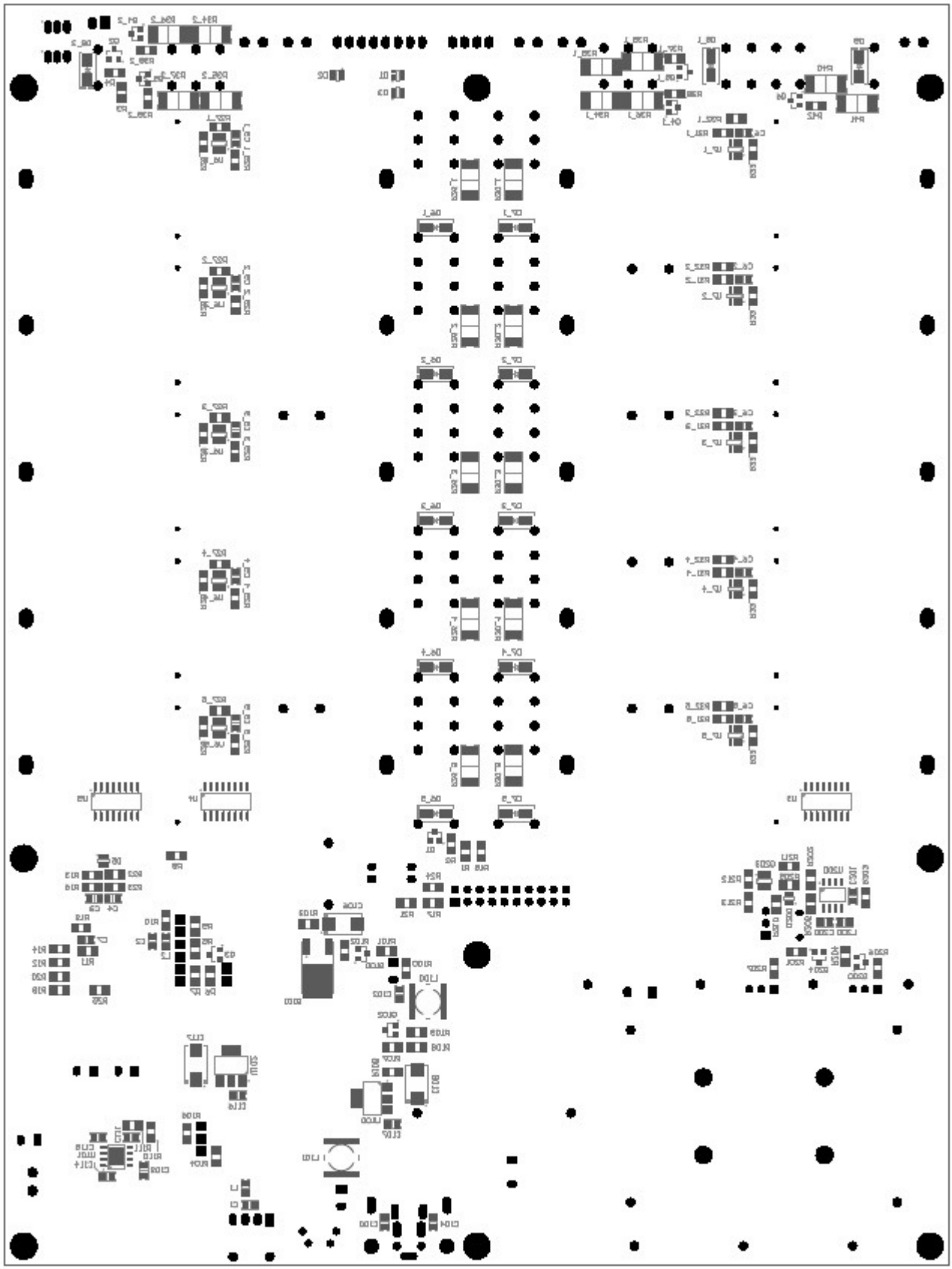
No switching devices or active oscillators during listening

No RF at all (no multiplexed display, microcontroller in stand-by mode during listening)

PCB layout (Top view)



PCB layout (Bottom view)



Connectors and switches

J1: 3V3 or 6V6 output rail depending on the installed batteries.

J2: 3V3 or 6V6 output rail depending on the installed batteries.

J3: 3V3 output rail. It can be used to power the clock section of the TWSAFB-LT FIFO Lite.

J4: 3V3, 6V6, 9V9, 13V2 or 16V5 output rail depending on the installed batteries. It can be used to power the oscillators and the frequency doublers.

