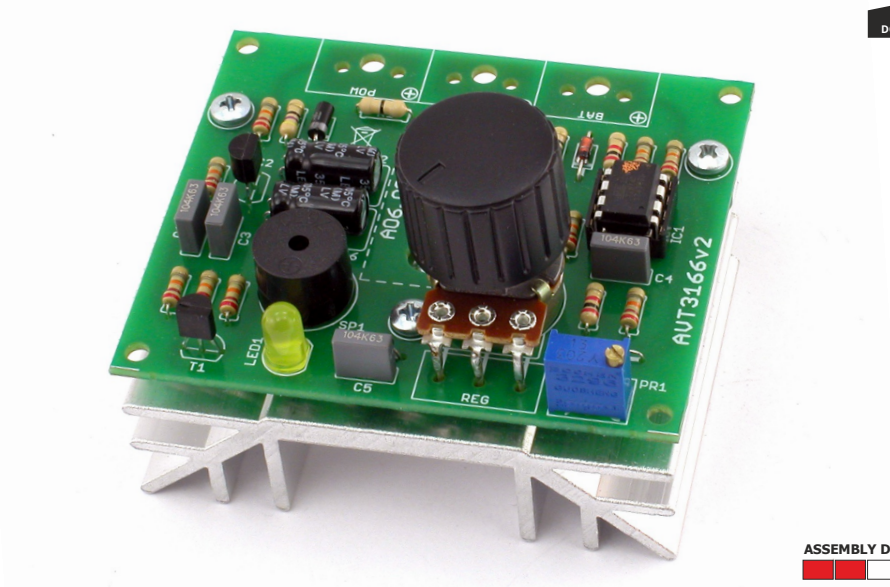
Rectifier Controller

PDF DOWNLOAD

AVT 3166



ASSEMBLY DIFFICULTY

This module is an extension for simple factory rectifiers, which allows automation of charging process. Its basic functions are: charge current control, wrong polarity indication and protection against overcharging.

The set is based on a project of the same title published in Electronics for All 11/2016
Full version of the original manual can be downloaded here:
http://bit.ly/2O8a4VH

Features

- adjustable charging current up to ca. 10 A
- automatic charging termination
- charging status indication with LED
- short circuit and reverse polarity protection
- can operate as an extension to a rectifier
- power supply - transformer 100-200 W / 16-18 VAC
- suitable for charging batteries up to approx. 100 Ah

Circuit description

The controller should be regarded as a rectifier extension. Primary function of this device is regulation of the charging current. Control is performed using a method similar to phase control. This solution ensures much lower power losses and easier and more flexible control. The sinusoidal waveform, rectified, is fed to the actuating transistor, the transistor is opened when the voltage waveform passes zero, so that the current builds up smoothly - along with the sinusoidal waveform. Timing of the transistor's closure is adjustable; the later this occurs, the more of the waveform will be passed through and more current will flow as a result. The circuit described is not a current stabiliser, it will not keep the current value constant. Instead, it allows limiting the initial current value, which is in fact a maximum value, because during charging the current value decreases as the battery charge increases. In the final stage, the charging current may be much lower than at the beginning.
This prolongs the time needed for a full charge but allows for a more precise timing of completion.
The second important function of this circuit is to control the battery voltage. For the most accurate result, the measurement is performed with the executive transistor closed. Such a measurement cycle is triggered once every 200 supply voltage half-periods, i.e. every approx. 2 seconds, and then no charging current flows (for approx. 10 ms). Measurement result is not affected by charging current or voltage pulsing, or even by the resistance of the wires and connections. If the measured voltage has reached 14.4 V, charging is interrupted, and when the voltage drops, charging resumes. At the end of charging, such a cycle will be repeated many times because even a fully charged battery will not maintain a voltage of 14.4 V at its

