
10AH 100AH Battery Charging Circuit (1A-10A Adjustable)

The classic rectifier has two basic drawbacks. First of all, there is no protection against overcharging, and even if you watch over it during charging, you can't tell from the indications of the 1. ampmeter itself that it's time to stop charging. On the other hand, charging up to gassing the electrolyte is a deliberate overcharge.

The second disadvantage: the lack of regulation of the charging current. The charging current should not exceed the permissible value for the respective battery, which depends on its capacity. Charging with excessive current can irreversibly damage the plates (cells) from which the battery is built. Exceeding the permissible voltage or current adversely affects the performance and life of the battery. The presented system allows you to remove both of the described defects, its basic parameters are:

1. Charging Lead Batteries

12V, with a capacity of 10...100Ah,

- 2. regulation of the charging current in the range of approx. 1...10A,*
- 3. overcharge protection,*
- 4. multi-stage charging process,*
- 5. Power supply: 17VAC transformer or pro-st.*

It is worth noting that it can be an automatic device, like the model shown in the photographs, but it can also be an attachment to a simple, classic product. In both cases, we get an automatic charger. An additional option is to use it as an attachment for a switched-mode power supply – details at the end of the article.

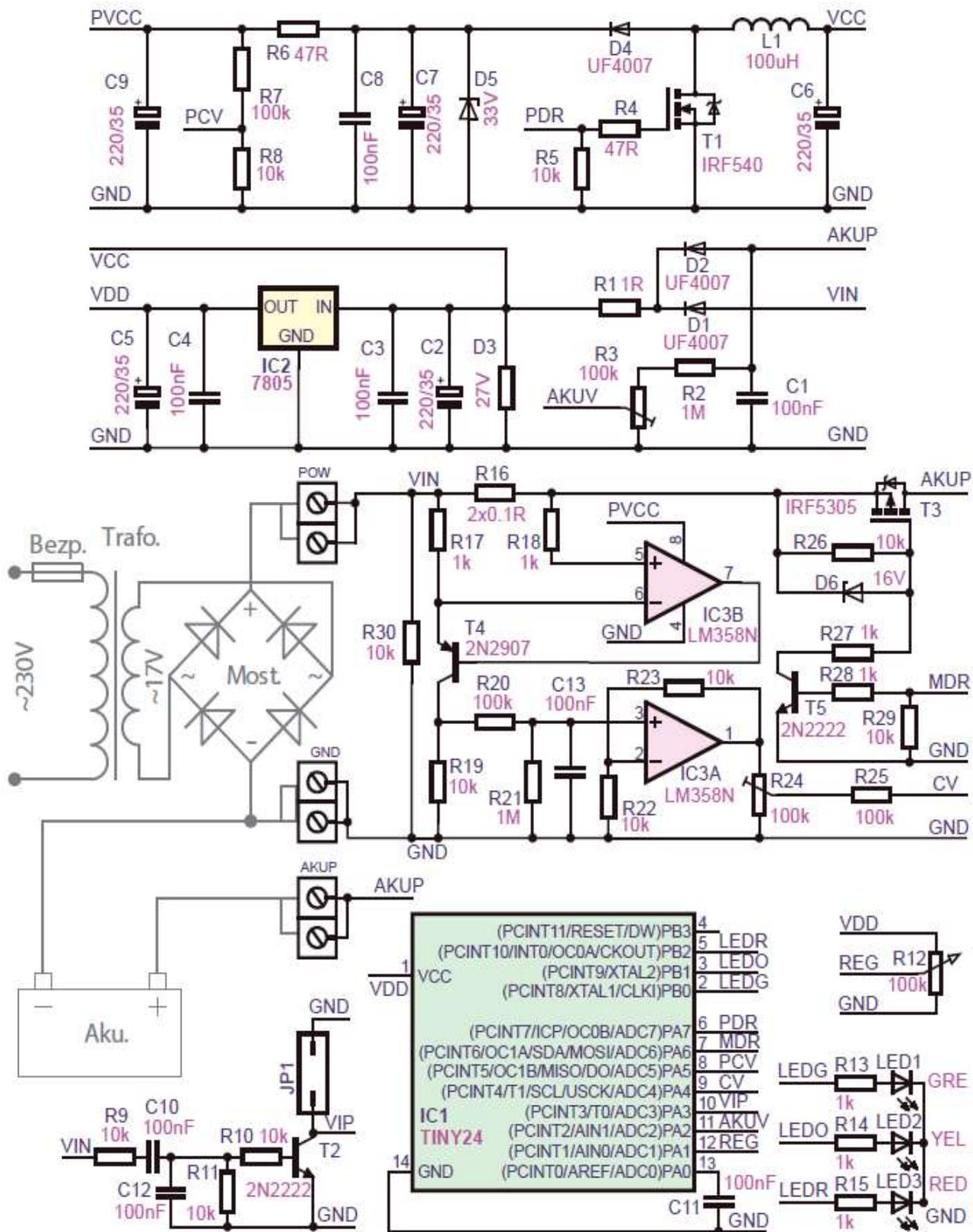
System description

The diagram is shown in the **figure**

1. It can be divided into several blocks.

Current measurement block – built with LM358 chip (IC3A, IC3B). The positive output from the rectifier is led to the POW terminal and goes to the R16 measuring shunt consisting of two low-resistance power resistors. The IC3B op-amp, together with the T4 transistor and adjacent components, form a current-to-voltage converter. At its output there is a filter made of R20, C13 elements and an IC3A amplifier. The output signal is calibrated using the R24 precision potentiometer and goes to the microcontroller – the signal marked CV.

1. Power stage – built on T3 and T5 transistors. The T3 is used to control the voltage/current applied to the battery. The T5 transistor and its adjacent components allow the MOSFET to be controlled directly from the microcontroller's pin.
2. Voltage converter block – L1, T1, D4 components. It is a classic step-up converter, at the output (signal marked PVCC) it obtains a voltage of approx. 29V, which is necessary for the proper operation of the current measurement block. Adjacent components are used to stabilize and filter the output voltage.