J5: same output rail as J4 with 15V backup from linear regulator to power the oscillators during batteries recharge. It can be used instead of J4 to never switch off the oscillators.

J6: Reserved for future use.

J7: Reserved for future use.

J8: 20 pin header to fit the TWRPS-LBS-D daughter board. Install only if the daughter board is in use. Suitable connector is Samtec SSW-110-01-F-D Mouser part 200-SSW11001FD. Provided separately with finished board option.

J9: On-Off function. A push-button or a switch have to be cabled to switch on and off the output rails. It's a good practice to switch off the output rails when the power supply system is not in use to avoid batteries discharging. When the board move in recharging state the output rails are disconnected. Once the system has reached the charged state the push-button connected to J9 has to be pressed to reconnect the output rails.

J10: Reserved (ICSP).

J11: Reserved for future use.

J12: Reserved for future use.

J100: Input power supply for batteries charging and oscillators supply backup. Use a 3 pole cable to connect the output connector installed on the TWRPS-LBS-PSU. The 7V conductor has to be large enough to carry the high current flows from the PSU (3-4 A).

J101: 5VDC auxiliary regulated power supply control (if the ADM7151 regulator has been installed). Use a jumper to select the desired operation: Off (No Jumper) means regulated output disconnected, MCU-Enabled means the regulated output is activated by the MCU when the board is operating, Always On means the 5V regulated output always active.

J102: 5VDC low noise regulated power rail output (if the ADM7151 regulator has been installed).

Charge current measurement test point (close to R200): Use this test point to measure the voltage drop across R200 (0.2 Ohm) in order to calculate the charge current. The current is calculated by the Ohm law I=V/R where V is the measured voltage and R is 0.2 Ohm. For example measuring 0.5V the charge current is 2.5A (0.5V/0.2R=2.5A).

SW1: MCU reset. Use this button to reset the system in case of failure.

SW2: Use the dip-switch to force batteries disconnection from the circuit. Use this function to prevent batteries discharging when the board is not used for long time. The upper switch disconnect the batteries of the TWRPS-LBS-M main board, while the lower switch disconnect the batteries of the TWRPS-LBS-D daughter board. When the switches are in the ON position the batteries are connected to the circuit.

Settings

The only necessary setting is the charge current. The max charge current is around 2.5A.

Turn the trimmer R208 to set the charge current at the desired value using the Charge current measurement test point.

The charge current might be set to the maximum value without any damaging for the batteries. The charge current should be decreased if not all the batteries are installed. As the rule of thumb 250mA for each battery can be used as the reference to set the charge current.

Getting started

Both finished and semi-finished boards are supplied without batteries and battery holders.

A good source for the LiFePo4 batteries is NKON: https://eu.nkon.nl/a123-systems-anr26650m1b-a-grade-3-3v-a-grade.html

CAUTION: INSTALL 3.3V LiFePO4 CELLS ONLY.

Battery holders can be sourced from Aliexpress or eBay.

Suitable battery holders.

The battery holders should be installed if even the cell will be installed. Don't install the battery holders of the unused rails.

Use zip ties to keep the batteries in place.

The rails composed of series of batteries like both 6V6 rails and 16V5 rail can be used to get lower output voltage than the nominal one. For each composed rail to get lower voltage install the battery holders to get the desired output voltage, for example to get 3V3 from one of the 6V6 rails only one batter holder has to be installed. Then in place of the other battery holder install a jumper to connect the output as indicated on the PCB overlay.

CAUTION: DON'T INSTALL BOTH BATTERY HOLDER AND JUMPER IN THE SAME BATTERY REGION TO AVOID SHORT CIRCUIT.

CAUTION: don't install new battery when the other cells are charged and the board is switched on to avoid overvoltage of the batteries that are already charged. Firstly switch off the board, then install the new battery and wait at least 2-3 hours. This way the charged cells yield current to the low new battery balancing the charge of all the cells installed.

There are 2 available options for this board:

- finished boards (fully assembled and tested)

- semi-finished boards (users have to solder a few parts, mostly TH)

The BOM for semi-finished board is available at post #164 on the diyaudio.com thread: The Well Regulated Power Supply.

Notes on semi-finished board

The semi-finished board option needs some parts to be soldered (mostly through hole parts), both on the top and the bottom layer.