terminals. Voltage quite quickly drops to a value of around 13 V and should then stabilise around 12.6 V. Current charge level is indicated by the LED. The LED flashes at a frequency of approx. once every 2s, with the fill depending on the battery charge. At voltages up to about 11 V, the LED flashes at a fill of about 5%, the higher the voltage, the longer the diode will be on at each cycle, up to a voltage of 14.4 V, when the diode will be steadily on. In practice - even when the battery is charged, the LED may flash from time to time as the voltage value on the battery drops. This will be the stage of what is known as maintenance charging. An additional function of the device is short-circuit protection. This function is that as long as there is no voltage at the output terminals of the circuit (no battery connected), charging will not be switched on. Only the voltage of min. 9 V (from the battery) will enable charging. State of the output terminals is checked in each half-period of the supply voltage waveform, just before the transistor is switched on, so even accidentally disconnecting the leads from the battery and short-circuiting them will not damage the circuit. The last function of the device is to signal incorrect polarity of the connected battery. If the battery is connected inversely to the output terminals, the buzzer sounds immediately. For safety reasons, connect the battery when the rectifier supply is off and if there is no audible indication, you can connect the rectifier supply.

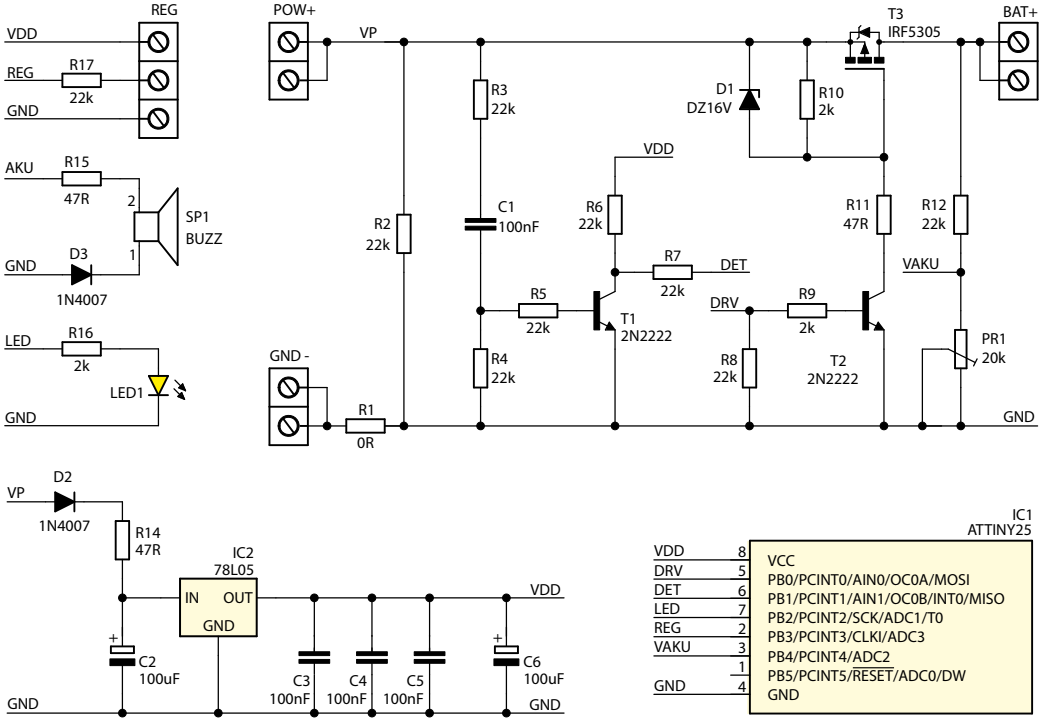


Fig. 1. Schematic diagram

Schematic of the circuit including the rectifier components is presented in Figure 1. Transistor T1, together with its adjoining components, is a detector of the passage of the voltage waveform through zero. Transistor T2, together with its adjoining components, works as a driver for executive transistor T3. Positive 5V pulses from the microcontroller output are converted into ground pulses and open the executive transistor T3, while resistor R10 causes its closure at the end of the pulse. Too high an amplitude of the control waveform could cause damage to the gate circuit of the MOSFET transistor, which is why Zener diode D1 was used. The other components of the circuit are a power supply block based on IC2 - 78L05, microcontroller IC1 with a control programme in memory, a reverse polarity battery indication circuit - elements R15, SP1 and D3, a REG connector for connecting a potentiometer, and a voltage measurement block - an adjustable resistive divider from elements R12 and PR1.