3. Power block – IC2 stabilizer and adjacent components. The task of the



is to obtain and filter a voltage in the range from 10V to maximum 26V, which is taken via diodes D1 and D2 from the battery or rectifier. Then, through the IC2 stabilizer, the 5V voltage needed to power the microcontroller is obtained. Precision potentiometer R3 and resistor R2 create a divider for reading the battery voltage. The potentiometer allows you to calibrate the reading.

5. **AC voltage sensor block** - made using transistor T2 and adjacent elements. The task is to detect the sine wave by superimposed on the battery's constant voltage f , which will be discussed in detail later.

6. **Steering block** - potentiometer R12 is used to set the charging current, LED diodes signal the system status and the microcontroller controls part of the process. However, the most important element of the system was not included in the diagram, and it is the program contained in the microcontroller memory. The tasks it performs are: controlling the operation of the boost converter ~ maintaining a constant output voltage value, reading all analog values, regulating the charging current value and switching the stages of the charging process.

The charging current is controlled by the phase control method used in thyristors and triacs, including; difference, i.e. without thyristor or triac, but with a MOSFET transistor with a P channel. This solution simplified the system and reduced energy losses on the executive element. The waveforms in the system are shown in Figure 2. Waveform A is the rectifier output, B is the superimposed rectifier output and battery DC voltage (V_{IN} in the diagram), Waveform C is the waveform at the output of the AC voltage sensor (VIP in the diagram) - it precisely determines the time in which the voltage waveform from the rectifier exceeds the battery voltage and charging current is possible, the falling edge marks the beginning of the phase regulation period. Waveform D is a signal controlling the power level (MDR in the diagram), the greater the fill, the larger part of waveform B will be fed to the battery - waveform E (AKUP in the diagram).

Waveform F is the output from the current-voltage converter block (CV in the diagram). The charging process is divided into several stages selected depending on the battery's charge level, i.e. the voltage on its terminals. Figure 3 shows the complete process.

The symbols at point A are the charging stages, graph B is the charging current values, graph C is the voltage waveform on the battery, and the symbols at point D are the method of signaling on the LED diodes.

