TEMPERATURE CONTROLLED BATTERY CHARGER

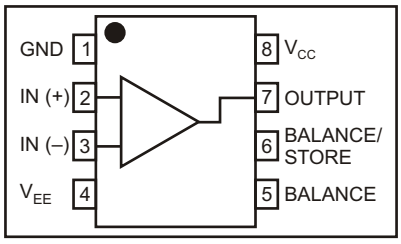
EM
N. SHARMA
TESTED

Narendra Sharma

Here is a circuit of a temperature controlled constant current battery charger. It works with NICD, NIMH, and other rechargeable cells. The circuit works on the principle that most rechargeable batteries show an increase in temperature when the cells becomes fully charged. Overcharging is one of the main causes of short cell life, hot cells pop their internal seals and vent out electrolyte. As cells dry out, they lose capacity.

The transformer X1, the bridge rectifier D1-D4, and capacitor C1 provide DC power to run the circuit. The IC1, 7812 regulator drops this to 12V to run the IC3 LM311 voltage comparator and IC4 4011 nand gates.

The switch S1 is pressed to start the charging cycle. This causes the two 4011 nand gates, which are wired as an R-S flip-flop, to go into the charging mode. The LED2 is lit, and the MOSFET current switch is turned on. Charging



Schematic and Pin assignment of IC LM311

current runs though the battery pack. If the battery pack is warmer than the reference temperature, the circuit will not switch into charging mode. Let the pack cool down. When the battery pack reaches a full state of charge, the differential temperature sensor causes the flip-flop to switch off, turning off the MOSFET current switch, and lighting the LED1.

The IC2 is wired as a constant current regulator. This provides a safe maximum charge current for a number of through the battery pack after the bulk different cell types. The R8 resistor across the MOSFET sets the trickle charge current which flows through the battery pack after the bulk charging is finished.

The diode D5 prevents the pack from discharging if the AC power is turned off.

The resistor R4, diode D6, and capacitor C6 around the S1 cause the circuit to auto-start when power is first applied.

The differential temperature sensor circuit works by presenting two voltages to the input of the LM311 comparator. The comparator output switches on or off depending on which input is at a higher voltage than the other. As the thermistors warm up, their resistance drops, lowering the associated comparator input. Since there are two sensors, the room temperature can vary and the circuit will only react to the difference in temperature between the sensors.

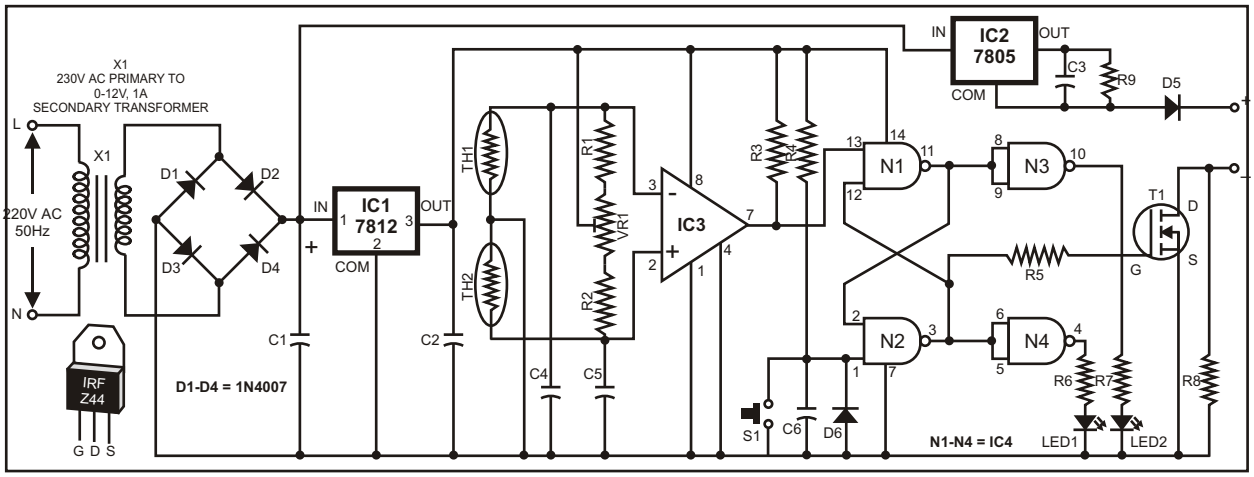


Fig. 1: Circuit diagram of the Automatic Light Switch.