Mounting and start-up

The circuit is mounted on the board shown in Figure 2 and Photo 1. Mount the circuit according to general principles. Exposed tracks on the board should be additionally tinned. Mount the executive transistor on the underside of the board so that its heat sink insert faces outwards and the mounting hole matches the hole on the board, but it should not adhere to the board. Attach the heat sink using three screws and additional spacers. Finally, screw the transistor to the heat sink using a washer and insulating sleeve. Photo 2 shows how the transistor and heat sink are mounted. Connect the potentiometer with a short length of silver or a 3-wire cable. Once the circuit has been assembled and checked, mount the preprogramed microcontroller in the socket. Now, you can connect the transformer and, if everything has been done correctly, the LED will flash cyclically to indicate that the circuit is working.

Note: the LED will not flash if the circuit is supplied with DC voltage - e.g., from the battery only.

Finally, the circuit requires a simple adjustment - set the charge termination voltage. To do this, the control of the executive transistor must be disconnected - the easiest way is to remove the microcontroller from its socket and bend pin 5 so that when the microcontroller is inserted into the socket, the pin "hangs in the air" - Photo 3. Now, connect the power supply from the transformer via a rectifier bridge (Figure 3) or the rectifier and connect a regulated power supply with a set voltage of 14.4 V to the output. The adjustment is performed by setting such state that the LED is steadily on, but it is also just near the flashing limit. When completed, disconnect everything and mount typically the microcontroller in the socket.

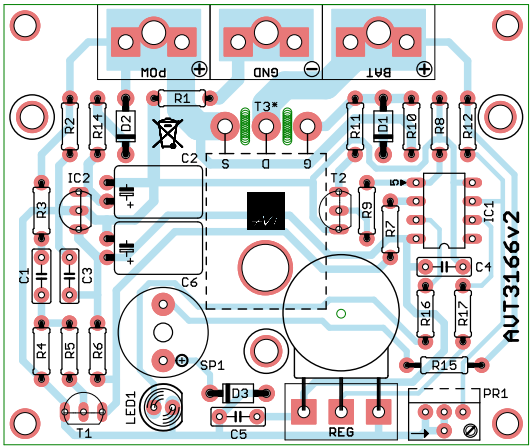
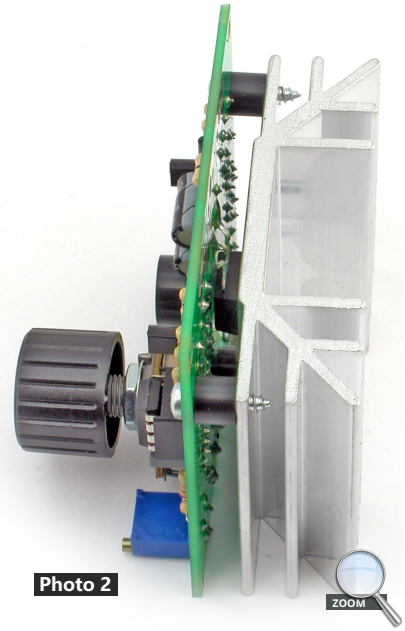
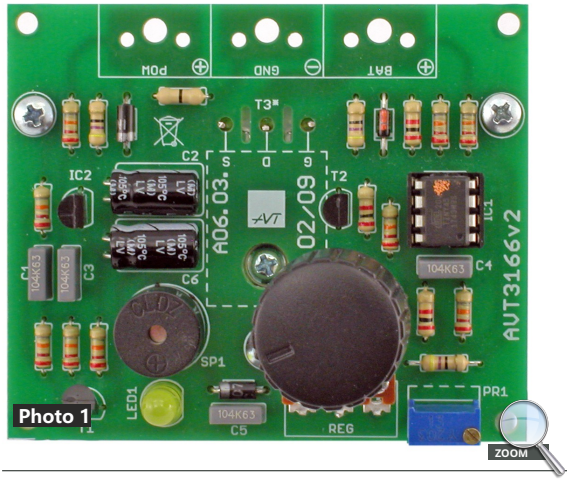
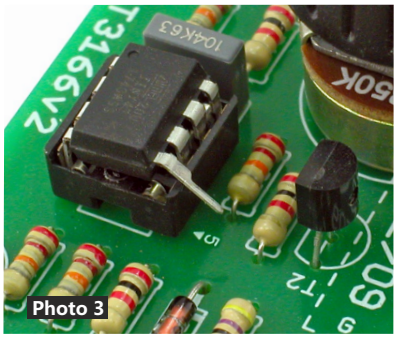