Stage 0 - no battery. If the rectifier is switched on, the system signals this stage by the constant illumination of the red diode. The power stage is turned off, there is no voltage at the output terminals, so there is no risk of a terminal short circuit, this state lasts until the output appears

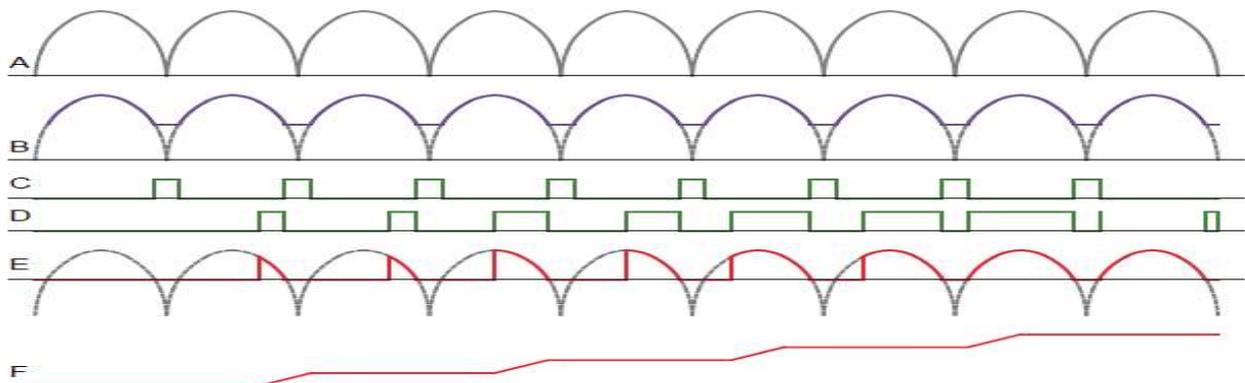


Figure 2

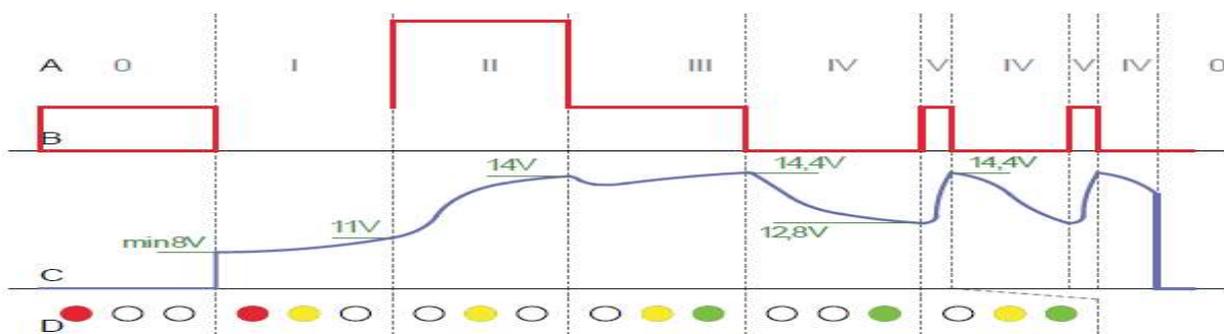


Figure 3

voltage of at least 8V.

Stage I - Pre-loading. When a battery with a voltage not exceeding 11V is connected to the output terminals, it means that it is in a state of deep discharge. Such a battery connected to a regular rectifier can force a very high current due to the significant voltage difference. In such a case, the presented system reduces the charging current to 1/3 of the set range and waits until the battery partially regenerates - the voltage exceeds 11V

Stage II - basic charging. At this stage, the charging current reaches the full set value, but unlike a classic rectifier, it does not decrease as the charge level increases, but is kept at a constant level, thus shortening the charging time. The stage continues until the voltage reaches 14V. Here it was important to pay attention to the method of measuring the voltage, which is different than in the other stages - charging takes place cyclically, each cycle takes about half a minute of charging, and then a short break, charging stops - and at this moment the battery voltage is measured.

Thanks to this, the measurement is not burdened with errors resulting from voltage drops on the connecting cables.

