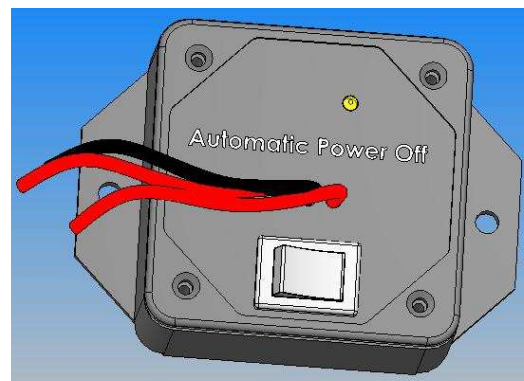


# APO2: Automatic Power Off

A product of  
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## **Introduction & a note to Winona Amateur Radio Club members:**

Congratulations, you are a beta tester! Walt Kelly, KE0XI, came to me asking if I could provide a project for the club that would protect batteries from being over discharged. I described to him a device that I had already designed that would accomplish it. We decided on some slight changes and then Walt asked me to have a project ready in just over four weeks! Going from a one-off prototype to custom circuit boards, milled cases, and documentation is a lot of work for such a short period of time.

Long story short, there are a few errors on the circuit board and probably in this manual. I'll try to point out these problems, but do understand if I've overlooked something.

73's,

-Jim KB0THN

## Parts supplied:

Before you start assembling your APO2 please check to make sure that all of the parts are included. If you find any parts missing please contact me immediately and I will rush you a replacement along with my apologies.

### Electrical Parts

Designator	Quantity	Description
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C1	1	100uF capacitor
D1	1	Yellow T1 LED
F1	1	PTC fuse device (yellow package)
JP1	1	2 pin 0.1" header (white plastic base)
R1	1	22k resistor (red-red-orange)
R2, R4	2	10k resistor (brown-black-orange)
R3	1	220 ohm resistor (red-red-brown)
SW1	1	Rocker switch
U2	1	LM78L05 voltage regulator (TO-92 case)
U3	1	IPS5451
U3	1	PIC12F675 (8 pin DIP)

### Mechanical Parts

Quantity	Description
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1	8 pin DIP socket
1	black case body
1	black case covered with 5 milled holes
1	Black, 16 or 18 gauge wire pigtail
1	Printed circuit board
1	Shorting jumper
2	Red, 16 or 18 gauge wire pigtail
2	Yellow 24 gauge jumpers
4	Black, #4 thread forming screw
4	thread forming #4 screws, 0.25"

## Tools needed:

You will need a low wattage soldering iron with a fine tip, small solder, a small diagonal cutters, and a Phillips (+) screwdriver.

## **Assembling the circuit board:**

You will find that there are three parts already installed on the circuit board. They are the 8 pin DIP socket, a 10k resistor, and the IPS5451 surface mount device. The surface mount part was installed to make assembly easier for you, and the other two parts were specially installed to fix small errors on the printed circuit board.

You should install the components in the order below. After installing each component use your diagonal cutters to trim the leads on the solder side of the board.

Resistors, R1 through R4. Resistors are not polarized, so install them either direction.

PTC Fuse, F1. The fuse is not polarized, so install it either direction.

Electrolytic capacitor, C1. The capacitor is polarized. On the board there is a + marking. Put the positive lead (without the stripe above it) in this hole. Make sure the capacitor is tight up against the board and then solder it down.

Voltage regulator, U2. The silkscreen legend on the board is misprinted. The curved side of the package should face the capacitor. Be careful not to bridge the pins with solder.

Header, JP1. The header is a two pin connector with a white plastic body. It is not polarized, so insert it into the position marked JP1 either direction. After putting the red shorting pin over the jumper, hold the header tight up against the board and solder it down. Note that there are two footprints marked JP1 on the white solder mask on the PCB. Ignore the footprint that is crossed out and instead use the one closer to the copyright text.

LED, D1. The LED is tricky to install because it should be elevated far enough away from the board so it is flush with the top cover of the case. Once this height is determined then you must orient the LED the right direction, since it is polarized. Looking through the side of the LED you'll see one side of the internals is larger than the other. The small side inside the LED should go into the square pad on the printed circuit board. This was the pin that was longer before you cut it to length!

Big wires, red and black. You should install a large red wire in the large pad marked "In" and one in the large pad marked out. Be sure to use enough heat to have solder flow evenly around the wires. Also make sure that the red wire jumper attached to the top of the "In" pad stays attached. A black wire should be installed in the pad marked Ground.

Little wires, yellow. You will need to cut the supplied yellow wire in half and to strip the ends to make two jumpers. These wires are soldered to the pads marked SW1 and the other ends are left unconnected now. Later they will be soldered to the rocker switch.

## **Case assembly:**

After the printed circuit board is built you should use the #4 thread forming screws to secure the printed circuit board to the plastic case.

The rocker switch should be inserted in the case cover. It is a tight fit, so you may need to press hard. The yellow wires should be solder to the switch terminals. It is important that these wires be parallel to the switch body so that the assembly is as low profile as possible.

The three wires should be inserted through the 1/8" holes in the case cover. The "In" wire should go in the (from the top) left most hole, the Ground wire in the middle hole, and the Out wire in the remaining hole.

The case cover should be attached to the case using the four black thread forming screws. Be careful not to allow the big wires to bunch underneath the cover.

After the case is assembled you should apply the self-adhesive labels to case. The smaller label should be stuck to the side of the case and the larger label should be installed on the cover of the case between the LED and the wires.

## **Operation:**

The APO2 is designed to disconnect a DC load if the input voltage goes below a pre-defined threshold. You can configure your APO2 for a 12.1 volt threshold voltage by installing the red shorting jumper on the JP1, or a 13.05 volt threshold by removing the red shorting jumper.

The 12.1 volt option is designed to be used for battery protection. If a battery is discharged lower than this voltage permanent battery damage may occur. The 13.05 volt option is designed for use in vehicles to turn off a load (radio) once the vehicle is turned off. In either case there is a 15 minute delay between when the voltage goes below the set threshold and when the load is turned off. If the rocker switch is in the position marked "1" the APO2 will never disconnect the load.

The yellow LED is used to indicate the status of the APO2. It will flash for 4 seconds when power is first connected to the APO2. After that the yellow LED will be lit to indicate that the input voltage is below the threshold and that the shutdown countdown is in progress (unless overridden by the switch).

The APO2 can switch up to 35 amps at 13.8 volts. The APO2 is protected against reverse hookup and excessive current. The device draws less than 10 milliamps quiescent current. It is designed to be hooked in series with the load.