Fig. 2. Arrangement of components on the PCB







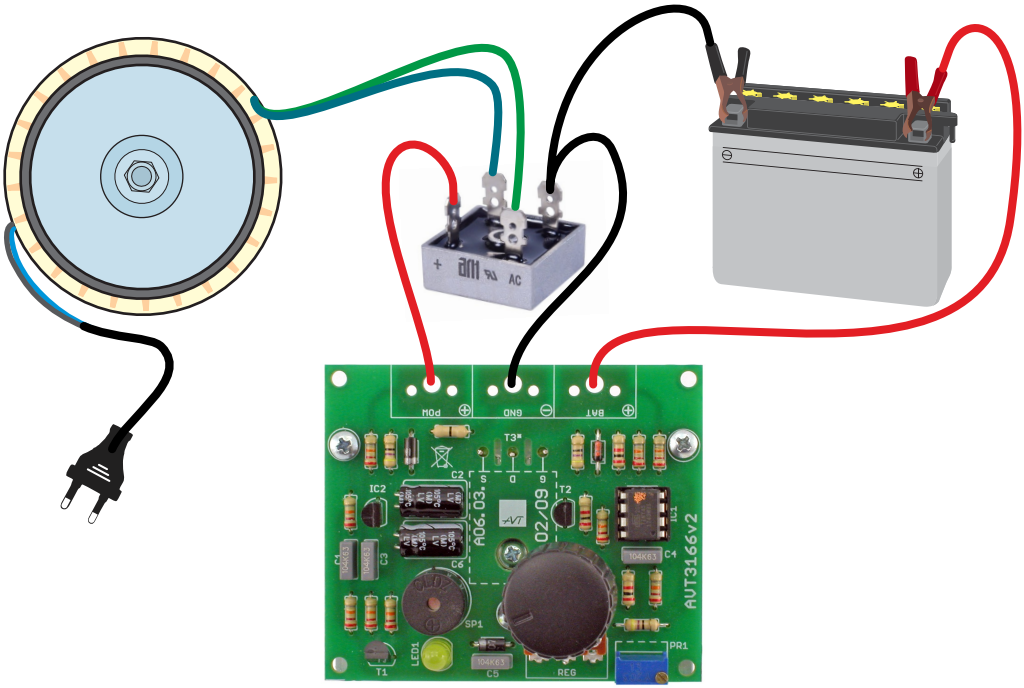


Fig. 3. Example of connection

List of elements

Resistors:
R1: .....0 Ω (black)
R2-R8, R12, R17:.....22 kΩ (red-red-orange)
R9, R10, R16:.....2k Ω (red-black-red)
R11, R14, R15: .....47 Ω (yellow-violet-black)
PR1:.....Precision potentiometer 20 kΩ
REG: .....Potentiometer 50 kΩ
Capacitors:
C1, C3, C4, C5:.....100 nF
C2, C6:.....100 uF / 35 V
Semiconductors:
D1:.....Zener diode 16 V
D2, D3:.....1N4007
D4:.....LED 5mm
T1, T2:.....2N2222
T3:.....IRF5305
IC1:.....Attiny25
IC2:.....78L05
Other:
SP1:.....Buzzer with 12V generator
Spacer sleeves 3/7mm × 2pcs
Spacer sleeve 3/6mm × 1pcs
Screws 2.9/13mm × 3pcs
Screw 2.9/9.5mm × 1pc
Washer and insulating sleeve for TO220 housing
Heat sink e.g. type 4463
Knob for potentiometer

AVT SPV Sp. z o.o.
Leszczynowa 11 Street,
03-197 Warsaw, Poland
https://sklep.avt.pl/

This symbol means do not dispose of your product with your other household waste. Instead, you should protect human health and the environment by handing over your waste equipment to a designated collection point for the recycling of waste electrical and electronic equipment.