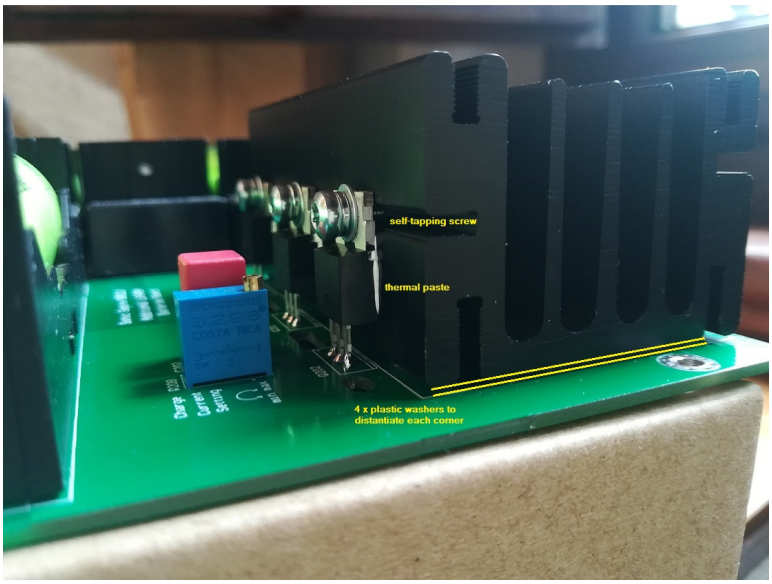
There are a few things to pay the maximum attention:

- be careful installing connectors and polarized parts with the right orientation, the component orientation is clearly visible on the PCB overlay

- pay particular attention to the comparators to be soldered on the bottom layer (part MCP65R41T-1202E/CHY) because the laser marked pin 1 is not well identifiable. If the orientation of the component is not respected the board will not work

- do not install the ADM7151 if the 5 VDC regulated output will be unused

- be careful assembling the heat-sinks and the component attached to them; the heat-sink has to be spaced from the PCB using 4 plastic washers (one for each corner), then they have to be blocked with nuts and bolts, so the parts on the heat-sink should be soldered after the heat-sink has been installed; use thermal paste to improve dissipation between the parts and the heat-sink; use self-tapping screw to block the parts on the heat-sink (be careful when tightening)



Operation

The following threshold voltage levels for the LiFePo4 cells are used to determine the charge of the batteries:

- 2.5V cells under voltage

- 3.28V low cells default voltage

- 3.33V cells minimum operating voltage (allows power-on during recharge)

- 3.55V end-of-charge voltage

- 3.8V cells overvoltage (abnormal)

During fault condition or recharge power-on commands are not allowed so they are ignored.

When an overload situation is detected the proper error condition is forced.

Low batteries detection forces off state of the device (output rails disconnected). Device On/Off condition received through the on/off pushbutton is evaluated. If the voltage of the cells is equal or greater than 3.33V threshold the power-on during recharge function is allowed.

If the batteries are deeply low conditioning charge is tried. Output rails are disconnected.

If the batteries are normally low they are recharged. Output rails are disconnected.

When the batteries are fully charged the recharge state is stopped and the output rails are ready to be activated by the On/Off push button.

When low batteries condition is detected the system force the recharge state and the output rails are deactivated.

If an overload condition is detected the batteries are straightaway disconnected and the auxiliary regulator is shutdown.

If recharge time is excessive or batteries are in overvoltage condition the proper fault state is activated and the output rails are disconnected. This means that at least one cell is defective and has to be replaced.

When batteries settling time has expired the system waits for a power on command via the On/Off button. If the power on command is not detected the system enters a suspend state.

In case of an early exit from the recharge process (power on during recharge) the recharge state is resumed at power off.

Power on sequence:

- output rails go disconnected

- auxiliary regulator goes disabled

- output current is checked

- fault condition is evaluated

- low batteries detection is activated

- if all the controls are passed the output rails are enabled

Power off sequence:

- auxiliary regulator goes enabled

- output rails are disconnected

- batteries level is measured

Status indicator (LED D4)

The led D4 should remain visible because it's used to indicate the operation and the failure of the board.

It indicates the actual function of the board and the error in case of failure as in the following list:

fast blinks: push button detection (push button can be bi-stable and mono-stable)

double speed dimmer: ready level during recharge is reached (power on allowed)

3 times blink: battery fault (output rails disconnected, On/Off detection disabled)

4 times blink: load fault (output rails disconnected, On/Off detection disabled)

2 times blink: pre-charge state

normal speed dimmer: fast charge

continuous dimmer: batteries settling

off: the system is powered off

on: the system is correctly operating