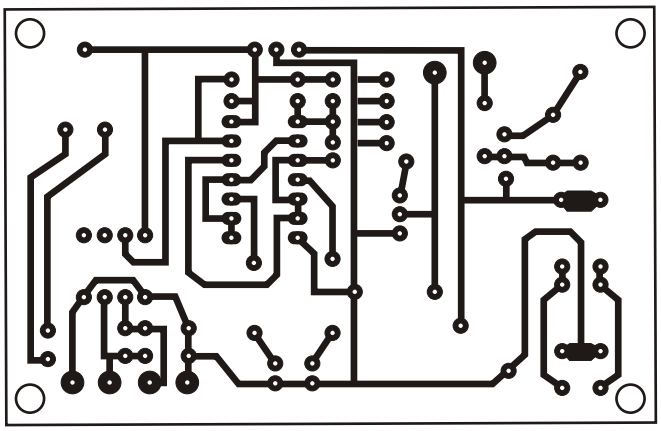


Fig. 2: Actual - size, solder-side PCB layout.

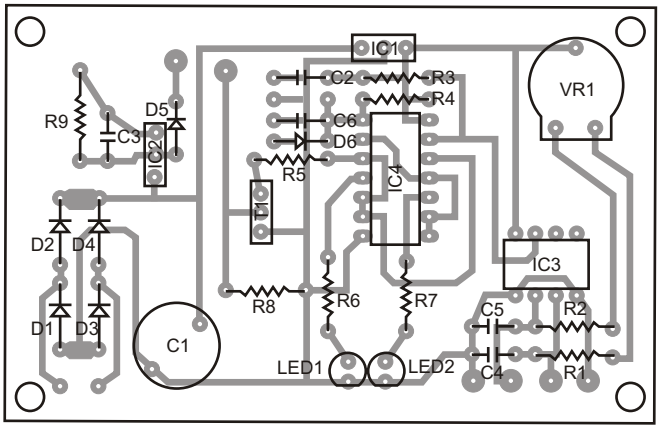


Fig. 3: Component layout for the PCB.

SEMICONDUCTORS

IC1	7812, 12V Regulator
IC2	7805, 5V Regulator
IC3	LM311, Voltage Comparator
IC4	CD4011, Quad 2-input NAND Gate
T1	IRF Z44, MOSFET
D1-D5	1N4007, Rectifier Diode
D6	1N4148, Switching Diode
LED1	Green LED
LED2	Red LED

RESISTORS

R1,R2	3.9k
R3,R4	10k
R5	150
R6,R7	820
R8	470
R9	18 2W
VR1	2K Preset
TH1,TH2	5K, NTC

CAPACITORS

C1	1000µF/25V
C2-C6	0.1µF

MISCELLANEOUS

S1	Push-to-on Switch
X1	230V AC Primary to 0-12V, 1A Secondary Transformer

Construction

Parts placement is non critical with the exception of the thermistors which should be fixed to separate aluminum plates and connected to the main circuitry via a cable with two wires and a shield. The IC2 should be mounted on a heat sink.

Be sure to thermally separate the battery and sensors from the other electronics so the heat from the circuitry doesn't affect the sensors. Fix the both thermistors to separate aluminum sheets and set the battery sensor on top of the pack being charged. It is important to make sure the batteries have a decent thermal contact to the sensor.

Adjustment

Allow the two temperature sensor plates to reach the same temperature, place a voltmeter across the IC3's pins 2 and 3. Adjust the VR1 for a reading of -0.025 volts on the meter. Press the S1 and make sure the LED2 lights. Warm the battery temperature plate up and observe that the LED1 light comes on.

Use

- Connect a rechargeable battery pack to the charger "+" and "-" connectors. The pack may need to cool down to the ambient temperature before charging.
- Place the "battery temperature" sensor under the battery pack and hold it in place with a rubber band or a heavy object.
- Place the "reference temperature" sensor in a location that is not too close to the charger, the battery, or any other source of heat.
- Press the S1, observe that the LED2 lights. Note: if the battery was recently discharged at a high rate, or it was moved from a warmer place, it may be warmer than the ambient temperature sensor and the circuit won't go into charging mode. Let the battery cool down to ambient temperature, or temporarily warm up the reference sensor if you are in a hurry.
- Note that some cells in a series string will always be first to get warm. After several cycles it would be a good idea to leave the pack on the charger for a few hours to trickle charge the lower cells up to a full state of charge. This process is called "equalizing" the pack. It is also possible to press the S1 again, the weak cells will get more charge for a while, then the full cells will warm up and turn of the current.

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