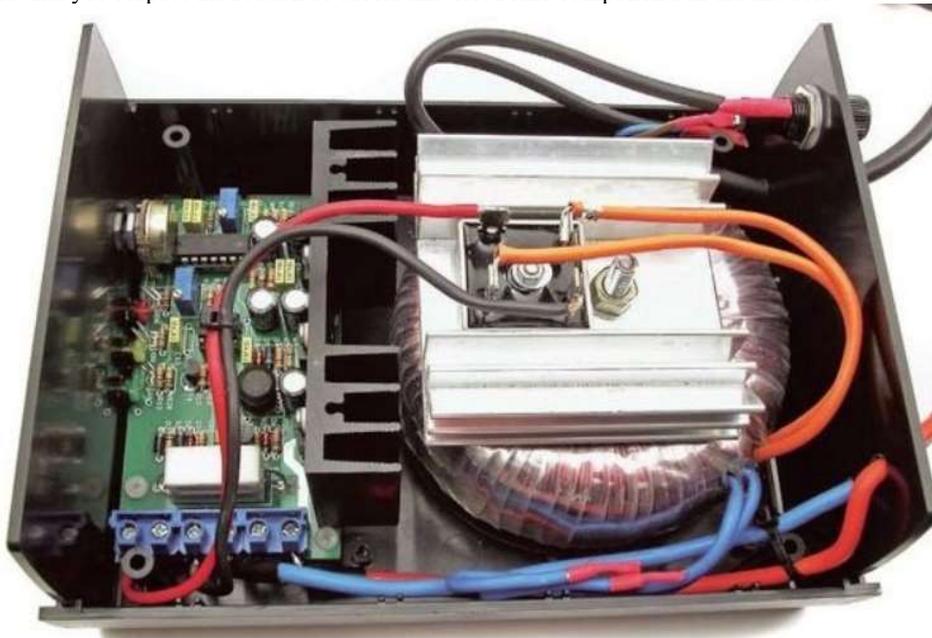
Stage III - final landing. When the voltage exceeds 14V, the charging current is reduced to 1/3 of the set value. Charging with a lower current allows the battery to be "saturated" with energy and allows for a more precise determination of the termination point. At first, the battery will respond with a sudden drop in voltage, as seen in Figure 3, but then it will slowly reach the maximum value of 14.4V.

Stage IV - loading completed. When the green LED is lit, the charging process is finished and the battery is fully charged and ready for use. The voltage on the battery drops quickly to about 13V, and then more slowly to about 12.6V, so you should not expect that after charging is finished, you will measure a voltage of 4.4V on it. If the battery remains connected to the presented charger, its voltage will be constantly monitored and when it drops to approximately 12.8V, an additional stage will be activated.

Stage V - conservation loading. As for final charging, the charging current is 1/3 of the set value and the final voltage is 14.4V. This step is intended to keep the battery charged if it remains connected, even long after charging has finished. When we connect the battery to the system and the power supply to the system is disconnected (rectifier turned off), the LEDs will indicate the battery status in the same way as during charging, with the difference that the LEDs will flash. The system measures the charging current and if it does not reach the minimum value, it signals it like this. The same thing will happen when, for example, the 230VAC mains voltage disappears during charging, flashing LEDs will signal this emergency condition. Please remember that the device then draws power from the battery and discharges it with a small current.

Installation and commissioning

The system was designed and built on a double-sided board using the through-hole assembly technique. The rest is all clear as the photo below. It is recommended that you respect the section of cables and electronic components in the list below.





Electronic Components List

List of items	
R1	1Ω
R2	1MΩ
R3, R24	pot. prec. 100kΩ
R4, R647Ω
R5, R8, R9, R10, R11	10kΩ
R7, R20, R25	100kΩ
R12	pot. 100kΩ
R13, R14, R15, R17, R18, R27, R28	1kΩ
R16	2 x 0.1Ω 5W
R19, R22, R23, R26, R29, R30	10kΩ
R21	assembly
C1, C3, C4, C8, C10, C12, C13	100nF MKT
C2, C5, C6, C7, C9	uF/35V
C11	100nF
L1	100uH, 0,5A
D1, D2, D4,	UF4007
D3	Zener diode 27V
D5	Zener diode 33V
D6	Zener diode 16V
LED1-3	LED 5mm, R, Y, G
T1	IRF540 or similar
T3	IRF5305 or similar
T2, T5	2N2222
T4	2N2907
IC1	ATTINY24 programmed
IC2	7805
IC3	LM358
JP1	goldpin 1x2 + jumper
	Rectifier bridge min. 15A
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